Lexicon of Geologic Names of Kansas (through 1995)

D. L. Baars and Christopher G. Maples, editors

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A Compilation of the Geologic Names of Kansas

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Preface

Stratigraphy is interpretive as well as observational; only rarely are full stratigraphic relations exposed in three-dimensional outcrops. As concepts of our science evolve, so do consequent interpretations of rock correlation. In today's re-adoption of event or sequence stratigraphic ideas, global correlation through recognition of common geological events is possible. Kansas is blessed with fine exposures of sedimentary rock formed during a time of tectonic activity and glaciation that affected much of the earth. These Pennsylvanian deposits have long been a standard reference for ideas about cyclic sedimentation. Continued study of these and other sedimentary rocks in Kansas has resulted in redefinition and reinterpretation of these and other sedimentary rocks, geologic history of the midcontinent, and regional correlations.

The first Kansas rock column and synthesis of stratigraphic nomenclature was prepared as a chart by R. C. Moore and handed out at an American Association of Petroleum Geologists meeting in 1935. In 1944, the Kansas Geological Survey issued an updated version entitled *Tabular Description of Outcropping Rocks in Kansas*. By 1951, the charts were formalized into Bulletin 89, *The Kansas Rock Column* (Moore, Frye, Jewett, Lee, and O'Connor, 1951), which summarized extant knowledge of the entire rock column, including those rocks known from the subsurface. Merriam (1963) summarized and interpreted the stratigraphic column in *The Geologic History of Kansas* (Bulletin 162), which was then followed by Zeller's (1968) *The Stratigraphic Succession in Kansas* (Bulletin 189).

The Kansas Geological Survey is undertaking a re-mapping of surface geology of the state, necessitated by concerns for an adequate geological data base for resource development and environmental impacts of population and industry growth. As a consequence, all studies of the stratigraphic section in Kansas are being reviewed, terminology standardized, and correlations established. This volume is a compilation of the decisions and interpretations made as a result of the review and is the first synthesis of Kansas stratigraphy in twenty-seven years.

The work presented is the current geological interpretation of the surface and subsurface rock section, using outcrop studies, cores, samples, and well logs as base data. We recognize that interpretations will change in the future and that advances in science will suggest changes in the relationships outlined herein. Donald L. Baars has cajoled, directed, and extracted information and ideas from the Kansas Geological Survey staff and others who have studied Kansas rocks. We are indebted to his perseverance and dedication to this project and to all of the contributors who created time to finish this important work. Major contributors are listed in the introduction to this report.

Lee C. Gerhard
State Geologist and Director
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Stratigraphic succession in Kansas

[Names approved by the Kansas Geological Survey]

To the extent possible, this stratigraphic succession uses updated terminologies. In those cases where the stratigraphic terms are contentious, we have deferred to the last accepted published stratigraphic guide for the state (D. E. Zeller, ed., 1968, The Stratigraphic Succession in Kansas: Kansas Geological Survey, Bulletin 189, 81 p.).

Unit

- Quaternary System
  - Holocene Series
    - Recent Stage
      - Bignell Formation
  - Pleistocene Series
    - Wisconsinan Stage
      - Brady Soil
      - Peoria Formation
      - Gilman Canyon Formation
    - Sangamonian Stage
      - Sangamon Soil
    - Illinoian Stage
      - Loveland Formation
      - Crete Formation
    - Yarmouthian Stage
    - Kansan Stage
      - Sappa Formation
      - Pearlette Ash Bed
      - Cedar Bluffs Till
      - Nickerson Till
      - Grand Island Formation
    - Aftonian Stage
      - Afton Soil
    - Nebraskan Stage
      - Iowa Point Till
      - David City Formation
      - Fullerton Formation
      - Holdrege Formation
      - Leon Gravel
- Tertiary System
  - Pliocene Series
    - Ogallala Formation
      - Kimball Member
      - Ash Hollow Member
      - Valentine Member
- Cretaceous System
  - Upper Cretaceous
    - Montana Group
      - Pierre Shale
        - Beecher Island Shale Member
        - Salt Grass Shale Member
        - Lake Creek Shale Member
        - Weskan Shale Member
        - Sharon Springs Shale Member
    - Colorado Group
      - Niobrara Chalk
        - Smoky Hill Chalk Member
        - Fort Hays Limestone Member

Unit

- Carlile Shale
  - Codell Sandstone Member
  - Blue Hill Shale Member
  - Fairport Chalk Member
- Greenhorn Limestone
  - Pfeifer Shale Member
    - Fencepost limestone bed
  - Jetmore Chalk Member
  - Hartland Shale Member
  - Lincoln Limestone Member
- Graneros Shale
- Dakota Formation
  - "D" sandstone
- Lower Cretaceous Series
  - Terra Cotta Clay Member
  - Janssen Clay Member
  - "J" sandstone
- Kiowa Formation
  - Longford Member
- Cheyenne Sandstone
- Jurassic System
  - Upper Jurassic Series
    - Morrison Formation
- Triassic System
  - Upper Triassic Series
    - Dockum Group
- Permian System
  - Upper Permian
    - Guadalupian Series
      - Big Basin Formation
      - Day Creek Dolomite
      - Whitehorse Formation
        - Kiger Shale Member
        - Relay Creek Dolomite Member
        - Marlow Sandstone Member
  - Lower Permian
    - Leonardian Series
      - Nippewalla Group
        - Dog Creek Formation
        - Blaine Formation
          - Haskew Gypsum Member
          - Shimer Gypsum Member
          - Nescatunga Gypsum Member
          - Medicine Lodge Gypsum Member
        - Flower-pot Shale
        - Cedar Hills Sandstone
        - Salt Plain Formation
        - Harper Sandstone
          - Kingman Sandstone Member
          - Chikaskia Sandstone Member

Unit

- Auburn Shale
- Bern Limestone
  - Wakarusa Limestone Member
  - Soldier Creek Shale Member
  - Burlingame Limestone Member
- Sacfox Subgroup
  - Scranton Shale
    - Silver Lake Shale Member
    - Rulo Limestone Member
    - Cedar Vale Shale Member
      - Elmo coal bed
    - Happy Hollow Limestone Member
    - White Cloud Shale Member
  - Howard Limestone
    - Utopia Limestone Member
    - Winzeler Shale Member
    - Church Limestone Member
    - Shanghai Creek Shale Member
    - Wauneta Limestone Member
    - Aarde Shale Member
      - Nodaway coal bed
    - Bachelor Creek Limestone Member
  - Severy Shale
- Shawnee Group
  - Topeka Limestone
    - Coal Creek Limestone Member
    - Holt Shale Member
    - Du Bois Limestone Member
    - Turner Creek Shale Member
    - Sheldon Limestone Member
    - Jones Point Shale Member
    - Curzon Limestone Member
    - Iowa Point Shale Member
    - Hartford Limestone Member
  - Calhoun Shale
  - Deer Creek Limestone
    - Ervine Creek Limestone Member
    - Larsh–Burroak Shale Member
    - Rock Bluff Limestone Member
    - Oskaloosa Shale Member
    - Ozawkie Limestone Member
  - Tecumseh Shale
  - Lecompton Limestone
    - Avoca Limestone Member
    - King Hill Shale Member
    - Beil Limestone Member
    - Queen Hill Shale Member
    - Big Springs Limestone Member
    - Doniphan Shale Member
    - Spring Branch Limestone Member
  - Kanwaka Shale
    - Stull Shale Member
    - Clay Creek Limestone Member
    - Jackson Park Shale Member
  - Oread Limestone
    - Kereford Limestone Member
    - Heumader Shale Member
    - Plattsmouth Limestone Member
    - Heebner Shale Member
    - Leavenworth Limestone Member
    - Snyderville Shale Member
    - Toronto Limestone Member
  - Douglas Group
    - Lawrence Formation
      - Unnamed shale member
        - Williamsburg coal bed
      - Amazonia Limestone Member
      - Ireland Sandstone Member
      - Robbins Shale Member
      - Haskell Limestone Member
    - Stranger Formation
      - Vinland Shale Member
      - Westphalia Limestone Member
        - coal(s)
      - Tonganoxie Sandstone Member
      - Iatan Limestone Member
      - Weston Shale Member
- Missourian Series
  - Lansing Group
    - Stanton Limestone
      - South Bend Limestone
        - Little Kaw Limestone Member
      - Rock Lake Shale
      - Stoner Limestone Member
      - Eudora Shale Member
      - Captain Creek Limestone Member
        - Benedict limestone bed
    - Vilas Shale
    - Plattsburg Limestone
      - Spring Hill Limestone Member
      - Hickory Creek Shale Member
      - Merriam Limestone Member
  - Kansas City Group
    - Zarah Subgroup
      - Bonner Springs Shale
      - Wyandotte Limestone
        - Farley Limestone Member
        - Island Creek Shale Member
        - Argentine Limestone Member
        - Quindaro Shale Member
        - Frisbie Limestone Member
      - Lane Shale
    - Linn Subgroup
      - Iola Limestone
        - Raytown Limestone Member
        - Muncie Creek Shale Member
        - Paola Limestone Member
      - Chanute Shale
        - Cottage Grove Sandstone Member
        - Thayer coal bed
        - Noxie Sandstone Member

Unit

Unit

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A

Aarde Shale Member (of Howard Limestone)
Pennsylvanian (Virgilian Series): eastern Kansas
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 94, 96. [See under *Bachelor Creek limestone*. On p. 21, *Aarde shale* is described as consisting of 3 ft (1 m) of yellowish-gray clayey shale with Nodaway coal near base. On p. 20, it is given a thickness of 4 1/2 ft (1.4 m).]
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 39, 205–207. Bachelor Creek limestone is basal member of Howard limestone in southern Kansas, from Greenwood County southward. Where it is absent, as in northern Kansas, the Nodaway coal and other beds that are stratigraphically equivalent to the Aarde shale member of Howard limestone are classed as belonging to top of Severy shale, because boundary between the two shales cannot be drawn. In northern area, Severy shale extends up to base of Church limestone.
R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 172–173. Nodaway coal occurs in Aarde shale at no particular stratigraphic level, but recognizable in Iowa, Nebraska, northwestern Missouri, Kansas, and 50 mi (80 km) or more into Oklahoma. The Nodaway coal is mined in Osage County where it is about 2 ft (0.6 m) thick.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 57 (fig. 22), 63, 70 (fig. 25). Bluish- to yellowish-gray clayey and sandy shale containing a persistent coal bed (Nodaway), ranging from about 1 inch (2.5 cm) to 2 ft (0.6 m) in thickness, and a persistent black fissile shale in many outcrops. Thickness ranges from about 2 to 15 ft (0.6–4.5 m). Underlies Church limestone member; overlies Bachelor Creek limestone member.
N. J. McMillan, 1956, Kansas Geological Survey, Bulletin 119, p. 198–202. The Aarde shale member is separated into seven distinct units; the uppermost division of the Aarde shale is a well-laminated gray clay unit, which constitutes the most fossiliferous part of the member; thickness of the marine clay shale ranges from 0.3 to 1.5 ft (0.1–0.5 m).
M. G. Wilmarth, 1957, U.S. Geological Survey, Bulletin 896, p. 7. Cites R. C. Moore (personal communication, April 20, 1934), who stated that lower part of Howard limestone intertongues with upper part of Severy shale, which accounts for Aarde shale containing Nodaway coal. The underlying Bachelor Creek limestone also interfingers in Severy shale, he stated.
M. R. Mudge, C. P. Walters, and R. E. Skoog, 1959, U.S. Geological Survey, Bulletin 1060–D, p. 193, 252–253, pl. 7. In Nemaha County, Kansas, member is basal unit of Howard limestone. Consists of silty slightly calcareous dark-gray to tan shale. Average thickness 4 1/2 ft (1.4 m). Base of Nodaway coal designated as base of Aarde. Underlies Church limestone member.
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 39. Bluish-gray to yellowish-gray clayey and sandy shale containing the persistent Nodaway coal bed; a black fissile shale is present in the upper part of the Aarde; a hard, dense limestone, 0.2–1.0 ft (0.06–0.3 m) thick, occurs above the Nodaway coal and below the black fissile shale in many outcrops; thickness of the Aarde ranges from about 2 to 15 ft (0.6–4.5 m); overlies the Bachelor Creek Limestone Member; underlies the Church Limestone Member. Where the Bachelor Creek Limestone Member is absent, the part of the Aarde beneath the Nodaway coal is not differentiated from the Severy Shale.
D. F. Merriam, 1989, Kansas Academy of Science, Transactions, v. 92, p. 107–111. Black fissile shale and hard dense limestone removed from Aarde Shale Member and erected to member status (Shanghai Creek Shale Member and Wauneta Limestone Member, respectively); Aarde underlies Wauneta Limestone Member, where present.
Type locality: Aarde farm, sec. 4, T. 26 S., R. 11 E., Greenwood County, Kansas.

Abilene conglomerate
Tertiary: central Kansas.
C. S. Prosser, 1895, Journal of Geology, v. 22, p. 786, 789, 797. Top member of the Marion formation.
J. W. Beede, 1909, Kansas Academy of Science, Transactions, v. 22, p. 248–256. Top member of Marion formation; heavy, hard, perhaps dolomitic stone, composed of fragments of yellow, orange, and gray masses firmly united in a light-gray cementing material.
R. C. Moore and W. P. Haynes, 1917, Kansas Geological Survey, Bulletin 3. Top member of Marion formation; peculiar, somewhat variable, conglomeratic limestone. calcareous conglomerate with some sand and sandstone pebbles at type locality. Overlies Pearl shale member.
R. C. Moore, 1920, Kansas Geological Survey, Bulletin 6, pt. 2, p. 63. So-called Abilene conglomerate is Tertiary [as opposed to Permian as others have classified it].
C. C. Williams and S. W. Lohman, 1949, Kansas Geological Survey, Bulletin 79, p. 60. Conglomerate at base of McPherson formation similar to so-called Abilene conglomerate; believed that beds called Abilene conglomerate are different ages at different localities, therefore term Abilene may not have much stratigraphic significance.
Named for Abilene, Dickinson County, Kansas.
See also Abilene limestone.

Abilene limestone
Tertiary: central Kansas.
E. C. Parker, 1925, American Association of Petroleum Geologists, Bulletin 9, p. 982. This bed in type section at Abilene, Kansas, at the few exposures where it is unaltered, is a soft gray limestone about 2 ft (0.6 m) thick. The interval down to the top of the Herington limestone varies from 40 ft (12 m) at Abilene, Kansas, to about 50 ft (15 m) at Ponca City, Oklahoma. In the majority of exposures this calcareous material has been partly or wholly dissolved and redeposited in the same horizon, often with gypsum derived by solution from strata higher in the section. Due to this mode of origin, pieces of the green shale above the Abilene limestone, as it might be better named, have been included in some places in this massive bed of secondary limestone. It can no more be called a conglomerate than the top member of the Herington, which is often similarly altered at the type vicinity.
See also Abilene conglomerate.

irregular pisolites of the Green River formation. The bed belongs to the Ogallala and is the capping rock of the section. Underlain by somewhat softer, porous or spongy, cream to nearly white limestone with a mixture of sand grains; some parts of the limestone contain small lenses and bands of transparent or milk-white chert; usually 10–20 ft (3–6 m) thick and grades downward into the ordinary grit of the Ogallala.

D. F. Merriam and J. C. Frye, 1954, Kansas Geological Survey, Bulletin 109, p. 53–56, 61, 62. Extends from Cloud County, Kansas, westward [at least] to Sherman County, Kansas, northward [at least] to Cheyenne and Rawlins counties, Kansas, southward [at least] to Clark County, Kansas; overlies Kimball member of Ogallala; missing in areas including Kearny, Grant, Haskell, Gray, Stevens, Seward, and Meade counties.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 59. Locally a hard, pisolitic limestone (mature caliche, formerly called an "algal limestone") occurs at the top of the Kimball Member of the Ogallala Formation.

Allen limestone

Pennsylvanian: southeastern Kansas.

G. I. Adams, 1904, U. S. Geological Survey, Bulletin 238, p. 20. Limestone, 10–25 ft (3–7.6 m) thick, underlying Vilas shale and overlying Concreto shale.

F. C. Schrader and E. Haworth, 1906, U.S. Geological Survey, Bulletin 296, p. 13. Limestone 5–70 ft (1.5–21 m) thick, underlying Vilas shale and overlying Concreto shale; classed as member of the Wilson formation.

E. Haworth and J. Bennett, 1908, Kansas University Geological Survey, v. 9, p. 100, 101. Applied name to exposures of limestone above Lane shale and below Bonner Springs shale near Lane, Franklin County, Kansas; applied name to lower member of Garnett limestones.

R. C. Moore, 1922, Kansas Geological Survey, Bulletin 22, p. 117, 119, 121, 127. Gives history of name usage in Kansas; discards name; declared synonymous with Plattsburg Limestone, as used by most authors.

Named for Allen County, Kansas.

Alma limestone (of Council Grove Group)

Permian: northeastern Kansas.

C. S. Prosser, 1894, Geological Society of America, Bulletin, v. 6, p. 44–45. Light-yellowish-gray massive limestone, 5 1/2 ft (1.7 m) thick, quarried at Alma and locally known as *"Alma stone."* Same as Cottonwood or Manhattan limestone.

C. S. Prosser, 1902, Journal of Geology, v. 10, p. 711–712. Suggested name "Alma limestone" be used instead of "Cottonwood limestone" because Cottonwood already had been used in Texas.

E. Haworth and J. Bennett, 1908, The University Geological Survey of Kansas, v. 9, p. 115–116. Alma limestone is another name for Cottonwood limestone. Quoted letter from C. S. Prosser to J. Bennett (1907) stating that "Cottonwood or Cottonwood Falls would be the correct nomenclature" instead of Alma.

Named for Alma, Wabaunsee County, Kansas.

Altamont Limestone (of Marmaton Group)

Altamont Limestone Member (of Oologah Limestone)

Pennsylvanian (Desmoinesian Series): southeastern Kansas, southern Iowa, northwestern Missouri, and northeastern Oklahoma.

G. I. Adams, 1896, Kansas University Geological Survey, Vol. 1, p. 22. Variable limestone at summit of ridge at Altamont, usually rough and unsuited for building purposes; thickness 12 ft (3.6 m); overlies Pleasanton shales.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Altamont limestone consists of 10 ft (3 m; maximum of 15 ft [4.5 m]) of gray crystalline irregular limestone; shown as a separate formation within the Marmaton group; underlies Nowata shale; overlies Bandera shale.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 40. Was for many years treated as lower member of Parsons formation in southeastern Kansas (being the so-called "lower Parsons limestone" of early reports).

L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, no. 1, p. 29. Subdivided into two formations, Tina below and Worland above. Occurrences in Iowa noted.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, part 11, p. 325–334. Further subdivided to include a middle member, Lake Neosho Shale. Type section designated, where thickness is about 19 ft (5.8 m).

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 7–8; R. C. Moore and others, 1951, Kansas Geological Survey, Bulletin 89, p. 96. Comprises Worland Limestone Member, Lake Neosho Shale Member, and Amoret Limestone Member. Name Amoret Limestone replaces Tina Limestone. Overlies Bandera Formation; underlies Nowata Formation.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 26. Formation locally absent in the subsurface due to pre-Missourian erosion. Average thickness 19 ft (5.8 m).

Type locality: Near center of west line of sec. 5, T. 33 S., R. 19 E., about 3.5 mi (5.6 km) west of Altamont, Labette County, Kansas. No exposures in vicinity of Altamont show whole formation.

Altoona limestone

Pennsylvanian: southeastern Kansas.

E. Haworth and W. H. H. Piatt, 1894, Kansas University Quarterly, v. 2, p. 115–117. Heavy limestones, 50–60 ft (15–18 m) thick, capping hills along Verdigris River from a few miles above Coffeyville to vicinity of Altoona. Separated from overlying Iola limestone by 100 ft (33 m) of shales with interbedded sandstones, and from underlying Independence limestone by 80–150 ft (24–45 m) of shales and sandstones; believed to be same as Erie limestone.

Named for Altoona, Wilson County, Kansas.

Amazonia Limestone Member (of Lawrence Formation)

Pennsylvanian (Virgilian Series): northwestern Missouri and eastern Kansas.

H. Hinds and F. C. Greene, 1915, Missouri Bureau Geology and Mines, v. 13, 2nd series, p. 31, 170, 179. Amazonia limestone bed in places attains thickness of 16 ft (4.8 m) in

43 (fig. 17), 49, 51, (fig. 19). Basal member of Foraker limestone. Underlies Hughes Creek shale member; overlies Oaks shale member of Hamlin shale. Commonly two limestone beds separated by shale. Thickness ranges from 6 to 22 ft (1.8–6.7 m). Wolfcampian.

M. R. Mudge and R. H. Burton, 1959, U.S. Geological Survey, Bulletin 1068, p. 14 (table 2), 53–56. Described in Wabaunsee County, Kansas. Limestone formerly called Houchen Creek south of Pottawatomie County does not correlate with type section in Nebraska, but coalesces with Americus limestone member in Wabaunsee County. This limestone has distinctive type of algae in lower part of Americus that can be traced north into Pottawatomie and Jackson counties. Americus formerly consisted of one or two beds of limestone 12 or more inches (30 cm) thick in lower part, 4–8 ft (1.2–2.4 m) of gray fossiliferous shale in middle part, and bed of gray limestone 18 or more inches (45 cm) thick in upper part. In this report, upper contact of Americus is restricted to top of lower one or two beds of limestone. This places upper bed of limestone, which is absent in some places, and beds of shale in Hughes Creek shale member. Lower part of Americus is redefined to include algal bed heretofore referred to as Houchen Creek limestone in Chase County (Moore, Jewett, and O'Connor, 1951, Kansas Geological Survey, v. 11, pt. 1) and in Lyon County (O'Connor, 1953, Kansas Geological Survey, v. 12, pt. 1). In southern part of Wabaunsee County, Americus now consists of three beds of limestone separated by two beds of shale, but northward lower shale bed pinches out and lower bed of limestone coalesces with, and becomes part of, middle bed of limestone in northern part of county. Shale that lies above algal limestone was called Oaks shale member in Chase County (Moore, Jewett, and O'Connor, 1951) and in Lyon County (O'Connor, 1953). In Wabaunsee County, this is lower shale bed of Americus. Underlies Hughes Creek shale member; overlies Hamlin shale member of Janesville shale.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 30–33. Houchen Creek limestone bed differs from lowest limestone bed in Americus Limestone Member (commonly erroneously called Houchen Creek in Kansas) because the Americus unit has stromatolites enclosed in a lime matrix, which are denser and darker, are smaller in diameter, are always connected, and typically are underlain by a calcarenite. Thickness ranges from 1.5 ft (0.5 m) to about 20 ft (6 m), averaging 4 ft (1.2 m) north of Lyon County and about 12 ft (3.6 m) south of Lyon County.

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva Limestone to conform, including the Americus Limestone Member.

Type locality: Exposures near Americus, Lyon County, Kansas.

Amoret Limestone Member (of Altamont Limestone)

Pennsylvanian (Desmoinesian Series): eastern Kansas, northwestern Missouri, south-central Iowa, and northeastern Oklahoma.

J. G. Grohskopf and E. McCracken, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 10, p. 17. Mentioned as basal member of Altamont. Underlies Lake Neosho Shale Member. Name credited to J. M. Cline and F. C. Greene.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 7–8. Name Amoret suggested as substitute for Tina, which is abandoned because type Tina proved not to be Altamont. Type locality designated.

L. M. Cline and F. C. Greene, 1950, Missouri Geological Survey and Water Resources, Report of Investigations 12, p. 18–21. At type locality, consists of three gray limestone beds and a thin greenish-gray shale bed; thickness about 5 ft (1.5 m). Varies in thickness and lithology in short distances. Overlies Bandera Shale. Reference is made to an underclay as part of Amoret cyclothem. Occurrence in Madison County, Iowa, noted.

R. C. Moore, J. C. Frye, J. M. Jewett, W. Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 96. Light-gray, massive, coralline and dense limestone, associated with two shale beds in southern part of outcrop area. Thickness from 1 to 2 ft (0.3–0.6 m) in north to about 10 ft (3 m) in southern part of outcrop.

R. D. Alexander, 1954, Oklahoma Geological Survey, Circular 31, p. 15, 16 (fig. 2). Occurs in Oklahoma where it is shown as a limestone (bed) within Altamont member of Oologah formation.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 31 (fig. 5). Represented in Madison County by thin layer of freshwater limestone nodules in matrix or red underclay that is continuous with Neosho Lake Shale Member above. Amoret is not present farther south in Iowa. Maximum thickness exposed in Madison County 10 inches (25 cm).

Type locality: Two miles (3.2 km) south of Amoret, Bates County, Missouri, in sec. 33, T. 40 N., R. 33 W.

Andrew shale (of Douglas Formation)

Pennsylvanian: southwestern Iowa, northwestern Missouri, and eastern Kansas.

C. R. Keyes, 1899, American Geologist, v. 23, p. 306. Upper member of Lawrence shale in Missouri and eastern Kansas; overlies Iatan limestone member of Lawrence shale and underlies Plattsmouth limestone.

Named for Andrew County, Missouri.

Angell Member (of Ballard Formation)

Pleistocene: southwestern Kansas.

C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55, 57, 58. Name applied to sand, gravel, and cobble member at base of Ballard formation; about 7 ft (2.1 m) thick; underlies Missler member; overlies Rexroad formation.

Type locality: Sanders gravel pit SE NW sec. 7, T. 32 S., R. 28 W., Meade County, Kansas. Named for old Angell Schoolhouse (southeast corner NE sec. 31, T. 32 S., R. 29 W.).

Anna Shale Member (of Pawnee Limestone)

Pennsylvanian (Desmoinesian Series): eastern Kansas, western Missouri, northeast Oklahoma, southwestern Iowa.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, pt. 11, p. 316–317, pl. 1. Lowermost member of Pawnee Limestone. Includes thin dark slabby limestone (at base) and a black platy and locally fissile shale. Thickness 3–11 ft

units. Ardmore is 13th in sequence (ascending); occurs above Croweburg and below Bevier. Average thickness 5 ft (1.5 m).

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 45. Cyclothem redefined to include Croweburg cyclothem of Abernathy (1937).

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 98–99, 101. A cyclothem that includes the rock sequence below the Croweburg coal that includes limestone or sandstone, underclay, coal (Croweburg) up through the massive limestone (Ardmore), and the gray shale above the Ardmore limestone. Thickness ranges from 20 to 35 ft (6–10.6 m).

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 72–74. Verdigris limestone comprises bed or beds called Ardmore by Gordon (1893) in Missouri. Term Verdigris has had wider usage than Ardmore and for that reason was adopted at Nevada Conference (Searight and others, 1953, American Association of Petroleum Geologists, Bulletin, v. 37) for limestone in Verdigris formation.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 25. Verdigris Limestone Member of Cabaniss Formation has been called "Ardmore limestone."

Named for Ardmore, Macon County, Missouri.

Argentine Limestone Member (of Wyandotte Limestone)

Pennsylvanian (Missourian Series): eastern Kansas and northwestern Missouri.

R. C. Moore, 1931, Kansas Geological Society, Guidebook, 5th Annual Field Conference, correlation chart. Underlies Island Creek shale and overlies Lane shale.

R. C. Moore, 1935, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 92. Cited manuscript by N. D. Newell. Proposed name.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 60. Consists of 20–30 ft (6–9 m) of light-gray, thin-bedded, wavy limestone; underlies Island Creek shale member; overlies Quindaro shale member. Comprises main part of so-called Iola limestone of Missouri and northeastern Kansas, which is younger than true Iola limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 121–122. Compose main part of "Iola Limestone" of E. Haworth and J. Bennett (1908, Kansas University Geological Survey, vol. 9, p. 98). So-called "crusher ledge" in Kansas City.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 106 (fig. 20), 109–110. Mostly very fine grained light-bluish-gray limestone that weathers creamy white, grayish white, or light buff. Bedding thin and uneven; many layers distinctly nodular. Normally, thickest subdivision of Wyandotte Formation. Average thickness 20 ft (6 m); 30 ft (9 m) thick at Kansas City. Overlies Quindaro Shale Member; underlies Island Creek Shale Member, or, where shale is absent, underlies Farley limestone member. Disappears south of Lane, Kansas, but is persistent northeastward in Missouri; identified in Iowa and southeastern Nebraska.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 25, fig. 5. Argentine Member in Madison County is 18-ft (5.5-m) sequence of two or three massive limestones separated by dark-gray to buff calcareous shales. Fossiliferous throughout with *Osagia* and brachiopods. Thickness 12 ft (3.6 m) in Union County. Overlies Quindaro Shale Member; underlies Island Creek Shale Member.

D. J. Crowley, 1969, Kansas Geological Survey, Bulletin 198, p. 9, 13 (fig. 8). Phylloid algal mounds in Kansas City area with thicknesses up to 50 ft (15 m). Average 25–35 ft (7.6–10.6 m) thick. Thickens in algal banks in Johnson County to as much as 50 ft (15 m).

H. G. O'Conner, 1971, Kansas Geological Survey, Bulletin 203, p. 17, 18. Lists surface localities.

P. H. Heckel, J. Harris, and W. L. Watney, 1985, Midcontinent Section of Society of Economic Paleontologists and Mineralogists, Guidebook, 3rd Annual Field Conference, p. 29, 30, 40–43. Describes variation in thickness and lithofacies of Argentine in Wyandotte and Johnson counties, Kansas.

W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 95–96, 98 (fig. 2–2), 109–110 (fig. 3–2, b,c). Describes variation in areas of algal buildups in Johnson and Wyandotte counties, Kansas.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 14. Thins down to 4 ft (1.2 m) in Miami County where it rests on Iola Limestone separated from the latter by only several inches of shale. Is composed of non-algal skeletal calcilutite where thin.

Type section: In quarry south of 26th Street and Metropolitan Avenue, near Argentine Station on south side of Kansas City, Kansas, Wyandotte County (south of north line, sec. 29, T. 11 S., R. 25 E.).

Arickaree shale

Upper Cretaceous: northwestern Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 52. Light-colored, olive, yellowish, and brownish fossiliferous gray shales referred to lower part of Fox Hills division; overlies Lisbon shales.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 69. Conflicts with better established name (Arikaree) for a Miocene formation. These beds belong to Pierre shale. No beds of Fox Hills age are known in Kansas.

Named for Arikaree River, Cheyenne County, Colorado.

Ash Hollow Member (of Ogallala Formation)

Pliocene: western Kansas, western Nebraska, South Dakota, and southeastern Wyoming.

H. Engleman, 1876; *in*, Appendix 1, Report of Explorations Across the Great Basin of the Territory of Utah for a Direct Wagon Route from Camp Floyd to Genoa, in Carson Valley, in 1859, by Capt. James H. Simpson, Engineer Department, U.S. Army: Washington, U.S. Government Printing Office, p. 260–262, 283. Strata first encountered near junction of North and South Forks of Platte River; best developed in Ash Hollow, along South Fork, where they attain a thickness of >250 ft (75.8 m). Series is alternating loose, finely sandy, and harder rocky strata, the latter consisting of fine or coarse drift-sand, generally cemented by carbonate of lime, forming more or less calcareous sandstone, and gritty, very impure limestone. Probably Pliocene–Tertiary. From Ash Hollow westward, rocks gradually assume different appearance, becoming less calcareo-arenaceous, more purely arenaceous, and finally, argillo-arenaceous. This formation is older than Ash hollow series. Ash Hollow formation referred to on p. 283.

C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55. Atchison is basal member of unnamed formation in upper part of Meade group.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 60, 63. Proglacial deposit not recognized beyond limits of Kansas glaciation; similar deposits occur between the Cedar Bluffs and Nickerson tills; maximum known thickness is nearly 100 ft (30 m), but it is commonly less than 40 ft (12 m) thick. Overlies Afton soil; underlies Nickerson till.

Type locality: Exposures in creek bank in SE SW sec. 2, T. 6 S., R. 20 E., Atchison County, Kansas.

Atchison shale

Pennsylvanian: northwestern Missouri, southwestern Iowa, and southeastern Nebraska, eastern Kansas.

C. R. Keyes, 1899, American Geologist, v. 23, p. 309. *Atchison shales*—500 ft (152 m) thick, extend from top of Forbes limestone to base of Cottonwood limestone. [Includes Wabaunsee group and large part of underlying Shawnee group; abandoned.]

Named for Atchison County, Missouri.

Atokan Group

Middle Pennsylvanian (Atokan Stage): western Kansas.

Rock sequences of dark-colored shales and limestones and some thin basal sandstone are recognized in western Kansas as being of Atokan age based on fusulinids. Commonly correlated with the Thirteen-finger lime of the Anadarko basin area of Oklahoma and Texas.

J. C. Maher, 1947, Kansas Geological Survey, Oil and Gas Investigations, no. 4, p. 7. Rocks equivalent to Atoka Formation of Oklahoma are recognized in one Kansas well in Hamilton County and several adjacent wells in Colorado. The rock sequence is 480 ft (145 m) thick in the Hamilton County well.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 102–103. Assigns rocks from a featheredge to about 500 ft (152 m) in thickness in southwest Kansas to the Atokan Series. These rocks are mainly limestone and shaly limestone and are separated from Morrowan deposits and Desmoinesian rocks by unconformities.

Wallace Lee, 1953, Kansas Geological Survey, Oil and Gas Investigations No. 9, p. 12–13. Recognized Atokan rocks in two wells in Meade County. The Atokan is 190 and 400 ft (58 and 121 m) thick in the wells. *Fusulinella* was recognized in the rock sequence.

W. L. Atkinson and V. J. Veroda, 1966, American Association of Petroleum Geologists, Cross Section Publication 4, p. 11. Atokan-age rocks are recognized in wells in Stanton, Stevens, Seward, and Meade counties.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 23. Interbedded dark-gray, black, and dark-brown cherty limestones, and dark-gray to black shales. Near the base are a few fine-grained sandstones that occur locally. Thickness 0–500 ft (0–52 m).

G. Moore, 1983; *in*, J. M. Hills and F. E. Kottlowski (coord.), American Association of Petroleum Geologists, Correlation of Stratigraphic Units of North America (Cosuna) Project, Southwest/southwest Midcontinent Region. Lists the rocks of this interval as Atokan Group.

No type section designated for Atokan Group, named for Atoka, Atoka County, Oklahoma.

Atokan Stage

Atokan Series

Atoka Formation

Atoka sandstone

Middle Pennsylvanian: eastern Oklahoma, Kansas, western Arkansas, Texas, and New Mexico.

J. A. Taff and G. I. Adams, 1900, U.S. Geological Survey, 21st Annual Report, part 2, p. 273. Alternating sandstones and shales, 7,000 ft (2,121 m) thick, with four groups of sandstone strata, each nearly 100 ft (30 m) thick, spaced at intervals of 1,000–1,200 ft(303–364 m); underlies hartshorne sandstone; is basal formation of Coal Measures.

C. W. Wilson, Jr., 1935, American Association of Petroleum Geologists, Bulletin, v. 19, p. 504–507. Atoka Formation is basal formation of Des Moines Group.

M. G. Cheney, R. H. Dott, B. F. Hake, R. C. Moore, N. D. Newell, H. D. Thomas, and C. W. Tomlinson, 1945, American Association of Petroleum Geologists, Bulletin, v. 29, p. 156. Discussion of main divisions of Pennsylvanian System. Suggested that Atokan could be used as time-stratigraphic unit as a series or stage.

R. C. Spivey and T. G. Roberts, 1946, American Association of Petroleum Geologists, Bulletin, v. 30, p. 185–186. Raised to series rank and defined to include all beds from top of Wapanucka Limestone, Morrowan Series, to base of Hartshorne Sandstone, Des Moinesian Series. As thus defined, includes Marble Falls, Smithwick, and overlying *Fusulinella* (restricted)-bearing beds of central and north Texas, Derryan Series of New Mexico and west Texas, and equivalent beds in other areas.

C. A. Moore, 1947, Oklahoma Geological Survey, Bulletin 66, p. 17 (table 1), 50–52. Detailed discussion of Morrowan Series in northeastern Oklahoma. Placed Atoka sandstone at base of Des Moinesian Series.

R. C. Moore and M. L. Thompson, 1949, American Association Petroleum Geologists, Bulletin, v. 33, p. 292. Rocks of Oklan Series (new) are divisible into two stages, Atokan (or Derryan) and Desmoinesian.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 22–23. Atokan Stage is lower unit of Middle Pennsylvanian Series as used in Kansas.

Named for Atoka, Atoka County, Oklahoma, which is situated on outcrop of formation.

Atwater Member (of Crooked Creek Formation)

Pleistocene (Kansan Stage): central and western Kansas.

C. W. Hibbard, 1958, American Jounal of Science, v. 256, no. 1, p. 55, 58. Sandy silt, silt, silty clay, and clay that contains Pearlette ash lentil, where present; massive caliche generally present at top of member; thickness about 50 ft (15 m). Overlies Stump Arroyo sand and gravel member; underlies Kingsdown formation.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 66. Rejected Hibbard's (1959) terminology; undifferentiated part of Sappa Formation.

Type locality: North half sec. 21, T. 33 S., R. 28 W., on east side of Crooked Creek, Meade County, Nebraska. Named for old Atwater post office.

Bachelor Creek Limestone Member (of Howard Limestone)
Pennsylvanian (Virgilian Series): eastern Kansas.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 94, 96. Members of Howard limestone have been assigned names as follows, ascending: *Bachelor Creek limestone, Aarde shale* (containing Nodaway coal), *Church limestone, Winzeler shale*, and *Utopia limestone*. [Derivation of names not stated. On p. 21 *Bachelor Creek limestone* is described as consisting of 1.35 ft (0.4 m) of blue limestone weathering brown and shaly.]
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 205–207. *Bachelor Creek limestone member*—Lowest member of Howard limestone, is developed in southern Kansas from Greenwood County southward. It is hard, somewhat sandy, impure, bluish-gray limestone ranging in thickness up to 3± ft (0.9± m). Occurs below Aarde shale member, in which Nodaway coal lies near base.
R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 172. Also well developed, perhaps locally, in Lyon and Osage counties, Kansas.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 57 (fig. 22), 63. Basal member of Howard limestone. Underlies Aarde shale member; overlies Severy shale. Locally two beds separated by shale. Thickness as much as 8 ft (2.4 m).
Type locality: Bachelor Creek, sec. 33, T. 25 S., R. 11 E., about 5 mi (8 km) east of Eureka, Greenwood County, Kansas.

Bachelor Formation
Lower Mississippian: east-central and southwestern Missouri; ?Kansas.
M. G. Mehl, 1960, Denison University, Journal of Science Laboratories, v. 45, article 5, p. 94–98. Proposed for a basal Mississippian sandstone that cuts across time zones ranging in age from oldest Mississippian to as late as early Osagean.
T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 16, 26–34, 47, 50. Discusses nomenclatural history of name and distribution in Missouri. [Based on geographic range and stratigraphic thickness reported in Missouri, the Bachelor Formation probably is present in Kansas, but has not yet been reported.]

Bader Limestone (of Council Grove Group)
Bader Formation (of Council Grove Group)
Permian (Wolfcampian Series): northeastern Kansas and southeastern Nebraska.
R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Stratigraphic sections of Pennsylvanian and "Permian" rocks of Kansas River valley, Kansas Geological Survey; R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita, Kansas [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]; G. E. Condra, 1935, Nebraska Geological Survey, Paper 8, p. 4, 7.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 61–62. Contains (ascending) Eiss limestone, Hooser shale, and Middleburg limestone; units named by Condra as members of Garrison Formation. Type exposure noted.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 46. Underlies Easly Creek shale; overlies Stearns Shale. Wolfcampian Series.
Type exposure is near Bader, Chase County, Kansas.

Badger limestone
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 44. Misspelling of "Bader limestone."

Bala intrusives
Bala kimberlite
Cretaceous: Riley County, Kansas.
R. C. Moore and W. P. Haynes, 1920, American Association of Petroleum Geologists, Bulletin, v. 4, p. 183–187. Described as basic igneous rock; outcrop is 20 mi (32 km) northwest of Manhattan and 1 mi (1.6 km) east of Bala, on the Chicago, Rock Island & Pacific railroad, about 500 ft (152 m) north of the track; igneous breccia; assumed by authors to be an ancient volcanic neck; discovery credited to T. S. Harrison of Denver, Colorado.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 96–97. Rock is an igneous breccia or agglomerate comprising a ground-mass of basalt and inclusions consisting principally of shale in various stages of alteration; fissures caused by jointing have become filled with calcite; age is probably Cretaceous.
R. M. Dreyer, 1947, Kansas Geological Survey, Bulletin 70, pt. 2, p. 21–28. Based on magnetic survey of the Bala intrusive, it is an eastward-plunging vertical dike.
R. L. Eastwood and D. G. Brookins, 1965, Kansas Academy of Science, Transactions, v. 68, p. 72–87. Describe chemistry of Stockdale kimberlite and Bala kimberlite.
R. L. Cullers and J. Mullenax, 1981, Geological Society of America, Abstracts with Programs, v. 13, no. 6, p. 275. Bala kimberlite petrogenesis described; intrusion is a kimberlite pipe.
Name derived from Bala, Riley County, Kansas. Informal usage in Kansas to describe this particular exposure in NW NW sec. 6, T. 9 S., R. 5 E.

Ballard Formation (of Meade Group)
Pleistocene (Nebraskan and Aftonian): southwestern Kansas.
C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55, 56. Includes deposits between Rexroad formation below and Crooked Creek formation above in southwestern Kansas, separated from both by erosional unconformities. Thickness about 20 ft (6 m). Includes Angell member below and Missler member above.
E. D. Gutentag, 1963 [1964], Kansas Academy of Science, Transactions, v. 66, p. 609, 610. Noted that because of the homotaxial arrangement of alluvial materials the Pliocene and Pleistocene deposits [in southwestern Kansas] have not been correlated with the formations cropping out in Meade County that have been dated by Hibbard using microvertebrates and invertebrate faunas.
C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 66. Referred to classification of Hibbard (1958), but not used by Kansas Geological Survey; equivalent unit considered as Fullerton Formation.
Type locality: On Big Springs Ranch in secs. 7 and 17, T. 32 S., R. 28 W., Meade County, Kansas. Named from Louise Ballard Ranch which is shown on Meade County plat book as included within the Big Springs Ranch.

preoccupied by a limestone of the Cincinnatian of Minnesota; Burlingame limestone, proposed by Hall (1896, University Geological Survey of Kansas, v. 1), is likewise preoccupied by a shale formation of that name; the name Eureka limestone, introduced by Haworth (1898, University Geological Survey of Kansas, v. 3), is likewise preoccupied by the Eureka quartzite of Colorado.

L. C. Wooster, 1905, Kansas Academy of Science, v. 20, p. 78. Part of the Eureka beds in the Upper Coal Measure (also known as Burlingame or Eureka lime); 8 ft (2.4 m) thick.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 215, 221. Barclay limestone of Beede equivalent to interval from top of Scranton shale (base of Burlingame limestone) up to base of Willard shale (top of Elmont, or "Emporia," limestone), just as defined by Beede. Referred to as "Tarkio limestone" erroneously by Hinds and Greene (1915, p. 34).

Probably named for Barclay, Osage County, Kansas.

Barneston Limestone (of Chase Group)

Barneston Formation (of Chase Group)

Permian (Wolfcampian Series): southeastern Nebraska and eastern Kansas.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, series 2, p. 41. Includes Florence flint and Fort Riley limestone, which are in contact, except at a few places where a thin shale intervenes; average thickness from southern Kansas to Nebraska is 50 ft (15 m) or more; produces bold round escarpments.

R. C. Moore, 1936, Kansas Geological Survey, 10th Annual Field Conference, Guidebook, p. 12 (fig. 4), 69 (fig. 45). Includes Oketo Shale Member.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 44–45. Includes: Fort Riley Limestone Member, Oketo Shale Member, Florence Limestone Member. Thickness 80–90 ft (24–27 m); underlies Doyle Shale; overlies Matfield Shale. Wolfcampian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 48–49. Formation caps much of the western Flint Hills; thickness 80–90 ft (24–27 m).

Type locality: In bluffs west and southwest of Barneston, Gage County, Nebraska.

Bartlesville sand

Pennsylvanian: eastern Kansas and northern Oklahoma.

S. Powers, 1926, Oklahoma Geological Survey, Bulletin 40-G, p. 14–15. Bartlesville sand applied to Ordovician rocks.

B. Mills–Bullard, 1928, Oklahoma Geological Survey, Bulletin 40-Q, p. 50. The Bartlesville sand lies 365 ft (111 m) below the top of the Oswego limestone in the Bartlesville–Dewey oil field, Washington County, Oklahoma.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 77–78. As used now, the name "Bartlesville" may mean any of several sandstone bodies that occur in the Kansas Cherokee section below the Ardmore limestone.

Bastard coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Fleming coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 73; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 68).

Baxter coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Mineral coal bed (W. G. Pierce, and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 70; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 62).

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 23, noted the Baxter as a local term equivalent to the Bevier coal. The Baxter is now generally considered equivalent to the Mineral coal.

Baxter Springs Member (of Boone Formation)

Mississippian: southeast Kansas, southwest Missouri, and northeast Oklahoma.

E. T. McKnight and R. P. Fischer, 1970, U. S. Geological Survey, Professional Paper 588, p. 13, 20, 40–50. Consists of three conspicuously different subunits, the L, K, and J beds of Fowler and Lyden (Fowler, 1942). Lower unit is bedded to massive pale chert or cotton rock, glauconitic at base (L bed); overlain by crinoidal glauconitic limestone and variegated chert, the limestone locally shaly or containing glauconitic oolite and phosphate nodules (K bed); topped by thin phosphatic and highly glauconitic crinoidal limestone containing variegated and, in part, very dark chert (J bed).

Type section: Outcrops in the west bluff of Spring River about 1,000 ft (300 m) south of the Kansas–Oklahoma state line, 2 mi (3.2 km) south of Baxter Springs, Kansas.

Bbj coal bed (in Cabaniss Formation, Cherokee Group)

Pennsylvanian (Desmoinesian Series).

An informal unit used for subsurface correlation of an unnamed coal in the lower part of the Cherokee Group. First used in an unpublished M. S. thesis by J. W. Harris, 1984, University of Kansas, p. 29–30, 46–47. The Bbj coal bed is a persistent coal below the Ajb coal bed and above the Seville Limestone Member and a persistent sandstone informally called the "Upper Bluejacket." A highly radioactive shale overlies the Bbj coal that provides a convenient marker bed in southeast to east-central Kansas.

L. L. Brady, L. M. Nuelle, D. B. Haug, D. C. Smith, J. L. Bostic, and J. C. Jaques, 1994, U.S. Geological Survey, Miscellaneous Investigations Series I–2426–A. Coal resource quantities of the Bbj coal bed in southeast Kansas and general stratigraphic relations are shown.

Beattie Limestone (of Council Grove Group)

Permian (Wolfcampian Series): northeastern Kansas, southeastern Nebraska, and north-central Oklahoma.

G. E. Condra and C. E. Busby, 1933, Nebraska Geological Survey, Paper 1, p. 13. *Beattie formation*—In section on West Branch Creek, NW sec. 10, T. 1 N., R. 10 E., 3 1/2 mi (0.8 km) south and 7 mi (11.2 km) west of Pawnee City, Pawnee County, Nebraska, it consists of (descending): Morrill limestone, 1 ft (0.3 m); Florena shale, 3 ft (0.9 m); and Cottonwood limestone, 11 1/2 ft (3.5 m). The Kansas Geological Survey is to group the Morrill, Florena, and Cottonwood as *Beattie formation*.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 7, followed above classification, as did R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 46–47. Beattie Limestone includes: Morrill Limestone

form base of Kiowa, show similar fossil content and sedimentary structures and are continuous throughout the area; upper beds are discontinuous and variable in composition and thickness.

Belvidere Formation
Belvidere Shale
Lower Cretaceous: south-central Kansas.
R. T. Hill, 1895, American Journal of Science, series 3, v. 50, p. 208–234. Defined (p. 208–210) as blue shale, with indurated fossil layers, 106 ft (32 m) thick, overlying Cheyenne sandstone and underlying "Dakota" sandstone, both including and excluding oyster bed (Champion shell bed) at base. Defined (p. 211) as including Belvidere shales and Cheyenne sandstone, or all beds between "Dakota" sandstone above and red beds below.
F. W. Cragin, 1895, American Geologist, v. 16, p. 357–385. Belvidere beds (or Walker beds) proposed to include Kiowa shale, Champion shell bed, and underlying Cheyenne sandstone; Walker is suggested in case objection is made to use of Belvidere to include more than Belvidere shales of Hill (1895).
C. S. Prosser, 1897, University Geological Survey of Kansas, v. 2, p. 111. Divided the Comanche of southern Kansas into Kiowa shale (including Champion shell bed) and Cheyenne sandstone, and suggested that, if a name is needed for the two formations combined, some name other than Belvidere be used.
W. H. Twenhofel, 1924, Kansas Geological Survey, Bulletin 9. Belvidere formation defined to include (from top to bottom): Greenleaf sandstone member (25–50 ft [7.6–15 m]); Spring Creek shale member (25–50 ft [7.6–15 m]); and Kiowa shale member, including the Champion shell bed at the base. Overlies, apparently conformably, Cheyenne sandstone, but R. C. Moore says there is evidence of unconformity, at least locally. Underlies Kirby clay member of Dakota formation, apparently conformably.
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Underlies Ellsworth formation; overlies Cheyenne sandstone. Comprises (top to bottom): Mentor sandstone member, Marquette sandstone member, Kiowa shale. Dakota group.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 154. Kiowa shale defined to contain, probably, Greenleaf sandstone, Mentor beds, and others, and is in part equivalent to Belvidere formation, Medicine bed, Elk River beds, and others.
Named for Belvidere, Kiowa County, Kansas.

Benedict limestone bed (of Captain Creek Limestone Member)
Pennsylvanian and Missourian: southeastern Kansas.
P. H. Heckel, 1995, Kansas Geological Society, Geuidebook, 31st Regional Field Conference, p. 21. Fossiliferous oolitic calcarenite, 4-5 ft (1.2-1.5 m) thick at base of Captain Creek Limestone Member in central Wilson County; grades northward to zone of stromatolite heads in top of Vilas Shale.
Type section: Roadcut northeast edge of Benedict (NE NE NE sec. 10, T. 28 S., R. 15 E.), Wilson County, Kansas.

Bennett Shale Member (of Red Eagle Limestone)
Pennsylvanian (Virgilian Series): northeastern Kansas and southeastern Nebraska.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 84, 86, 88, 185. *Bennett shale*—Bluish-gray and nearly black argillaceous shale with one carbonaceous streak resembling coal and a thin yellowish to brownish limestone. Thickness 8–10 ft (2.4–3 m) in Nebraska and 12 ft (3.6 m) in northeast Kansas. Underlies Howe limestone and overlies Glenrock limestone; all included in Elmdale shale member.
G. E. Condra, 1935, Nebraska Geological Survey, Paper 8, p. 8. Rank reduced to member status in Red Eagle formation. Overlies Glenrock limestone member; underlies Howe limestone member.
M. G. Wilmarth, 1957, U.S. Geological Survey, Bulletin 896, p. 162. Quoted letter (dated October 16) from E. C. Reed, Assistant State Geologist, Nebraska, 1936, stating that the type location of Bennett shale is along the Little Nemaha and its branches south of Bennett, Lancaster County, Nebraska.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 48. Consists of shale and, locally, some impure limestone; shale is characteristically dark gray to black in lower part and light gray in upper part; brachiopods abundant locally in black shale; grades into limestone southward from Elk County, Kansas. Thickness 2 1/2–15 ft (0.8–4.5 m). Underlies Howe limestone member; overlies Glenrock limestone member.
M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 38–40. Mostly shale north of Greenwood County (except for biostrome in southern Wabaunsee/northern Lyon counties); mostly silty shale in Greenwood and Chase counties; almost all limestone (about 20 ft [6 m] thick) south of Elk County; member generally thins northward.
D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva Limestone to conform, including the Bennett Shale Member.
Type locality: Along Little Nemaha and its branches south of Bennett, Lancaster County, Nebraska.

Bern Limestone (of Wabaunsee Group)
Pennsylvanian (Virgilian Series): northeastern Kansas.
R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, p. 2,274 (fig. 1), 2,276–2,277. Defined to include persistent escarpment-forming limestone and associated strata below Auburn Shale and above Scranton Shale. Thickness 7–35 ft (2–10.6 m). Comprises Wakarusa Limestone Member, Soldier Creek Shale Member, and Burlingame Limestone Member.
Type section: In roadcut in SE SE sec. 7, T. 1 S., R. 13 E., about 1/2 mi (0.8 km) north and 1 mi (1.6 km) west of Bern, Nemaha County, Kansas. Name derived from town of Bern in northern part of county.

Big Blue series
Big Blue group
Permian: eastern Kansas and southeastern Nebraska.
F. W. Cragin, 1896, Colorado College, Studies, v. 6, p. 3, 5. *Big Blue series*—Limestone-bearing series, 900–1,100 ft (273–333 m) thick, known by its fossils to belong to Permian. Underlies, probably unconformably, Cimarron series. Divided into Sumner division above and Flint Hills division below. Includes (descending) Wellington shales, Geuda salt measures (now included in the Wellington Formation), Chase limestones, and Neosho shales.
R. C. Moore and W. P. Haynes, 1917, Kansas Geological Survey, Bulletin 3. *Big Blue group* adopted by the Kansas Geological Survey defined as extending from top of Wellington shale to base of Cottonwood limestone.
R. C. Moore and G. E. Condra, 1932, Kansas Geological Society, Sixth Annual Field Conference, Guidebook, 125 p. Revised classification of Permian and Pennsylvanian rocks of Kansas. Further expanded *Big Blue series*, as they called it, by including all beds down to base of Americus limestone.
G. E. Condra; *in*, R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22. Further expanded *Big Blue series* by including in it all beds down to unconformity at top of Brownville limestone.
J. E. Adams, M. G. Cheney, R. K. DeFord, R. I. Dickey, C. O. Dunbar, J. M. Hills, R. E. King, E. R. Lloyd, A. K. Miller, and C. E. Needham, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,677–1,678. In Oklahoma and Kansas, Leonard series extends from the horizon near the top of the Herington limestone up to the top of the Dog Creek shale (base of Whitehorse group). Therefore, forma-tions of Big Blue and Cimarron series of Kansas and Nebraska should be reclassified according to assignments in Wolfcamp, Leonard, and Guadalupe series.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin, v. 39, p. 40. Term Wolfcamp supplants term Big Blue, which has heretofore been used as name of lowermost series in Permian in northern midcontinent area. Big Blue series included some higher beds which are now assigned to the Leonard Series. Boundary between Wolfcamp and Leonard in Kansas is drawn at top of Nolans formation.
G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin, v. 14, p. 24, 30–31. Nebraska Geological Survey continues use of Big Blue series; includes section between top of Herington limestone and the unconformity at horizon of Brownville limestone (=redefined Chase, Council Grove, and Admire groups).
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 160, 200. Now called Wolfcampian Series in Kansas; outcrop thickness in Kansas about 835 ft.
D. L. Baars, 1990, Geology, v. 18, p. 687–690. Abandoned term "Big Blue Series" to be replaced by Standard North American series name Wolfcampian.
Named for Big Blue River, which in northern Kansas cuts deeply into these rocks.

Bigelow formation
Permian: southeastern Nebraska and northeastern Kansas.
G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 4, 6. *Bigelow limestone formation*, about 41 ft (12.3 m) thick, includes (descending): Funston limestone, Blue Rapids shale, and Crouse limestone of Council Grove group. [Derivation of name not stated.]
N. W. Bass, 1936, Kansas Geological Survey, Bulletin, v. 23, p. 51. A sequence of limestone and shale beds 40 ft (12 m) thick, more or less, comprise the Bigelow limestone.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 65. Proposed that Bigelow be dropped and that Funston Limestone, Blue Rapids Shale, and Crouse Limestone be recognized as formations.
Named for Bigelow, Marshall County, Kansas.

Big Lower coal bed (in Cherokee Group)
Pennsylvanian (Desmoinesian Series)
A local name for the Weir–Pittsburg coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 48).

Bignell Formation
Bignell Loess
Bignell Silt Member
Pleistocene/Holocene: southwestern Nebraska, northern and eastern Kansas.
C. B. Schultz and T. M. Stout, 1945, American Journal of Science, v. 243, no. 5, p. 241–244. Consists of gray loess; separated from Peorian loess by prominent soil and overlain by complex top soil.
J. C. Frye and O. S. Fent, 1947, Kansas Geological Survey, Bulletin 70, p. 50, 51. Extended into Kansas where it is considered silt member of Sanborn formation; occurs above Brady soil at top of Peoria silt member; thickness in Rice County, Kansas, is 1.5 ft (0.5 m).
J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 138–140. Forms thin, discontinuous, widely distributed deposits over northwestern part of Kansas; commonly less than 10 ft (3 m) thick; resembles underlying Peoria loess in lithology; contains distinctive, though sparse, molluscan fauna; rests on Brady soil. Caryan–Mankatoan.
C. K. Bayne and H. G. O'Connor, 1968; in D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 60, 65–67. In northeastern area, discontinuous deposits along the Missouri River valley; maximum thickness is 35 ft (10.5 m); thins rapidly away from the valley. In southeastern area, discontinuous eolian silt (loess) that has been incorporated into the modern soil. In central and western area, generally less than 10 ft (3 m) thick, becoming more widespread from central into western area.
Type locality: About 1.7 mi (2.7 km) due south of Bignell, southeast of North Platte, in E/2, E/2, sec. 3, T. 12 N., R. 29 W., Lincoln County, Nebraska.

Big Lake sand
Pennsylvanian: Miami County, Kansas.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 78. Shallow sandstone that is productive in the Big Lake field, a part of the Paola–Rantoul area; seemingly comprises two sandstone bodies, the Hepler sandstone (basal deposit of the Pleasanton group) and the Bandera Quarry sandstone, in the Bandera shale.

Big lime
Pennsylvanian: eastern Kansas.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 78. The term "Big lime" is used to designate the Pawnee limestone in the subsurface of eastern Kansas.

Black lime
Black limestone member (of Mississippi lime)
Mississippian (?Chesterian): south-central Kansas and northern Oklahoma.
F. L. Aurin, G. C. Clark, and E. A. Trager, 1921, American Association of Petroleum Geologists, Bulletin, v. 5, p. 117–153. The black limestone member (or Black lime) is a black shaly or sandy limestone that maintains its identity at least as far north as Cowley, Chautauqua, and Elk counties, Kansas, and east at least as far as Washington, Tulsa, Wagoner, and Muskogee counties in Oklahoma. From Osage County, Oklahoma, to the north and east it seems to become thinner. In Nowata County, Oklahoma, and eastern Montgomery, northern Greenwood and eastern Chase counties, Kansas, the Mississippi lime consists entirely of gray limestone and chert. Probably equivalent to the Mayes limestone of Chester age; middle member of Mississippi lime; underlies unconformably an upper member of gray limestone and chert of unknown age (if the Black lime correlates with the Mayes); overlies unconformably a lower member of gray limestone and chert that correlates with Boone limestone.

Blaine Formation (of Nippewalla Group)
Blaine Gypsum (of Double Mountain Group)
Blaine division
Permian (Leonardian Series): western Oklahoma, southern Kansas, and northern Texas.
C. N. Gould, 1902, Oklahoma Geological Survey, 2nd Biennial Report, p. 42, 47. Blaine division is red shales, with interbedded strata of gypsum and dolomite; average thickness 75 ft (22.7 m); includes (bottom to top) Ferguson gypsum, red shale, Magpie dolomite, Medicine Lodge gypsum, Jenkins clay, Altona dolomite, and Shimer gypsum; overlies Norman division; underlies Woodward division.
D. A. Green, 1936, American Association of Petroleum Geologists, Bulletin, v. 20, p. 1,468–1,469. In Oklahoma includes (ascending): Medicine Lodge, Alabaster, Shimer, Lovedale, and Haskew Members.
G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,764 (fig. 3), 1,766, 1,793–1,799. In Kansas, included in Salt Fork division of Cimarronian Series. Includes: Haskew Gypsum Member, Shimer Gypsum Member, Nescatunga Gypsum Member, Medicine Lodge Gypsum Member. Overlies Flowerpot Shale; underlies Dog Creek Shale.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 158, 161 (fig. 4). Included in Nippewalla Group. Thickness about 50 ft (15 m).
H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 52. Consists mainly of gypsum beds separated by dolomite and red shale. In many places, upper three members are absent. Crops out in Clark, Comanche, Kiowa, and Barber counties.
Type locality: In Salt Creek (Henquenet's) Canyon, northern Blaine County, Oklahoma.

Blanco formation
Blanco beds
Blanco Canyon beds
Pleistocene (Nebraskan): Texas and Kansas.
E. T. Dumble, 1890, Texas Geological Survey, 1st Annual Report, p. lxxi. Blanco Canyon beds are white clays, infusorial earth, etc., containing fossil remains of turtles and large animals. Forms upper part of Staked Plains. Probably corresponds to upper part of Fayette beds, which it closely resembles in some lithologic features.
W. F. Cummins, 1890, Texas Geological Survey, 1st Annual Report, p. 190. Red clay, white sandy clays, white clays, and a hardened clayey limestone; forms bold escarpment 200 ft (61 m) high. Unconformably overlies Dockum beds. Post-Cretaceous.
W. F. Cummins, 1892, Texas Geological Survey, 3rd Annual Report, p. 134. Name changed to Blanco beds.
G. L. Evans and G. E. Meade, 1944, Texas University Bureau of Economic Geology, Publication 4401, p. 485–507. Thickness 56–74 ft (17–22 m). Assigned Pleistocene (Nebraskan) age.
J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 58–68. Coarse-textured deposits in lower part that fine upward in Kansas and elsewhere in Great Plains, therefore two names should be used. Holdrege and Fullerton formations are used in Nebraska, therefore names used in Kansas as members of Blanco formation. Greatest thickness (>250 ft [76 m]) in southwestern Kansas.
[Blanco seems to have been dropped sometime before publication of KGS Bulletin 189. No mention is made of it, even though Holdrege and Fullerton Formations are used.]
Named for Blanco Canyon, Dickens County, Texas, and Mount Blanco post office, Crosby County, Texas.

Blankenship sand
Pennsylvanian (Desmoinesian): Greenwood and Butler counties, Kansas.
W. R. Berger, 1921, American Association of Petroleum Geologists, Bulletin, v. 5, p. 276. The main producing horizon is a lenticular sand termed the Sallyards or Blankenship sand; occurs about 300 ft (91 m) below the Fort Scott limestone and about 100–150 ft (30–45 m) above the "Mississippi lime."
Name probably derived from Blankenship pool, which is a southwestward extension of the Sallyards field.

Block Limestone Member (of Cherryvale Shale)
Block Limestone Member (of Sarpy Formation)
Upper Pennsylvanian (Missourian Series): eastern Kansas, southwestern Iowa, and northwestern Missouri.
R. C. Moore, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 85, 97. Cited manuscript of N. D. Newell. Term applied to dense, bluish, evenly bedded limestone about 15 ft (4.5 m) above the Winterset limestone; 3–5 ft (0.9–1.5 m) thick in the type region.
N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 37. First formal description.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,031 (fig. 4); 1949, Kansas Geological Survey, Bulletin 83, p. 68 (fig. 14), 94–95. Member of Cherryvale; underlies Wea shale member; overlies Fontana Shale Member. This is classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma with proviso that some differences may be required by regional variation.
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 38. In Nebraska, basal member of Sarpy formation

Columbus, and that caps the timbered hills 2 mi (3.2 km) southwest of Columbus.

W. B. Howe, 1951, American Association of Petroleum Geologists, Bulletin, v. 35, no. 9, p. 2,087–2,091. Type section revised. As originally defined by Ohern (1914, unpublished manuscript), type section of formation includes several sandstone beds, some of which are similar to the Bluejacket, and actual unit called Bluejacket is not clearly differentiated.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37. Shown on northern midcontinent composite stratigraphic column as Bluejacket formation in Krebs group. Overlies Drywood formation; underlies Seville formation.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22, 39–43. Formation includes beds directly above Dry Wood coal and extending to top of Bluejacket coal bed. Succession includes Bluejacket Sandstone (Ohern, 1914; Howe, 1951) from which formation takes its name. Overlies Dry Wood formation; underlies Seville formation. Krebs subgroup of Cherokee group.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas, Kansas Geological Survey. Shown on chart as Bluejacket Sandstone in Krebs Formation.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. Present near the top of the Krebs Formation. Thickness on outcrop is 10–40 ft (3–12 m).

L. A. Hemish, 1989, Oklahoma Geology Notes, v. 49, p. 72–89. Discussion of the Bluejacket Sandstone at its type area, and showing variation in lithology within a short distance.

Type locality: NE NE sec. 25, T. 27 N., R. 20 E., along road from Bluejacket west to Pyramid Corners, on east slope of Timbered Hill, Craig County, Oklahoma.

Blue Mound coal (in Stranger Formation, Douglas Group)

Pennsylvanian (Virgilian Series): northeast Kansas, in part of Douglas and Leavenworth counties.

R. E. Whitla, 1940, Kansas Geological Survey, Bulletin 32, p. 335–36. Located in the vicinity of Blue Mound, about 5 mi (8 km) south of Lawrence, Douglas County. The Blue Mound coal bed is the lowest of three coals lying just below the Tonganoxie Sandstone. The coal is about 55 ft (165 m) below the top of the Tonganoxie Sandstone. Thickness of the coal where exposed ranges from 7 to 14 inches (17.5–35 cm).

A. L. Bowsher and M. J. Jewett, 1943, Kansas Geological Survey, Bulletin 46, p. 39–40. Best developed in the Blue Mound area where it was mined at several locations. The coal becomes thin and disappears to the south in Douglas County, and is found very locally north in Leavenworth County.

Blue Rapids Shale (of Council Grove Group)

Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 22. *Blue Rapids shale* is new name for basal part of Speiser shale as originally defined. It includes the beds between Crouse limestone below and Funston limestone above. Thickness in Nebraska 23 ft (7 m) or more, decreasing southward to about 16 ft (4.8 m) at Oklahoma line. From Junction City, Kansas, southward to Oklahoma the lower part of the Blue Rapids is a slabby sandy shale. Type locality in cuts of K–77, about 1 1/4 mi (2 km) north of Blue Rapids, Kansas. *Blue Rapids shale* as used on p. 66 of Kansas Geological Society, 10th Annual Field Conference, Guidebook, September 4–7, 1936, is a misprint for *Blue Springs shale*.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 65. Proposed that Bigelow be dropped and that Crouse Limestone, Blue Rapids Shale, and Funston Limestone be recognized as formations.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 46. Gray, green, and red shale; contains local limestones and locally a coal bed in Geary County. Thickness 15–30 ft (4.5–9 m). Underlies Funston Limestone; overlies Crouse Limestone. Wolfcampian Series.

Type locality: In cuts of K–77, about 1.5 mi (2.4 km) north of Blue Rapids, Marshall County, Kansas.

Blue Springs Shale Member (of Matfield Shale)

Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 38. Top member of Matfield Formation. Thickness in Nebraska, 28 or 29 ft (8.5–8.8 m); 25 ft (7.6 m) in section east of Burden, Kansas, where it consists of upper and lower shales and a limestone below middle. These units extend north to beyond Florence and south to Oklahoma. Type locality in foot of Blue River bluffs southeast of Blue Springs, Gage County, Nebraska. Overlies Kinney Limestone and underlies Florence Flint.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 45. Middle member of Matfield Shale, chiefly red and gray, and relatively minor amount of limestone, except in southern Kansas where several limestone beds occur in upper part of member; farther north, member is less calcareous and limestone is absent; fossils occur in thin limestones and in gray shale beds in southern part of outcrop area. Thickness about 30 ft (9 m). Overlies Kinney limestone member; underlies Florence limestone member of Barneston limestone. Wolfcampian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 48, and pl. 1. The Blue Springs Member consists chiefly of red and gray shale, and a relatively minor amount of limestone. In southeastern Kansas the gray calcareous shales and several of the thin limestone beds, which occur in the upper part of the member, are fossiliferous. In northeastern Kansas, the member is less calcareous and limestone is absent. The thickness ranges from about 15 to 35 ft (4.5–10.6 m).

Type locality: In foot of Blue River bluffs southeast of Blue Springs, Gage County, Nebraska.

Boice Shale

Boice Shale (of Buckner Group)

Mississippian (Kinderhookian Series): subsurface of northeastern Kansas and southwestern Nebraska.

E. C. Reed, 1946, American Association of Petroleum Geologists, Bulletin, v. 30, no. 3, p. 348–349. Name applied to subsurface sequence previously referred to the Hannibal. Consists predominately of shale with minor amounts of siltstone and sandstone near top; base is marked by zone of

Member of Lane Shale and underlying Merriam Limestone Member of Plattsburg Limestone. Redefine Bonner Springs Shale as member of Lane Shale. Commonly contains maroon mudstone at top associated with local paleosol development.

Type locality: Lone Star cement plant northeast of Bonner Springs, Wyandotte County, Kansas (W/2, sec. 28, T. 11 S., R. 23 E.).

Bonneterre Dolomite

Bonne Terre limestone

Upper Cambrian: southeastern Missouri and Kansas subsurface.

F. L. Nason, 1901, American Journal Science, 4th, v. 12, p. 358–361. Non-cherty limestones, 300 ft (91 m) thick; some fossiliferous strata; contains upper and lower lead zones; overlies La Motte sandstone; unconformably underlies Potosi slates and conglomerates.

C. Lochman, 1940, Journal of Paleontology, v. 14, n. 1, p. 1–53. Basal 50 ft (15 m) is interbedded glauconitic sandstones, gray and yellow shales, fossiliferous limestones, and barren white or pink dolomites; upper 200- to 300-ft (61–91 m) section is barren crystalline dolomite. Upper Cambrian.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 12. Bonneterre is conspicuously glauconitic, dark-gray to brown dolomite in eastern Kansas subsurface, white in western Kansas. Thickness locally 0 ft on Central Kansas and Nemaha uplifts to 150 ft (45 m). Gradationally overlies Lamotte Sandstone.

V. E. Kurtz, J. L. Thacker, K. H. Anderson, and P. E. Gerdemann, 1975, Missouri Department of Natural Resources, Geological Survey, Report of Investigations 55, 118 p. The Bonneterre Dolomite is not present in southeastern Kansas and the adjoining areas of Missouri, Oklahoma, and Arkansas. Those rocks formerly named Bonneterre are interpreted to belong to the Derby–Doerun Dolomite and the Davis Formation. The Derby–Doerun is conformable with overlying Eminence Dolomite.

Named for exposures at Bonneterre, St. Francois County, Missouri.

Boone limestone

Mississippian.

J. C. Branner and F. W. Simonds, 1891, Arkansas Geological Survey, Annual Report 1888, v. 4, p. xiii, 27–37. [According to p. xiii, the formation was named by Branner; the description is by Simonds.] *Boone chert and cherty limestone*—Characterized by layers of limestone, usually hard, compact, and gray, interbedded with chert, white or gray on freshly broken surface but becoming brownish on exposure. Thickness 150–200 ft (45–61 m) in Washington County, Arkansas. Underlies Wyman [Batesville] sandstone and overlies Devonian(?) Eureka shale [Chattanooga shale].

T. C. Hopkins, 1893, Arkansas Geological Survey, Annual Report 1890, v. 4. Basal member of Boone chert is here named St. Joe limestone.

G. I. Adams and E. O. Ulrich, 1904, U.S. Geological Survey, Professional Paper 24. Correct stratigraphic succession in northern Arkansas is (descending): 1) Wedington sandstone (=Batesville sandstone of Simonds); 2) Fayetteville formation; 3) Batesville sandstone (=Wyman sandstone of Simonds); 4) Moorefield shale (=Fayetteville shale in part of Branner); 5) Spring Creek limestone (local); 6) Boone limestone, including St. Joe limestone member at base. Wedington sandstone may belong to Fayetteville formation. [The Wedington sandstone has for many years been treated as a member of Fayetteville shale.]

H. H. Charles, 1927, Kansas Geological Survey, Bulletin 6, pt. 7, p. 26. Rocks of Mississippian age found in Anderson County.

A. E. Fath, 1921, Kansas Geological Survey, Bulletin 7, p. 24, 29, pl. 7. A limestone near the base of the Mississippian System; often called Boone chert by operators and drillers.

G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 217, 218. *Boone formation*—limestone, dolomite, and chert; originally all limestone; constitutes almost entire Mississippian section in Tri-state mining district; divided into series of lettered beds (B–R); 200–400 ft (61–121 m) thick.

L. M. Cline, 1934, American Association of Petroleum Geologists, Bulletin, v. 18, no. 9, p. 1,132. St. Joe limestone, formerly considered member of Boone, here raised to formation rank. Term Boone should be suppressed as synonym of term Osage.

R. C. Moore, 1935, Kansas Geological Survey, Open-file Report 35–1, chart. Boone listed as upper part of Valmeyer Series; described as light-gray, fine- to coarse-grained limestone with abundant chert.

A. W. Giles, 1935, Geological Society of America, Bulletin, v. 46, no. 12, p. 1,815–1,867. Made a detailed study of the chert of the Boone limestone and divided the formation into the following members in northeast Oklahoma and northern Arkansas (descending order): Green limestone and Short Creek oolite (both of Warsaw age), Keokuk limestone, Burlington limestone, Fern Glen limestone, and St. Joe limestone (of Fern Glen age).

T. C. Hiestand, 1938, American Association of Petroleum Geologists, Bulletin, v. 22, p. 1,588–1,599. Stratigraphic studies using insoluble residues indicate that the "Mississippi lime" can be subdivided into zones that closely correspond with members of the Boone limestone of Missouri.

G. E. Abernathy, 1941, Kansas Geological Survey, Bulletin 38, p. 232. Several porous zones that occur locally within the Boone limestone of Mississippian age generally contain a supply of ground water.

J. A. Straczek and D. M. Kinney, 1950, U. S. Geological Survey, Mineral Investigation Field Studies Map MF–1. Boone chert mapped in Batesville manganese district. Includes St. Joe limestone member, locally, at base.

E. E. Glick, S. E. Frezon, and B. R. Haley, 1956, Kansas Geological Society, Guidebook, 20th Field Conference, cross section. Lower and Upper Mississippian.

G. G. Huffman, 1958, Oklahoma Geological Survey, Bulletin 77, p. 1, 14 (fig. 2), 40–41. Osagean series, frequently referred to as "Boone chert," includes St. Joe, Reeds Spring, and Keokuk formations.

C. H. Behre, Jr., and A. V. Heyl, Jr., 1959, Deutsche Geologische Gesellschaft, Zeitschrift, v. 110, pt. 3, p. 517 (fig. 2). Chart shows Boone formation comprises (ascending) Reeds Spring, Grand Falls, and Short Creek members. Overlies Northview shale; underlies Carterville formation.

E. T. McKnight and R. P. Fischer, 1970, U. S. Geological Survey, Professional Paper 588, p. 13, 15, 19–55. Areal distribution, thickness, and lithologic character of Boone formation in Kansas noted; Boone Formation consists of seven members (from bottom to top): St. Joe Limestone

more maturely developed than the modern soil and is dark gray in the upper part, grading into a grayish-brown zone containing small caliche nodules; widespread, but discontinuous in the uplands of northwestern Kansas below the Bignell Formation; identified only in alluvial deposits in south-central Kansas.

Type locality: Bignell Hill section, southeast of North Platte, 1.7 mi (2.7 km) south of Bignell, in E/2, E/2, sec. 3, T. 12 N., R. 29 W., Lincoln County, Nebraska (same type section as for Bignell loess).

Brazos series

Late Permian and Triassic: Texas, Oklahoma, southern Kansas, and eastern New Mexico.

R. T. Hill, 1901, U.S. Geological Survey, 21st Annual Report, pt. 7, p. 100–103. All rocks of Texas, Oklahoma, Kansas, and eastern New Mexico between the top of conformable Coleman division of Permian–Carboniferous beds below and base of unconformable Cretaceous above. Consists of red clays, sandstones, occasional impure limestone, some conglomerate, and great beds of gypsum. Includes Wichita, Clear Fork, Double Mountain, and Dockum formations.

Named for Brazos River, north-central Texas.

Breezy Hill Limestone Member (of Cabaniss Formation)
Breezy Hill Limestone Member (of Senora Formation)
Breezy Hill Limestone Member (of Cherokee Shale)
Breezy Hill Limestone Member (of Mulky Formation)

Pennsylvanian (Desmoinesian Series): Kansas, Missouri, and Oklahoma.

W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 17; 1938, Kansas Geological Survey, Bulletin 24, p. 33–35. Breezy Hill Limestone member is about 5 ft (1.5 m) below top of the Cherokee; in most places it consists of 6 inches to 2 ft (15 cm–0.6 m) of gray impure concretionary to nodular limestone, but may exhibit considerable variation in thickness and character of material. In most places it is from 1 to 3 ft (0.3–0.9 m) below Fort Scott coal; where coal is absent, Breezy Hill maintains its same stratigraphic position and is from 4 to 8 ft (1.2–2.4 m) below top of Cherokee. Underlain by "Squirrel sand" of drillers.

W. B. Howe, 1951, American Association of Petroleum Geologists, Bulletin, v. 35, no. 9, p. 2,091–2,092. Member of Cherokee formation. Geographically extended into northern Oklahoma where it is essentially a single massive bed about 3 ft (0.9 m) thick.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 99. Included in Breezy Hill cyclothem. The cyclothem consists of a thin sandstone known in subsurface as the "Squirrel" up to and including the Breezy Hill Limestone. In part of Labette County there is a thin coal, underclay, and calcareous shale present. Thickness ranges from 10 to 15 ft (3–4.5 m).

C. C. Branson, 1954, Oklahoma Geological Survey, Guidebook 2, p. 5. Shown as Breezy Hill Limestone in Mulky Coal cycle of Senora formation in Oklahoma. Occurs above Kinnison Shale. Mulky Coal and underclay not present in Oklahoma.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 84–87, measured sections. Reallocated to member status in Mulky Formation. Occurs between underclay of Mulky Coal, where latter is present, and above Lagonda ("Squirrel") sandstone in southeastern Kansas or above Kinnison Shale in northern Oklahoma. Known in western and northern Missouri only from scattered exposures.

J. V. A. Trumbull, 1957, U.S. Geological Survey, Bulletin 1042–J, pl. 16. Member of Senora Formation in Oklahoma.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas; Kansas Geological Survey. Shown on chart as member of Cabaniss Formation.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. Near Kansas–Oklahoma border, unit becomes thin-bedded to massive. Thickness ranges from 2 ft (0.6 m) in the north to about 16 ft (4.8 m) in the south.

Named for exposures at Breezy Hill, southwest of Mulberry, Crawford County, Kansas.

Bridge Creek Member (of Greenhorn Limestone)
Bridge Creek limestone member

Upper Cretaceous: western Kansas and southeastern Colorado.

N. W. Bass, 1926, Kansas Geological Survey, Bulletin 11, p. 67. Alternating limy shale and thin chalky limestone; four-fifths of member is limy shale, but the limestone beds are the conspicuous feature; thickness 74 ft (22 m). Top member of Greenhorn limestone in Hamilton and Kearny counties, Kansas. Top 25 ft (7.6 m) is equivalent to Pfeifer shale member of counties to the east, the rest of member corresponds to Jetmore chalk member of areas to the east. Rests on Hartland shale member of Greenhorn limestone; overlain by Fairport chalky shale member of Carlile shale.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 153. In Hamilton County, Kansas, the Pfeifer shale member and the underlying Jetmore chalk member are thicker then farther east; they cannot be distinguished and have together been designated the Bridge Creek limestone member; total thickness 74 ft (22 m).

Named for exposures in Bridge Creek, northwest of Medway, Hamilton County, Kansas.

Bronson Subgroup (of Kansas City Group)
Bronson Formation or Group

Pennsylvanian (Missourian Series): eastern Kansas, southern Iowa, western Missouri, and southeastern Nebraska.

G. I. Adams, 1904, U.S. Geological Survey, Bulletin 238, p. 1, 17, 21. Heavy limestone formation, 60–80 ft (18–24 m) thick, including some sandstone and shale; overlies Dudley shale; underlies Chanute shale; includes (bottom to top) Hertha limestone, Ladore shale, Mound Valley limestone, Galesburg shale, and Dennis limestone.

R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference, Guidebook, correlation chart. Bronson group extends from top of Winterset limestone (above) to base of shale and channel sandstone underlying Hertha limestone and resting unconformably on Pleasanton shale.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 90, 97. Includes (bottom to top) Swope, Galesburg, and Dennis formations.

J. M. Jewett, 1933, Kansas Academy of Science, Transactions, v. 36, p. 131. Defined type locality of Bronson group; extends from top of Winterset limestone to base of Sniabar limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 41, 43, 76. Conformably overlies Bourbon formation

of limestone separated by thin, very calcareous shale; commonly fine grained, locally silty; thickness ranges from 1.1 ft to 4.5 ft (0.3–1.4 m), average 2.2 ft (0.7 m).

Type locality: In Missouri River bluffs southwest of railway station at Brownville, Nemaha County, Nebraska [possibly NW SE sec. 19, T. 5 N., R. 16 E.].

Bruno limestone (of Chase group)

Permian: eastern Kansas and southeastern Nebraska.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 38, 40. Limestone just below middle part of Blue Springs shale, which separates the Blue Springs into an upper shale and lower shale.

Named for exposures on Bruno Creek, a few miles northeast of Florence, Kansas.

Buckeye shale (of Sumner group)

Buckeye shale member (of Wellington Shale)

Permian: southeastern Kansas.

R. C. Moore, 1936, Kansas Geological Society, 10th Annual Field Conference, Guidebook, p. 12. Lower part of Wellington shale (restricted); about 45 ft (13.6 m) thick.

J. L. Garlough and G. L. Taylor, 1941; *in*, Stratigraphic type oil fields; American Association of Petroleum Geologists, Tulsa, Oklahoma, p. 87. Lists rocks of Sumner group at their outcrop, 200 mi (320 km) east of Hugoton gas field; Wellington shale divided into (bottom to top): Buckeye shale, Carlton limestone, unnamed shale, and Geuda salt.

Derivation of name not given.

Buckskinian series

Middle Cretaceous: northwestern Kansas and eastern Colorado.

C. R. Keyes, 1941, Pan-American Geologist, v. 76, n. 4, p. 304 (chart). Includes Gove Chalk below and Wallace Shale above; thickness about 700 ft (212 m). Occurs above Pueblan Series and unconformably below Rawlinsian Series.

C. Keyes, 1942, Pan-American Geologist, v. 77, n. 3, p. 207. Includes a great section of dark shales exposed in eastern Colorado and northwestern Kansas, usually called vaguely and erroneously the Pierre Formation. Section covers a large but indefinite part of the median part of Asiniboine centrum shales. There is doubtless another series between the Buckskinian and the top of Apishapa Shale Member of Pueblan Series.

Name derived from a way station in Wallace County, Kansas.

Bunker Hill coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local coal bed name for the Mulky coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 78; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 88).

Burbank sand

Pennsylvanian (Desmoinesian): eastern Kansas.

B. Mills–Bullard, 1928, Oklahoma Geological Survey, Bulletin 40-Q, p. 28, 180. Producing sandstone in the Burbank oil field (T. 26 N. and T. 27 N., R. 5 E. and R. 6 E.), Osage and Kay counties, Oklahoma, occurring about 275–290 ft (83–88 m) below the "Oswego" limestone; Burbank sand is not the Bartlesville sand, but they are found at the same horizon.

H. T. Beckwith, 1928, Oklahoma Geological Survey, Bulletin 40-T, p. 44. The "Burbank" and "Bartlesville sands" of Osage County, Oklahoma, and the "Rainbow Bend" and "Fox Bush" sands in Kansas are seemingly about stratigraphically equal.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 79. Used somewhat commonly for sandstones in the Cherokee shale in eastern Kansas that lie below the Ardmore limestone and above deposits in the same areas that are called "Bartlesville." Seemingly, deposits that are called "Burbank" in some places are called "Bartlesville" or "Upper Bartlesville" elsewhere.

Burgess sand

Pennsylvanian (Desmoinesian): eastern Kansas and northern Oklahoma.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 79–80. Sandstone in the Cherokee shale in eastern Kansas that lies next above or almost in contact with Mississippian limestone; similar usage for basal Pennsylvanian sandstone in Oklahoma is common; however, the basal Pennsylvanian sands of Kansas probably are younger than those of Oklahoma. In some parts of eastern Kansas, "Burgess" and "Tucker" are used interchangeably, but "Tucker" seems to have been applied only to Ordovician rocks. "Tucker" in Oklahoma is used commonly for a Pennsylvanian sandstone below the "Bartlesville" and above the "Burgess."

Burlingame coal (in Wabaunsee Group)

Pennsylvanian (Virgilian Series).

Equivalent to the Nodaway coal bed of the Howard Limestone.

J. W. Beede, 1898, Kansas Academy of Science, v. 15, p. 29. Describes the coal as equivalent to the Osage (which is equivalent to the Nodaway).

Burlingame Limestone Member (of Bern Limestone)

Pennsylvanian (Virgilian Series): eastern Kansas, northern Oklahoma, northwestern Missouri, southeastern Nebraska, southwestern Iowa.

J. G. Hall, 1896, University Geological Survey of Kansas, v. 1, p. 105. *Burlingame limestone*—Just west of Burlingame [Osage County], Kansas, system no. 5 makes its first appearance. It is 8 ft (2.4 m) thick, brown, shelly, and covers the third and last heavy bed of shales in this section, which is 150 or 200 ft (45 or 61 m) thick.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 72, 73, 94, 105. *Burlingame limestone* proposed by J. G. Hall for limestone system no. 5, consisting of brown shelly limestone 8 ft (2.4 m) thick, overlying Osage shale. ["Osage" as here used included Burlingame (Scranton) shale.]

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 215–216. Soldier Creek shale and overlying Wakarusa limestone have been included by various writers in Burlingame limestone at several places in central and southern Kansas. The name *Burlingame* should be restricted to lower limestone, which seems to accord with Hall's original description. Thickness 4–16 ft (1.2–4.8 m). Has been mapped from southern Nebraska across Kansas, and identified 40± mi (64 km) south of Kansas–Oklahoma line. The limestone makes a fairly prominent escarpment that crosses western part of Burlingame, Kansas.

Missouri. Zones B2 and B3 are correlated with the Burlington limestone of Missouri.

J. M. Weller, 1939, Kansas Geological Society, Guidebook, 13th Annual Field Conference, p. 131, 132–133. Included in Osage group, Valmeyer series.

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 57–60, pl. 2. Gray limestone and dolomite with even-textured gray and white opaque chert; extremely cherty in most areas; considerable drusy quartz. The most widely distributed Mississippian formation in Kansas; thickness 0–165 ft (0–50 m), highly variable owing to unconformable upper contact.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, no. 2, chart 5. In Mississippian standard section, Burlington limestone is included in Osagean series. Occurs above the Fern Glen formation and below Keokuk limestone.

C. P. Kaiser, 1950, American Association of Petroleum Geologists, Bulletin, v. 34, no. 11, p. 2,163–2,168. Discussion of stratigraphy of Lower Mississippian rocks in southwestern Missouri. Burlington limestone ranges in thickness from a trace to 145 ft (44 m); thickest in Springfield area. Thins southward from Springfield and disappears from section between Mount Vernon, Lawrence County, and the Tri-state mining district. Divided into six faunal zones that are correlated with equivalent zones in northeastern Missouri. Rests unconformably on Reeds Spring formation in southern part of area. Reeds Spring and St. Joe formations pinch out a short distance north of Springfield, Greene County, and north of here the formation rests unconformably in Northview or Sedalia formations. Keokuk limestone rests with apparent conformity on Burlington limestone in southeastern part of area. Elsewhere the Burlington is either surface formation or is covered by thin veneer of Pennsylvanian sediments. Osagean.

T. R. Beveridge and E. L. Clark, 1952, Missouri Geological Survey and Water Resources, Report of Investigation 13, p. 71–80. Presentation of revision of early Mississippian nomenclature in western Missouri. Kaiser (1950) proposed that name Pierson be dropped, assigning the more dolomitic lower beds to the Sedalia and the upper beds to the St. Joe. Kaiser considered the entire St. Joe to be Osagean and the Sedalia to be Kinderhookian. Thus he placed a series line in the middle of the Pierson of Weller. In present report, the Pierson is accepted as defined by Weller and base of Osagean is placed at Pierson–Northview contact. The Pierson is extended northward to include the silty dolomitic limestone unit which lies between the Northview and the Burlington in west-central Missouri. This unit was included in upper Sedalia of west-central Missouri by Moore (1928, Missouri Bureau of Geology and Mines, 2nd series, v. 21) and Kaiser (1950). Hence Burlington directly overlies Pierson.

E. D. Goebel, 1968, American Association of Petroleum Geologists, Bulletin, v. 52, p. 1,734, 1,743–1,745, 1,750, 1,757–1,762, 1,776. White and gray semicrinoidal limestone interstratified with relatively thin beds of gray dolomite and limestone with minute granular dolomite crystals; large quantities of chert are locally present. The Burlington Limestone is extremely difficult to distinguish from the Keokuk Limestone in western Kansas. The Burlington Limestone probably is not widely distributed in western Kansas. The Burlington conformably overlies the Fern Glen Formation in south-central Kansas and probably overlaps it northward in western Kansas; it disconformably underlies the Keokuk Limestone, to which it is very similar lithologically.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 4–8, 10, 11, 13, 15, 22, 36–38, 40, 48, 62, 67, 68, 71–75, 77, 80, 90–92, 94. Presents synonymy and history of use of the name "Burlington Limestone" in the type area and the rest of Missouri.

Type locality: Exposures in the bluffs of the Mississippi River valley at Burlington, Des Moines County, Iowa. A complete reference section is exposed along a 0.5-mi (0.8-km) stretch of US–65 (W/2 E/2, sec. 21, T. 28 N., R. 21 W., Ozark 7.5-min quadrangle), south of Springfield, Greene County, Missouri (Thompson and Fellows, 1970, p. 210–212).

Burlington–Keokuk Limestone

Mississippian (Osagean Series).

T. C. Hiestand, 1938, American Association of Petroleum Geologists, Bulletin, v. 22, p. 1,588–1,599. Stratigraphic studies using insoluble residues indicate that the "Mississippi lime" can be subdivided into zones that closely correspond with members of the Boone limestone of Missouri. Zone B is correlated with the Burlington–Keokuk limestones of Missouri.

C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 13–16. Burlington–Keokuk not recognized as distinct formations in southwestern Missouri, northeastern Oklahoma, and southeastern Kansas; equivalent to N–K beds of Fowler and Lyden (1932).

E. D. Goebel, 1968, American Association of Petroleum Geologists, Bulletin, v. 52, p. 1,750, 1,757–1,758, 1,761. The Burlington Limestone is extremely difficult to distinguish from the Keokuk Limestone in western Kansas. Where no distinction was possible, the interval of the Keokuk–Burlington Limestone was shown as Osagean in the stratigraphic cross sections. As an undifferentiated unit, the Keokuk–Burlington overlaps older Mississippian Kinderhookian rocks on the north in western Kansas.

C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–68, 71–73. Recommended usage in Kansas for those areas in which lithostratigraphic separation between Burlington Limestone and Keokuk Limestone is not possible (e.g., where the Short Creek Oolite Member is absent or where more than one oolitic bed is present). Where the two can be separated, usually most of the interval is Keokuk rather than Burlington.

Burr Limestone Member (of Grenola Limestone)

Pennsylvanian (Virgilian Series): eastern Kansas, southeastern Nebraska, and north-central Oklahoma.

G. E. Condra and C. E. Busby, 1933, Nebraska Geological Survey, Paper No. 1, p. 10. *Burr limestone member of Grenola formation*—The Grenola formation is divided into following members (descending): Neva limestone, Salem Point shale, Burr limestone, Legion shale, and Sallyards limestone. The salient lithologic feature of Burr member is its lamination. It is calcareous throughout and has a carbonaceous shale in the middle to north. Is of nearshore marine origin. Averages about 11 ft (3.3 m) in thickness from Roca, Nebraska, to Burbank, Oklahoma, disregarding

but not quite the same stratigraphically as Cherokee rocks of southeastern Kansas.

W. V. Searight, 1953; *in*, W. B. Howe and M. V. Searight, Missouri Geological Survey and Water Resources, Report of Investigations 14, pl. 1. Geographically extended into Carroll and Livingston counties, Missouri.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as overlying Krebs Formation and underlying Marmaton Group.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22 (fig. 5), 44–46. Term Cherokee Group re-adopted, and Cabaniss reduced to rank of subgroup.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shown as formation in Cherokee Group. Overlies Krebs Formation; underlies Fort Scott Limestone of Marmaton Group.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. Cabaniss Formation and Krebs Formation included in Cherokee Group. Cabaniss Formation includes: Mulky coal bed, Breezy Hill Limestone Member, Bevier coal bed, Verdigris Limestone Member, Croweburg coal bed, Fleming coal bed, Mineral coal bed, Scammon coal bed, Chelsea Sandstone Member, Tiawah limestone bed, Tebo coal bed, Weir–Pittsburg coal bed. Overlies Seville Limestone Member of Krebs Formation; underlies Excello Shale Member of Fort Scott Limestone, Marmaton Group. Thickness about 220 ft (67 m).

Named for village of Cabaniss in T. 6 N., R. 12 E., northwestern Pittsburg County, Oklahoma.

"Calcarenite zone" (calcarenite bed)

Mississippian.

C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 12, 15. The Burlington–Keokuk succession can be subdivided into four distinct lithologic units below the Short Creek oolite in the Joplin district; from youngest to oldest these units are designated: the calcarenite bed, the marble bed, the cherty bed, and the N-bed. Calcarenite zone is 20± ft (6± m) thick, calcarenite, somewhat crossbedded, containing "cotton rock" bands; upper part of "M bed" (directly below Short Creek oolite member, which is uppermost part of "M bed") of Fowler and Lyden (1932).

Calhoun limestone

Pennsylvanian: eastern Kansas and northwestern Missouri.

J. W. Beede, 1898, Kansas Academy of Science, Transactions, v. 15, p. 28. Three beds of bluish- to yellowish-gray limestone separated by layers of shale; thickness 15–20 ft (4.5–6 m); upper bed massive limestone 7–10 ft (2–3 m) thick. Underlies Calhoun shale; overlies Tecumseh shale.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 181. Same as Deer Creek Limestone. The name Calhoun also was applied to the overlying shale and is now restricted to this shale.

Named for Calhoun Bluffs, about 3 mi (4.8 km) northeast of Topeka, Kansas.

Calhoun Shale (of Shawnee Group)

Calhoun Shale Member (of Shawnee Formation)

Pennsylvanian (Virgilian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

J.W. Beede, 1898, Kansas Academy of Sciences, Transactions, v. 15, p. 29. Soft argillaceous sandstone, 12–20 ft (3.6–6 m) thick, overlain by 38–45 ft (11.5–13.6 m) of fine-textured bluish shale; overlies Calhoun limestone; underlies Topeka limestone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 65. Included in Shawnee Group. Clayey and sandy shale with minor amounts limestone and one or more coal beds. Maximum thickness about 45 ft (13.6 m) near Kansas River. Overlies Deer Creek Limestone; underlies Topeka Limestone.

Named for Calhoun Bluffs, about 3 mi (4.8 km) northeast of Topeka, Shawnee County, Kansas.

Calvert Ash Bed (in Valentine Member of Ogallala Formation)

Pliocene: northwestern Kansas.

J. S. Carey, J. C. Frye, N. V. Plummer, and Ada Swineford, 1952, Kansas Geological Survey, Bulletin 96, pt. 1, p. 9–11, 24–27. Volcanic ash bed, about 22 ft (6.7 m) thick, in lower half of Ash Hollow member and stratigraphically lower than Reager ash bed.

A. Swineford, J. C. Frye, and A. B. Leonard, 1955, Journal of Sedimentary Petrology, v. 25, no. 4, p. 244, 251. Reallocated to Valentine member of Ogallala formation.

Named from exposures in pit of Wyandotte Chemicals Corp., at Calvert, Norton County, Kansas.

Caneyville limestone

Pennsylvanian (Virgilian Series): southeastern Nebraska, eastern Kansas, north-central Oklahoma.

R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Kansas Geological Survey, chart. Two thin limestones separated by about 10 ft (3 m) of shale; overlies French Creek Shale; underlies Pony Creek Shale.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Gray limestone and shale; the Grayhorse limestone occurs at top and Nebraska City limestone at base; overlies French Creek shale; underlies Pony Creek shale; average thickness 15 ft (4.5 m); maximum thickness 35 ft (10.6 m).

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 49, 143, 241–243. Caneyville limestone defined to include beds from the base of the Nebraska City limestone to the top of the Grayhorse limestone.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 194–195. Caneyville limestone composed of Nebraska City member at base (less than 1 ft [0.3 m] to about 5 ft [1.5 m] thick), the unnamed "fusulinid-bearing limestone" (less than 1 ft [0.3 m] to about 1.5 ft [0.5 m] thick) approximately 5–10 ft (1.5–3 m) above the Nebraska City limestone member, and the Grayhorse limestone member (0.5–6.0 ft [0.15–1.8 m] thick) approximately 5–15 ft (1.5–4.5 m) above the fusulinid-bearing limestone. Average total thickness of Caneyville limestone is 15–20 ft (4.5–6 m).

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 41–43. Erected Wood Siding

central Kansas, comprises Fairport Chalk Member in basal part and Blue Hill Shale Member above. Overlies Greenhorn Limestone.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Carlile Shale of Colorado Group comprises (ascending) Fairport Chalk, Blue Hill Shale, and Codell Sandstone Members. Overlies Greenhorn Limestone; underlies Fort Hays Limestone Member of Niobrara Chalk. Upper Cretaceous.

D. E. Hattin, 1962, Kansas Geological Survey, Bulletin 156, 155 p. The Carlile Shale consists of chalky to marly shale and beds of chalky limestone (Fairport Chalk Member), silty clay shales (Blue Hill Shale Member), and sandy shale and sandstone (Codell Sandstone Member). The Greenhorn Limestone–Carlile contact is conformable at the top of the Fencepost limestone in the Pfeifer Member. The Carlile–Niobrara contact is diachronous. The Blue Hill and Codell Members are related through both lateral and vertical lithologic gradation. The Fairport Member is related more closely with the underlying Greenhorn Limestone than the overlying rocks in the Carlile. The rocks of the Carlile were deposited during the regressive phase of the Greenhorn cycle.

H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 57. Carlile Shale of Colorado Group about 300 ft (91 m) thick; includes: Codell Sandstone Member, Blue Hill Shale Member, Fairport Chalk Member.

Named for Carlile Spring and Carlile Station, 21 mi (33.6 km) west of Pueblo, Colorado.

Carlton Limestone Member (of Wellington Formation)
Carlton Limestone (in Sumner Group)

Permian (Leonardian Series): southeastern and south-central Kansas.

R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Kansas Geological Survey, Open-file Report 34–3, chart. Shown as Carlton Limestone Member of Wellington shale; overlies Buckeye shale member.

R. C. Moore, 1935, Rock formations in Kansas; *in,* Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Middle member of Wellington shale; overlies Buckeye shale; underlies shale and Geuda salt; light-gray flaggy limestone with pelecypods, insects and plant remains near base; 18 ft (5.5 m)thick.

W. A. Ver Wiebe, 1937, Wichita Municipal University, Bulletin, v. 12, n. 5, p. 6–8. Wellington Formation is divided into 10 members. The Carlton is the fifth in the sequence (descending). *See* Highland shale member and Chisholm Creek shale member.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 41. Occurs a short distance below Hutchinson Salt Member. Contains fossil insects. Leonardian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 50. Lenticular, locally dolomitic, freshwater limestone. Identified southward from Walton, Harvey County, to Wichita, Sedgwick County, Kansas.

H. G. O'Connor and P. K. Chaffee, 1983, Kansas Geological Survey, Open-file Report 83–25, p. 34. In Meade County, Kansas, consists of several beds of thin impure limestones interbedded with shale; separated from the Annelly Gypsum below by about 40 ft (12 m) of Chisholm Creek Shale.

Derivation of name not given.

Carlyle limestone

Pennsylvanian: eastern Kansas.

E. Haworth and M. Z. Kirk, 1894, Kansas University Quarterly, v. 2, p. 109, 119. Compact, buff-colored limestone, 4–20 ft (1.2–6.1 m) thick, overlain by Le Roy shales and separated from underlying Iola limestone by 75 ft (22.7 m) of shale.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 104. Carlyle is known to be a synonym of Garnett and has to be abandoned.

G. I. Adams, 1903, U.S. Geological Survey, Bulletin 211, p. 41. Carlyle is a synonym of Stanton.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 117, 126, 127. Field work shows that the Carlyle limestone at the type locality is an exact equivalent of Plattsburg limestone. Adams (1903) was correct in considering Carlyle a synonym of Stanton, inasmuch as the type Stanton is shown to be typical Plattsburg limestone.

Named for Carlyle, Allen County, Kansas.

Carterville Formation

Mississippian.

W. S. T. Smith and C. E. Siebenthal, 1907, U.S. Geological Survey, Atlas, Folio 148. *Carterville formation*—Light to dark shales and shaly and oolitic limestones with some massive soft to hard sandstones. Thickness 0–50 ft (0–15 m). Unconformably underlies Cherokee formation and unconformably overlies Boone formation, the upper 100 ft (30 m) of which, above Short Creek oolite member, consists of limestone containing the Carthage quarry beds. The Carterville formation contains Chester fossils (listed). Defined from exposures in sinkholes west of Carterville, Jasper County, Missouri.

G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 217. *Carterville formation*—Sandstones, limestones, and shale; occurs as outliers in sinkholes in all parts of the [Tri-state mining] district; 0–50 ft (0–15 m) thick.

E. B. Branson, 1944, Missouri University, Studies, v. 19, no. 3, p. 268–270. Consists of shaly, lumpy, somewhat conglomeratic, and in most places oolitic limestone, calcareous shale, light to dark argillaceous arenaceous shale, and shaly sandstone, massive unindurated sandstone, massive hard sandstone, and quartzite. Thickness ranges from a few inches up to 50 ft (15 m). Occupies depressions (apparently old sink holes) in Boone formation; in all occurrences surrounded by a rim of Boone limestone.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, p. 148, pl. 2. Name used for Hindsville limestone, Batesville sandstone, and Fayetteville shale, where latter three units are not recognizable.

C. H. Behre, Jr., and A. V. Heyl, Jr., 1959, Deutsche Geologische Gesellschaft, Zeitschrift, v. 110, pt. 3, p. 517 (fig. 2). Chart shows formation, about 16 ft (4.8 m) thick, overlying Short Creek member of Boone formation and underlying Cherokee shale.

E. T. McKnight and R. P. Fischer, 1970, U. S. Geological Survey, Professional Paper 588, p. 60. The Carterville

Cbj coal bed (in Krebs Formation, Cherokee Group)
Pennsylvanian (Desmoinesian Series).
An informal unit used for subsurface correlation of an unnamed coal in the lower part of the Cherokee Group. First used in an unpublished M.S. thesis by J. W. Harris, 1984, University of Kansas, p. 29–30, 42). The Cbj coal bed is a persistent coal below the Seville Limestone of Kansas. Both the Cbj and the underlying Dbj coals are both above the Bluejacket Sandstone Member.
L. L. Brady, L. M. Nuelle, D. B. Haug, D. C. Smith, J. L. Bostic, and J. C. Jaques, 1994, U.S. Geological Survey, Miscellaneous Investigations Series I–2426–A. General stratigraphic relations of the Cbj coal bed with other Cherokee units in southeast Kansas is shown.

Cedar Bluff coal bed (in Galesburg Shale, Bronson Subgroup, Kansas City Group)
Pennsylvanian (Missourian Series): southern Kansas.
J. M. Jewett, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 97 (table), 101. Proposed name for coal separating sandstones in the Galesburg Shale in southeastern Kansas.
W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 202 (fig. 13–2). Cedar Bluff coal bed identified in spillway exposure along spillway at Big Hill Lake, Labette County, Kansas.
Coal is named from a hill west of Verdigris River a few miles north of Coffeyville.

Cedar Bluffs Till
Pleistocene Series (Kansan Stage): northeastern Kansas, southern Nebraska.
E. C. Reed and V. H. Dreezen, 1965, Nebraska Geological Survey, Bulletin, v. 23, p. 32. Thickness about 17 1/2 ft at type locality; overlies Fontanelle Soil at top of Nickerson Till. Well developed in prominent drainage divide between Big Blue River and Missouri River drainage in southeastern Nebraska where it forms prominent lateral moraine.
C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 60, 61, 63, 64. Till of Kansas age has been named Cedar Bluffs Till in the Platte River valley in Saunders County, Nebraska, and the name is adopted for use in Kansas. The Cedar Bluffs Till is typically exposed above the Nickerson Till near the center of sec. 33, T. 3 S., R. 22 E., and in a quarry in SE NW NE sec. 9, T. 5 S., R. 21 E., Doniphan County, Kansas, where a poorly developed interstadial soil underlies the Cedar Bluffs. Locally contains some lenses of sorted sand and gravel; erratics are more common in the Cedar Bluffs than in the Nickerson Till; Cedar Bluffs generally more deeply weathered than Nickerson Till. Commonly brown or reddish-brown clay, but locally contains gray or light-gray clay. Maximum thickness probably exceeds 100 ft (30 m), but generally less than 40 ft (12 m) thick. "Nortonville clay" (as much as 40 ft [12 m] thick) is present at the top of the Cedar Bluffs Till, at the upland level.
Type locality: In bluffs on southwest side of Platte River valley below Boy Scout Camp Cedar, about 3 mi (4.8 km) northeast of Cedar Bluffs, Saunders County, Nebraska, in SW NE sec. 24, T. 17 N., R. 7 E.

Cedar Hills anhydrite
Permian: central Kansas.
R. G. Moss, 1932, Kansas Geological Survey, Bulletin, 19. Bed of gypsum 20–60 ft (6–18 m) thick, forming basal bed of Cimarron group in Ness and Hodgeman counties, Kansas. Tentatively correlated with Cedar Hill formation.

Cedar Hills Sandstone (of Nippewalla Group)
Cedar Hills Sandstone Member (of Hennessey Shale)
Cedar Hills Sandstone (of Cimarron Group)
Permian (Leonardian Series): southern Kansas and northern Oklahoma.
F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 3, 24. Chiefly unevenly hard, in part massive, concretionary, fine-grained, bright red sandstones, 50–75 ft (15–23 m) thick, locally underlying Flower-pot shales and overlying Salt Plain measures in Barber County, Kansas; included in Salt Fork division.
G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,782, 1,789–1,791. Assigned to Nippewalla Group (new).
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 39. Consists of feldspathic sandstone, siltstone, and silty shale, chiefly red, containing beds of white sandstone in upper and lower parts; upper part contains "snow balls" of white gypsum; shaly siltstone separates the more resistant and more massive coarse siltstone and very fine sandstone. Thickness about 180 ft (55 m). Underlies Flowerpot Shale; overlies Salt Plain Formation. Nippewalla Group. Leonardian Series.
Named for Cedar Hills, Barber County, Kansas.

Cedar Point shales and shaly limestones
Permian: central Kansas.
L. C. Wooster, 1905, The Carboniferous rock system of eastern Kansas: Kansas State Teachers College, Emporia. Cedar Point (Matfield) shales and shaly limestones, about 92 ft (28 m) thick, overlie Wreford limestone and underlie Florence flints. Included in Florence beds.
Probably named for Cedar Point, Chase County, Kansas.

Cedarvale shale
G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, series 2, p. 1–12. Named the shale bed underlying Rulo limestone, the *Cedarvale shale*, and his 1935 classification (Nebraska Geological Survey, Paper 8) adheres to that nomenclature.
M. G. Wilmarth, 1957, U. S. Geological Survey, Bulletin 896, p. 384. Misspelling of Cedar Vale shale.

Cedar Vale Shale Member (of Scranton Shale)
Pennsylvanian (Virgilian Series): eastern Kansas, northern Oklahoma, northwestern Missouri, southeastern Nebraska, southwestern Iowa.
G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, p. 53. Nebraska Geological Survey now restricts White Cloud shale to that part of Scranton shale below Happy Hollow limestone and applies *Cedar Vale shale* to interval between Rulo limestone above and Happy Hollow limestone below. Classed as a member of the Scranton shale.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 49 (fig. 11), p. 212. *Cedar Vale shale* is bluish- to

Goodland limestone. However, the line between the Fredericksburg and Washita [formations in southern Oklahoma and northern Texas] is difficult to establish from paleontologic evidence, which has resulted in the Champion shell bed being included with the Kiowa shale. The Champion shell bed is either basal Washita or Fredericksburg in age.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 28. Occurs at base of Kiowa shale in the type area.

H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 55. Champion shell bed at base of Kiowa Formation in much of the type area.

S. Ross and C. Longpine, 1976, Transactions of the Kansas Academy of Science, v. 79, no. 3/4, p. 93–94. The Champion shell bed is presumed to be the base of the Kiowa Shale. The contacts of the lower shell beds are well defined, while the upper beds are often covered. The upper beds are discontinuous and variable in composition and thickness.

Named for Champion Draw, an arroyo on Medicine Lodge River crossed by AT&SF Railway at Belvidere, Kiowa County, a few rods west of the railway station.

Chanute Shale (of Kansas City Group)

Chanute Shale Member (of Kansas City Formation)

Pennsylvanian (Missourian Series): eastern Kansas, southern Iowa, northwestern Missouri, southeastern Nebraska, and northeastern Oklahoma.

E. Haworth and M. Z. Kirk, 1894, Kansas University Quarterly, v. 2, p. 109. Shales and sandstones, with some coal, 100–150 ft (30–45 m) thick, underlying Iola limestone and overlying Erie limestone.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, pt. 1, p. 50–51. Thickens toward the south. In eastern Kansas, maroon shale near the base ranging in thickness from 1 to 5 ft (0.3–1.5 m) underlain by olive-green shale and overlain by marlite (nodular, spongy rock ranging from argillaceous limestone to calcareous shale).

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 109–111. Stabilized stratigraphic extent to beds between Drum Limestone below and Iola Limestone above. Exposure typical for Chanute Shale identified by Moore along highway in SE sec. 33, T. 26 S., R. 18 E. in Allen County. Thickness ranges from about 10 ft (3 m) in Kansas City area to over 100 ft (30 m) in southern Kansas.

R. C. Moore, N. D. Newell, R. H. Dott, and J. L. Borden, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 40 (table), 43. Lowermost formation in Ochelata Group. Normally overlies Drum Limestone and underlies Iola Limestone. Lower sandstone named Noxie Sandstone Member for exposures around Noxie (NW corner sec. 30, T. 29 N., R. 15 E.) in northern Nowata County, Oklahoma; upper sandstone named Cottage Grove Sandstone Member.

J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. Columnar section, Jackson and Cass counties, shows Chanute Shale comprises (ascending) Quivira Shale, Cement City Limestone, Union Station Shale (new), Paola Limestone, Muncie Creek Shale, Raytown Limestone, and Liberty Memorial Shale (new) members. Overlies Cherryvale Shale. Kansas City Group.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, n. 11, p. 2,031 (fig. 4), 2,032–2,033; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report Investigations 11, p. vi (fig. 2), 12–13. Classification of Kansas City Group revised; Chanute Shale overlies Drum Limestone and underlies Iola Formation.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 36. Thickness of formation 6–7 ft (1.8–2 m) east of Louisville, Nebraska; about 10 ft (3 m) near Kansas City; 25 ft (7.6 m) in northeastern Kansas; about 100 ft (30 m) in southern Kansas.

T. L. Welp, L. A. Thomas, and H. R. Dixon, 1957, Iowa Academy of Science, Proceedings, v. 64, p. 418 (fig. 1), 420. Thickness about 2 ft (0.6 m) in Madison and Adair counties, Iowa. Underlies Iola Formation; overlies Drum Formation. Kansas City Group.

M. C. Oakes, 1959, Oklahoma Geological Survey, Bulletin 81, p. 28–31, pls. 1, 2, measured sections. Rocks assigned to Chanute Formation, in Oklahoma, were included by Ohern (1910) in lower part of Ochelata Member of his Ramona Formation (southern area) and in lower part of unnamed interval between Dewey and Avant limestone lentils of Copan Member of his Wann Formation (northern area). According to classification used on Geologic Map of Oklahoma (Miser, 1926), these beds lie at base of Ochelata Formation (Ochelata group), occupying lower part of interval between Dewey and Avant limestones. On Geologic Map of Oklahoma (Miser, 1954), they are shown as Chanute Formation, lying between Dewey Formation below and Iola Limestone (formation) above. Thickness in Creek County 45–110 ft (13.6–33 m). Formation crops out across Oklahoma in direction slightly west of south from Kansas–Oklahoma line to North Canadian River. Name is not applied farther south.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 26, fig. 5. Consists of greenish-gray, fossiliferous upper shale bed of varying thickness separated from lower greenish-gray shale by thin coal smut. Thickness about 5 ft (1.5 m). Underlies Iola Limestone; overlies Drum Limestone. Kansas City Group.

J. M. Jewett, H. G. O'Conner, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 31. Chanute Shale, in Linn Subgroup, Kansas City Group, is yellowish-brown, sandy shale and dark- to greenish-gray shale, sandstone, and one coal bed. Thickness 12 ft (3.6 m) near Kansas City to 200 ft (61 m) in southeastern Kansas. Lower Noxie Sandstone Member and upper Cottage Grove Sandstone Member recognized in southeastern Kansas.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 14. Type locality mislocated but rediscovered along center line SE SE sec. 34, T. 26 S., R. 18 E. in Neosho County. Principal reference section for upper Chanute Shale at underpass of new US–169 over old highway just to north (SE SW NE, sec. 33, T. 26 S., R. 18 E.) consisting of 17 ft (5.2 m) of sandy micaceous shale with thin sandstone beds well exposed below Iola. Lower Noxie Sandstone and Cottage Grove Sandstone Members as formal members due to lenticularity and diachroneity. Retain as informal names. Thayer coal bed in south separates lower Noxie Sandstone bed from Cottage Grove Sandstone Member.

Named for thick development in vicinity of Chanute, Neosho County, Kansas.

Chattanooga Shale–Mississippian limestone contact, which they interpreted as a goethite ironstone whose anomalously high thorium content suggested a lateritic bauxite precursor. They named this zone the "Boice Shale" facies of the Chattanooga Shale.

Type locality: Hillside exposure at north end of Cameron Hill, Chattanooga, Hamilton County, Tennessee. Standard section: Cut on T–26, at east approach to Sligo Bridge over Caney Fork, 7.1 mi (11.4 km) east of courthouse at Smithville, DeKalb County, Tennessee.

Chautauqua sandstone

Pennsylvanian: southeastern Kansas.

G. I. Adams and E. Haworth, 1898, University Geological Survey of Kansas, v. 3, p. 57–60. The wide zone (15–25 mi [24–40 km]) through which Lawrence shales alternating with sandstones are exposed south of the Neosho River is exceedingly sandy and hilly; proposed name Chautauqua sandstone. Passing south from the Neosho River the shales grade into sandstones, so that at Yates Center they become conspicuous, producing the hill on which town is built. The area broadens to the south, its eastern border passing west of Buffalo, Fredonia, and Tyro, while its western border runs approximately from Yates Center to Toronto, Fall River, Elk Falls, Sedan, and Elgin. To this region the name Chautauqua Sandstone Hills may be given.

Named for Chautauqua Sandstone Hills, which extend through parts of Chautauqua, Woodson, Wilson, Montgomery, Greenwood, and Elk counties, Kansas.

Checkerboard Limestone (of Pleasanton Group)

Checkerboard Limestone Member (of Hepler Formation)

Checkerboard Limestone (of Skiatook Group)

Checkerboard Limestone Member (of Coffeyville Formation)

Pennsylvanian (Missourian Series): northeastern and central Oklahoma, and southern Kansas.

L. L. Hutchinson, 1911, Oklahoma Geological Survey, Bulletin 2, p. 151–164. Lenapah limestone is same formation that is known as "Checkerboard limestone" in region of Glenn pool.

C. N. Gould, 1925, Oklahoma Geological Survey, Bulletin 35, p. 72. Limestone, 2.5–3 ft (0.8–0.9 m) thick, fine-grained, fossiliferous, bluish-white on fresh surfaces, weathers yellowish white. In bare areas it presents a "checkerboard" appearance due to solution channels along joints, which occur in two sets, the one crossing the other. Designated type locality.

R. C. Moore, N. D. Newell, R. H. Dott, and J. L. Borden, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 40 (table), 42. Rank raised to formation in Skiatook Group. Overlies Seminole Sandstone; underlies Coffeyville Shale.

M. C. Oakes and J. M. Jewett, 1943, American Association of Petroleum Geologists, Bulletin, v. 27, p. 634 (fig. 1), 638–639. Extended into southern Kansas; overlies Hepler Sandstone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 91. Included in Pleasanton Group; underlies shales below Knobtown sandstone. Thickness 0–6 ft (0–1.8 m).

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 27. An important marker bed in northeastern Oklahoma and southern Kansas. Thickness 0–14 ft (0–4.2 m) in Kansas. Overlies Seminole Formation; underlies Tacket Formation.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 5, 7. Lower member in Tacket Formation. Overlies South Mound Shale Member of Hepler Formation and underlies Lower Tacket Shale. Recognized in extreme southern Kansas.

Type locality: Exposures along Checkerboard Creek in T. 15 N., R. 11 E., Washington County, Oklahoma. A good exposure may be seen at "Checkerboard Crossing" of the creek near east-west quarter line of sec. 22, T. 15 N., R. 11 E.

Reference section: Exposure along top of high bank of Pumpkin Creek in SW NE, sec. 10, T. 33 S., R. 18 E., in Labette County, Kansas. One to 1.3 ft (0.3–0.4 m) of dense skeletal calcarenite.

Chelsea Sandstone Member (of Cabaniss Formation)

Chelsea sandstone lentil (in Cherokee formation)

Pennsylvanian (Desmoinesian Series): southeastern Kansas, northeastern Oklahoma, and southwestern Missouri.

G. C. Clark and C. L. Cooper, 1927, Oklahoma Geological Survey, Bulletin 40–H, (fig. 3). Chelsea sandstone lentil is 250± ft (75.8± m) below Fort Scott coal (top of Cherokee shale) and 200± ft (60.6± m) above Bluejacket sandstone.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 410. This name was first used by D. W. Ohern in an unpublished manuscript on the Nowata and Vinita quadrangles.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748 (fig. 1). Included in Scammon Formation (new) above Tiawah Limestone.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 53, 57–58, 59. In Scammon Formation. Present in exposures in strip mines in Crawford County, Kansas, and Barton County, Missouri, where in many areas it rests upon an erosion surface extending down through lower beds and locally through the Tiawah Limestone and underlying Tebo coal. Typically a gray to brown, very fine grained micaceous crossbedded sandstone. Thickness 5–30 ft (1.5–9 m).

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Member of Cabaniss Formation in Kansas.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. A gray to brown, fine-grained sandstone that is locally conglomeratic. Maximum thickness about 30 ft (9 m). Forms prominent escarpment from upper branches of Whiteoak Creek, then south and west to Chelsea, Rogers County, Oklahoma.

Named for exposures that form prominent escarpment from upper branches of Whiteoak Creek, south and west to Chelsea, Rogers County, Oklahoma.

Cherokee coal (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Weir–Pittsburg coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 48).

Group. Occurs between Dennis Limestone and Drum (equivalent to Dewey) Limestone. Precisely equivalent to Nellie Bly Formation (Gould, 1925, from unpubl. ms. of D. W. Ohern) of northeast Oklahoma, which by misunderstanding of section near Coffeyville was formerly thought to be an expansion of shale equivalent to part of Drum of Kansas. Thickness about 90 ft (27 m) at Cherryvale; 10 ft (3 m) or less west of Coffeyville; southward increases to about 125 ft (38 m) east of Bartlesville and to more than 300 ft (91 m) in latitude of Tulsa.

J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. Shows Cherryvale Shale in Kansas City Group, comprises (ascending) Fontana Shale, Block Limestone, Wea Shale, and Westerville Limestone members. Overlies Dennis Limestone; underlies Chanute Shale.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 191. South of Linn County, where Westerville and Block limestones have not been identified, the interval between the Drum and Winterset limestones is known as Fontana–Quivira or Cherryvale Shale. Near Cherryvale, unit comprises about 60 ft (18 m) of bluish-gray, silty shale containing layers of blue, dense limestone near top.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,030, 2,031 (fig. 4). Cherryvale Shale, at type locality, consists entirely of shale, but farther north there are persistent limestones (Block, Westerville) that extend into Iowa and Nebraska. As recognized by interstate agreement of State Geological Surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, formation consists of: Quivira Shale Member, Westerville Limestone Member, Wea Shale Member, Block Limestone Member, Fontana Shale Member. Overlies Dennis Formation; underlies Drum Limestone. Kansas City Group. Classification of Missourian strata in northern Oklahoma diverges from interstate usage.

T. L. Welp, L. A. Thomas, and H. R. Dixon, 1957, Iowa Academy of Science, Proceedings, v. 64, p. 418 (fig. 1), 420–421. Thickness of formation about 24 1/2 ft (7.4 m) in Madison and Adair counties, Iowa. Comprises (ascending) Wea–Fontana Shale, Westerville Limestone, and Quivira Shale Members. Overlies Dennis Formation; underlies Drum Formation. Kansas City Group.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 11. Cherryvale Shale is redefined as Cherryvale Formation overlying the Dennis Limestone and underlying the Nellie Bly Formation. Redefined to include only: Westerville Limestone (Drum Limestone) Member, Wea Shale Member, Block Limestone Member, Fontana Shale Member. In southern Kansas: Drum Limestone Member, Middle flaggy limestone member, Lower shale member.

Classification is original to Hinds and Greene (1915). Drum Limestone correlation in type area of Independence with Cement City Limestone in Kansas City area by Moore (1949) is incorrect. Drum Limestone is facies in upper Cherryvale that is at the same stratigraphic level as Westerville Limestone, but precise correlation has not yet been established. Block Limestone of eastern Kansas is at similar stratigraphic level as Middle flaggy limestone.

Type section: In road ditch along east line SE SE, sec. 32, T. 31 S., R. 17 E., 2 mi (3.2 km) north of Cherryvale, Montgomery County, Kansas.

"cherty bed"

Mississippian.

C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 12, 15. The Burlington–Keokuk succession can be subdivided into four distinct lithologic units below the Short Creek oolite in the Joplin district; from youngest to oldest these units are designated: the calcarenite bed, the marble bed, the cherty bed, and the N-bed. Cherty bed is 20± ft (6± m) thick; chert and limestone; chert white, dense to porous; limestone medium-grained, crinoidal; lowermost part of "M bed" of Fowler and Lyden (1932).

Chesterian Series

Chester Stage

Upper Mississippian.

A. H. Worthen, 1860, American Association for Advancement of Science, Proceedings, v. 13, p. 312–313. Upper Archimedes or Chester Limestone usually consists of three subdivisions: 1) Upper limestone, 40–60 ft (12–18 m) thick in Pope County, Illinois, massive, gray, in regular beds with argillaceous partings; 2) arenaceous or calcareous-argillaceous material, which in Pope County contains shaly sandstone with terrestrial plants; 3) lower limestone.

A. H. Worthen, 1866, Illinois Geological Survey, v. 1, p. 40, 77, 284–292, 305–308. *Chester group*—In 1853 I designated in my notes the beds at Chester as Chester limestone. In 1856 Hall read a paper before Albany Institute. His reasons for substituting Kaskaskia for Chester limestone do not appear, and we [Worthen and F. B. Meek] prefer to retain the name first given to it, when its true position in the series was determined. The group consists of three or more limestones with intercalated beds of arenaceous and argillaceous shales and sandstones, 500 to 800 ft (152–242 m) thick, underlying Coal Measures and Millstone grit and overlying St. Louis group [Meramec group]. Includes Ferruginous [Aux Vases] sandstone at base.

R. C. Moore, 1935, Kansas Geological Survey, Open-file Report 35–1, sheet. *Chester Series*—Blue-gray limestone and shale, local thin deposits filling sinks and depressions as in Joplin district and several hundred feet in the Dodge City basin. May include some Morrow beds in this area. Unconformity at base. Maximum thickness of 1,125 ft (341 m) in Watchorn's Morrison No. 2, Dodge City basin.

J. M. Weller, 1939, Kansas Geological Society, Guidebook, 13th Annual Field Conference, p. 131, 134-137. Chester series comprises (ascending) New Design, Homberg, and Elvira groups (all new). Chester series everywhere overlies Meramec strata (herein classified as group in Valmeyer series) unconformably, and in Monroe County, Illinois, it overlaps from the Ste. Genevieve onto the St. Louis. Pennsylvanian strata are everywhere separated from older beds in upper Mississippi valley by an unconformity. In southwestern Illinois, the Chester series is completely overlapped, and Pennsylvanian beds rest upon all formations from the Kinkaid to Ste. Genevieve or possibly St. Louis limestone.

J. R. Clair, 1948 [1949], Kansas Geological Society, p. 1–3, pl. 1 [World Oil, v. 129, no. 8, p. 61, 62]. No attempt to subdivide into component formations, but roughly three main lithologic groups developed (descriptions provided); 30–379 ft (9–115 m) thick.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 21. Unconformably overlies

of Harper Sandstone (restricted). Has three-fold character: 1) highly variable sand and shale section at base; 2) series of bench-forming well-cemented even-bedded red sandstones; and 3) white sandstones, dolomite lentils, and concretions in red shale. Type locality designated.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 51. Member thins northward along outcrop; thickness 100–160 ft (30–48 m).

Type locality: Sec. 10, T. 31 S., R. 6 W., Harper County, Kansas. Named for exposures along Chikaskia River.

Childers School Limestone Member (of Pawnee Limestone)

Pennsylvanian (Desmoinesian): southeastern Kansas and northeastern Oklahoma.

R. C. Price, 1984; *in*, N. J. Hyne, ed., Limestones of the Midcontinent, Tulsa Geological Society, Special Publication, no. 2, p. 383 (fig. 6), p. 384. Describe geometries and lithofacies variation in Nebraska, Iowa, Missouri, Kansas, and Oklahoma. Proposed Childers School Member. Originally suggested in M. S. thesis by Alcock (1942), who proposed a type section in a roadcut at southwest corner, sec. 6, T. 26 N., R. 17 E., Nowata County, Oklahoma.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 2. Include limestone as the lowest member in the Pawnee Limestone.

Type section: In southeast corner, sec. 1, T. 26 N., R. 16 E., Nowata County, Oklahoma (relocated by Price [1981]). Inch or two (2.5–5 cm) of black slabby calcarenite thickening southward.

Chimneyhill Dolomite (of "Hunton group")

Chimneyhill Limestone (of "Hunton group")

Silurian: central southern Oklahoma and subsurface of northeastern Kansas.

C. A. Reeds, 1911, American Journal of Science, 4th, v. 32, p. 256–268. Divided into three informal member: lower member—oolitic limestone, 0–12 ft (0–3.6 m) thick, average 5 ft (1.5 m) thick; middle member—glauconitic limestone, 0–25 (0–7.6 m) ft thick, average 15 ft (4.5 m) thick; upper member—pink crinoidal limestone 0–39 ft (0–11.8 m) thick, average 15 ft (4.5 m) thick; basal member of Hunton formation; unconformably underlies Henryhouse shale; unconformably overlies Sylvan shale.

T. W. Amsden, 1957, Oklahoma Geological Survey, Circular 44, pt. 6 (fig. 3), p. 7–25; 1960, Oklahoma Geological Survey, Bulletin 84, pt. 6, p. 27–66. Formation is complicated sequence which includes several members separated by unconformities. Thickness is 60 ft (18 m) at type location. Includes strata of Lower and Middle Silurian age. Designates type locality.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 15–16. Light-gray to buff, finely crystalline dolomite, with local interbedded limestone. Disconformably overlies Maquoketa Shale; disconformably underlies Devonian rocks. Lack of sand grains distinguishes Silurian from Devonian rocks in Kansas. Maximum thickness is 435 ft (132 m) in Nemaha County.

Type locality: SE sec. 5, T. 2 N., R. 6 E., Pontotoc County, Oklahoma. Named for Chimneyhill Creek which crosses formation in northeastern corner of Arbuckle Mountains.

Chisholm Creek shale member (of Wellington Formation)

Permian: central Kansas.

W. A. Ver Wiebe, 1937, Wichita Municipal University, Bulletin, v. 12, no. 5, p. 5, 11, 12. Approximately 40 ft (12 m) of soft, blocky, claylike shales; red color present in type area, but variably present elsewhere. Overlies Annelly gypsum member; underlies Carlton limestone member.

Type locality: Along the east branch of Chisholm Creek, beginning in the SW sec. 35, T. 26 S., R. 1 E. (Kechi Township)

Chocolate limestone

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 229. Noted that Swallow (1867, American Association for the Advancement of Science, Transactions, v. 15, p. 67) used name "Chocolate limestone" for a "coarse, rough, porous gray and chocolate limestone, full of a very large, ventricose *Fusulina*" on Mill Creek, eastern Wabaunsee County and eastward. The term "Chocolate limestone" is not available because it is not derived from a geographic name. Also used by Swallow (1868, Kansas Geological Survey, Preliminary Report, p. 19) and Beede (1898, Kansas Academy of Science, Transactions, v. 15, p. 27). [equivalent to Tarkio Limestone Member]

Chouteau Limestone

Mississippian (subsurface): northeastern Kansas.

G. C. Swallow, 1855, Missouri Geological Survey, 2nd Annual Report, pt. 1, p. 101, and sections opposite p. 98, 103. *Chouteau limestone*—In Cooper County region, upper part is thick-bedded, brownish-gray, earthy, silico-magnesium limestone 40–50 ft (12–15 m) thick; lower part compact, blue or drab, thin-bedded limestone 20 ft (6 m) thick. Underlies encrinital [Burlington] limestone and overlies vermicular sandstone and shales [Hannibal shale]. Included in Devonian; thins to east and is only 10–30 ft (3–9 m) thick in Marion County.

R. C. Moore, 1928, Missouri Bureau of Geology and Mines, v. 21, 2nd series. Restricted Chouteau limestone to lower member, which he correlated with upper part of Kinderhook group, and named the upper member Sedalia limestone, which he correlated with Fern Glen limestone, and assigned both to Osage group.

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 31–35, pl. 2, 8. Impure earthy, silty gray and dark-gray limestone containing varying amounts of dolomite and chert; also includes some porous sucrosic dark-gray or buff cherty dolomite similar to the overlying Sedalia limestone, except for the abundance of chert; 0–111 ft (0–33.6 m) thick. Present in subsurface of northeastern Kansas north of T. 19 S.; grades southward into Compton Limestone and overlying Northview Shale.

E. B. Branson, 1944, Missouri University Studies, v. 19, no. 3, p. 189–202. Formation in southwestern part of state includes (ascending) Compton, Northview, Pierson, and Reeds Spring members; in southeastern part of state, includes Fern Glen member; in central part of state, includes Sedalia member; in northeastern part of state, undifferentiated. Underlies Burlington limestone; overlies Hannibal shale or Bushberg sandstone.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, no. 2, chart 5. Chouteau limestone

379 m) of mostly red unfossiliferous rocks; overlies, probably unconformably, Big Blue or limestone-bearing series of Permian; unconformably underlies Cretaceous deposits. Includes the following formations (bottom to top): Harper sandstones, Salt Plain measures, Cedar Hills sandstones, Flower-pot shales, Cave Creek gypsums, Dog Creek shales, Red Bluff sandstones, Day Creek dolomite, Hackberry shales, and Big Basin sandstone.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Cimarron series unconformably overlies Sumner group and unconformably underlies Cheyenne sandstone; includes (bottom to top) Enid formation, Cave Creek formation, Woodward formation, and Greer formation.

J. E. Adams, M. G. Cheney, R. K. DeFord, R. I. Dickey, C. O. Dunbar, J. M. Hills, R. E. King, E. R. Lloyd, A. K. Miller, and C. E. Needham, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,677–1,678. Cimarron Series of northern midcontinent region should be abandoned and its constituent strata reclassified as belonging to Leonardian Series and Guadalupian Series.

G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,764 (fig. 3), 1,766–1,814. Cimarron Series overlies Wellington Formation; includes all overlying Permian red beds. Overlies Big Blue Series.

G. E. Condra and E. C. Reed, 1959, Nebraska Geological Survey, Bulletin 14A, p. 24–30. Formations of Cimarron Series are well developed in northern Oklahoma and southern Kansas, some extend in subsurface to southern and western Nebraska and grade into Permian red-bed section of Rocky Mountains.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 50. Cimarron Stage (O'Connor, 1963) includes evaporitic clastic rocks of the Sumner and Nippewalla Groups in Kansas. Probably equivalent to the Leonardian Stage and lower part of Guadalupian Stage of West Texas section.

D. L. Baars, 1990, Geology, v. 18, p. 687–690. Abandoned terms "Cimarronian Stage" and "Cimarronian Series" to be replaced by standard North American series name Leonardian.

Named for Cimarron River.

City Bluffs shale

Pennsylvanian: southwestern Iowa and northwestern Missouri.

G. L. Smith, 1909, Iowa Geological Survey, v. 19, p. 613, 615, 617, 622, 631. *City Bluffs shales*—Gray and yellow shales, 210 ft (63.6 m) thick, with three thin beds of limestone. Forms middle part of Atchison shales. Underlain by cap rock of Nodaway coal [on p. 628, Nodaway coal is included in City Bluffs shales] and overlain by Tarkio limestone. Included in Missouri stage.

G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science Publication, v. 9, no. 2. Stated that City Bluffs shale is same as Scranton shale.

Named for City Bluffs (now known as Burlington Junction), Nodaway County, Missouri.

Clay Creek Limestone Member (of Kanwaka Shale)

Pennsylvanian (Virgilian Series): eastern Kansas, northwestern Missouri, and southeastern Nebraska.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 94, 96. A very persistent limestone in upper Kanwaka Shale; portions of the Kanwaka above and below are given the names Stull Shale and Jackson Park Shale, respectively. On p. 52, Clay Creek Limestone is described as consisting of 2 ft (0.6 m) of hard bluish limestone that weathers brown; shelly. Derivation of name not stated.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 171. More fully described this limestone and gave type locality as Clay Creek, about 1 mi (1.6 km) west of Atchison, Kansas.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 24. Thickness about 1 ft (0.3 m) in Weeping Water Valley, Cass County.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. vii, 17. Overlies Jackson Park Shale Member; underlies Stull Shale Member.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 62 (fig. 23), 67. Dark-blue to bluish-gray limestone, commonly massive and dense; fusulines locally abundant. Thickness as much as 5 ft (1.5 m). Underlies Stull Shale Member; overlies Jackson Park Shale Member.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37 and pl. 1. Member is dark-blue to bluish-gray, commonly massive and dense limestone. Fusulines are locally abundant and other fossils are fairly plentiful. Locally, oolitic, algal, and crinoidal deposits occur in the upper part. Clay Creek Limestone Member is persistent in northeastern Kansas at least as far southward as Osage County and is identified in Coffey, Greenwood, and Elk counties as a zone of limestone and fossiliferous calcareous, sandy shale. Thickness may be as much as 5 ft (1.5 m).

Type locality: Clay Creek, about 1 mi (1.6 km) west of Atchison, Atchison County, Kansas. Persistent as far southward as Osage County, Kansas.

Cleveland sand

Pennsylvanian (Desmoinesian): eastern Kansas and northern Oklahoma.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 80. Used in some eastern Kansas areas for sandstone bodies in the Coffeyville formation; the names "Layton" and "Cleveland" are used more or less interchangeably, but in the Cleveland oil field, Pawnee County, Oklahoma, the "Layton" is 400 ft (121 m) above the "Cleveland"; in Kansas the name "Layton" is used more commonly for sandstone in the upper part of the Kansas City group.

Coal Creek Limestone Member (of Topeka Limestone)

Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, northeastern Kansas, and northwestern Missouri.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 42, 52, 53. Upper unit of Topeka Limestone was named Union Limestone by Condra and Bengston in 1915. That name being preoccupied, the unit is here named Coal Creek Limestone from exposures on Coal Creek, north of Union, Nebraska. The limestone is dark blue, dense, brittle, and quite fossiliferous. At places it is split into two or three beds. Overlies Holt Shale.

conformably overlies Checkerboard Limestone and conformably underlies Hogshooter Formation. Thickness 375–500 ft (114–152 m). Name Coffeyville not in current use in Kansas.

W. L. Watney, J. French, and E. K. Franseen, 1989, Kansas Geological Society, 41st Annual Field Conference, p. 8 (fig. 3). Coffeyville Group revived in Kansas, including interval from Nuyaka Creek Shale Member at base to Galesburg Shale at top.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 7. Includes Tacket Formation, Ladore Shale, Mound Valley Limestone, and Galesburg Shale. Limited to extreme southeastern Kansas.

Named for exposures at Coffeyville, Montgomery County, Kansas. Mapped as far south as Okfuskee County, Oklahoma.

Coffeyville limestone

Pennsylvanian: southeastern Kansas

E. Haworth and J. Bennett, 1908, Kansas Academy of Science, Transactions, v. 21, pt. 1, p. 74; Kansas University Geological Survey, v. 9, p. 87. Thin but persistent limestone that is prominently exposed along banks of the Verdigris River at Coffeyville, Kansas. Overlies Walnut shale; underlies Pleasanton shales.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 66. Synonymized with Lenapah limestone.

Named for Coffeyville, Montgomery County, Kansas.

Colony sand

Pennsylvanian (Desmoinesian): eastern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 80. Used for a gas-producing sandstone in several Anderson County, Kansas, fields; occurs in the upper middle part of the Cherokee shale and more commonly is called "Bartlesville."

Colorado Group

Colorado Shale, or Formation

Upper Cretaceous: Colorado, Idaho, Iowa, Kansas, Montana, Nebraska, New Mexico, North Dakota, South Dakota, and Wyoming.

F. V. Hayden, 1876, U.S. Geological and Geographical Survey of the Territories, 8th Annual Report, p. 45. Colorado group includes numbers 2, 3, and 4 of the Cretaceous, or the Fort Benton, Niobrara, and Fort Pierre divisions; underlies Fox Hills group; overlies Dakota group.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Colorado group overlies Dakota group and underlies Montana group; includes (bottom to top) Graneros shale, Greenhorn limestone, Carlile shale, and Niobrara chalk.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 492. The generally accepted definition of Colorado group includes only Benton and Niobrara and their equivalents.

W. A. Cobban and J. B. Reeside, Jr., 1952, Geological Society of America, Bulletin, v. 63, n. 10, chart 10b. Reference sequence for Upper Cretaceous, Western Interior, North America, shows Colorado Group comprises (ascending) Belle Fourche Shale (Wyoming), Greenhorn Limestone, Carlile Shale, and Niobrara Formation. Occurs above Lower Cretaceous Mowry Shale and below Telegraph Creek Formation.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Group comprises (ascending) Graneros Shale, Greenhorn Limestone, and Niobrara Chalk. Overlies Dakota Formation; underlies Pierre Shale of Montana Group.

H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 56–57, pl. 1. Group includes: Niobrara Chalk, Carlile Shale, Greenhorn Limestone, Graneros Shale.

Named for exposures along eastern base of Front Range, Colorado.

Columbia Ford limestone

Pennsylvanian: eastern Kansas.

L. C. Wooster, 1905, The Carboniferous rock system of eastern Kansas, Kansas State Teachers College, Emporia. [No definition except that it is included in Humphrey shale. Derivation of name not stated. If it occurs in Humphrey shale, it is probably Wakarusa limestone.]

L. C. Wooster, 1906, Kansas Academy of Science, Transactions, v. 20, p. 79. Part of the Humphrey shales in the Emporia beds.

Columbus coal (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook 11th Annual Field Conference, p. 21. The coal bed within the third cycle of the Cherokee called the Columbus cyclothem. The coal in the Columbus cyclothem is present a short distance below the Blueajacket Sandstone.

W. B. Howe, 1951, American Association of Petroleum Geologists, Bulletin, v. 35, p. 2,091. Columbus coal bed is considered to be the Rowe coal bed.

Named for coal mined near Columbus, in Cherokee County.

Columbus cyclothem (in Cherokee Group)

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 21; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 196. Cherokee Group is divided into 15-cyclic formational units. The Columbus cyclothem, third in the sequence (ascending), occurs above the Neutral and below the Bluejacket. average thickness 30 ft (9 m). Includes Columbus coal..

Columbus sandstone (of Cherokee shale)

Pennsylvanian: southeastern Kansas.

E. Haworth and M. Z. Kirk, 1894, Kansas University Quarterly, v. 2, p. 106. The most extensive sandstone system in the Cherokee shales. Occurs more than 200 ft (61 m) above base of Cherokee and in places divides Cherokee into two parts.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 496. Cites unpublished manuscripts by W. G. Pierce and W. H. Courtier that note Columbus sandstone probably includes both Little Cabin and Bluejacket sandstone members of Cherokee shale.

Named for exposures along Brush Creek, east of Columbus, Cherokee County, Kansas.

Kansas where the intervening Wyandotte limestone is absent.

Named for Concreto, Allen County, Kansas.

Corbin City Limestone Member (of Drum Limestone)

Pennsylvanian (Missourian Series): eastern Kansas and northwestern Missouri.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 92, 97. Upper bed of oolitic limestone in the Drum limestone (lower bed of light-blue limestone is the Cement City member); very local in development, but appears to be represented in Kansas City section by a thin bed of granular fossiliferous limestone separated by a few inches of shale from the main body of the Cement City limestone.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Upper member of Drum limestone; overlies Cement City limestone member of Drum limestone; underlies Chanute shale; granular or oolitic drab limestone; prominent only around Independence, Kansas; average thickness 0.5 ft (15 cm); maximum thickness 60 ft (18 m).

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,030; 1949, Kansas Geological Survey, Bulletin 83, p. 99–100. Predominately a crossbedded oolite locally 40 ft (12 m) or more thick. Disconformably overlies Dewey Limestone Member; underlies Chanute Formation.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 37. Type locality stated. Unit absent in Nebraska.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin, v. 89, p. 83, 85. Chiefly light-gray oolitic crossbedded limestone that is highly fossiliferous. Best developed (>50 ft [15 m]) in the vicinity of Independence; represented by a few feet of limestone conglomerate in southern Kansas near Coffeyville and by 1 ft (0.3 m) or less of chiefly algal limestone in the Kansas City area. Includes few inches of shale between Corbin City limestone member and underlying Dewey limestone member. In southern Kansas, the Corbin City limestone rests disconformably on the Dewey limestone. In the vicinity of Cherryvale in Montgomery County, the oolitic limestone of the upper member fills hollows nearly 5 ft (1.5 m) deep in the lower limestone.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 13. Abandon use of Corbin City limestone member. Stratigraphic unit is equivalent to Cement City member of Dewey Limestone (formation).

Type locality: Corbin City, 2 mi (3.2 km) south of Cherryvale, Montgomery County, Kansas.

Corral sandstone (of Cheyenne sandstone)

Cretaceous: south-central Kansas.

F. W. Cragin, 1895, American Geologist, v. 16, p. 361, 366. Sandstone, 30–50 ft (9–15 m) thick; lower part white; upper part often beautifully variegated with bright reds mingled with yellow, purple, and brown. Basal part of Cheyenne sandstone. Overlain by Elk Creek beds (upper part of Cheyenne).

W. H. Twenhofel, 1924, Kansas Geological Survey, Bulletin, v. 9. Impossible to recognize definitely any member of the Cheyenne formation beyond the limits of one locality. Cragin's (1895) divisions are considered to have no validity for more than local application.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 525. This name was discarded by U.S. Geological Survey in 1921, the bed being simply a local facies of Cheyenne sandstone and without stratigraphic value, and the name seems to have been discarded by Kansas Geological Survey.

Named for the natural corral, a short box canyon on Lanphier claim, in the southeastern corner of Kiowa County, Kansas.

Cottage Grove Sandstone Member (of Chanute Shale)

Cottage Grove sandstone bed (in Chanute Shale)

Pennsylvanian (Missourian Series): southeastern Kansas and northeastern Oklahoma.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 92, 97. Persistent bed of sandstone in the Chanute shale in central and southern Kansas.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 49. Upper sandstone mass of Chanute shale; overlies Thayer coal; generally soft, light-buff, crossbedded or even-bedded; thickness 1–30 ft (0.3–9 m).

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 110, 111. N. D. Newell is author of name; thickness 2 or 3 ft (0.6 or 0.9 m) in its northern area to about 50 ft (15 m) in southern Kansas.

M. C. Oakes, 1940, Oklahoma Geological Survey, Bulletin 62, p. 61 (fig. 6), 63–64. Described in Washington County where it is 6–50 ft (1.8–15 m) thick. Occurs above unit referred to as Thayer coal member and below unnamed carbonaceous shale member.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 84. Yellowish-brown or tan thin-bedded to massive sandstone; comprises upper one-third to one-half of Chanute Shale in southeastern Kansas; occurs only locally in northeastern Kansas. Thickness featheredge to 60 ft (18 m).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 14. Discontinue use of Cottage Grove Sandstone as member of Chanute Shale, but retain as informal name.

Named for Cottage Grove Township in Allen County, Kansas.

Cotter Dolomite (of Arbuckle Group)

Lower Ordovician: northern Arkansas, southern Missouri, Oklahoma, and Kansas.

A. H. Purdue and H. D. Miser, 1916, U.S. Geological Survey, Geologic Atlas, Folio 202. Chiefly two kinds of dolomite—a fine-grained, earthy textured, argillaceous, relatively soft, white to buff or gray variety (cotton rock), and a more massive medium-grained gray variety that weathers hackly on the surface and becomes dark on exposure; contains some chert and a little interbedded saccharoidal sandstone and green shale; thickness 500+ ft (152+ m); unconformably underlies Powell limestone.

J. S. Cullison, 1944, Missouri University School Mines and Metallurgy, Bulletin, Technical Series, v. 15, n. 2, p. 15, 32–39, pls. Predominantly cherty dolomite varying from gray to buff; fine-grained to coarse-grained; thin to massive bedded. Thickness 340 ft (103 m) in vicinity of Cotter. Includes Crooked Creek chert bed in lower part and Jenkins Branch chert bed near middle. Underlies Powell Dolomite; unconformably overlies Theodosia Formation of Jefferson City (Group) Dolomite. Type section designated.

of "Cottonwood Falls limestone" [even though it is unclear exactly when or how "Falls" was dropped from the name].

Cottonwood shales (of Council Grove group)
Permian: eastern Kansas.
C. S. Prosser, 1894, Geological Society of America, Bulletin, v. 6, p. 38–39. *Cottonwood shales*—Yellow fossiliferous shales, 10 ft (3 m) thick, forming upper part of Cottonwood formation in Cottonwood Valley and at Manhattan and vicinity. Overlies Manhattan stone or Cottonwood limestone.
E. Haworth, 1896, University Geological Survey of Kansas, v. 1, p. 164. Directly overlies the Cottonwood Falls limestone in Kansas.
C. S. Prosser, 1902, Journal of Geology, v. 10, p. 712. Conflicts with Cottonwood limestone. Replaced by *Florena shales*.

Council Grove Group
Permian (Wolfcampian Series): eastern Kansas, southeastern Nebraska, and northern Oklahoma.
C. S. Prosser, 1902, Journal of Geology, v. 10, p. 709. *Council Grove stage*—It is perhaps a more satisfactory classification to regard base of Permian as marked by lower limit of Wreford limestone, and writer is inclined to accept this as division line, as indicated by Dr. Frech. If this be done the writer would class the two formations succeeding Eskridge shales (Cottonwood limestone and Garrison). The upper part of stage is well shown in bluffs of Neosho River and its tributaries in vicinity of this city, while Cottonwood limestone and overlying Florena shales may be found in Neosho Valley about 6 mi (9.6 km) below Council Grove. Underlies Chase stage and overlies Wabaunsee stage.
J. W. Beede, 1922, Geological Society of America, Bulletin, v. 33, no. 4. Extended base of the Council Grove down to base of Neva limestone. This change was not adopted by other geologists, however.
G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, 2nd series, Bulletin 6, p. 13–15. Dropped Neosho and Florena as members of the Garrison; dropped Garrison as a formation, but showed it on chart (p. 13) and treated all units as "members." [Clearly, Condra preferred "Council Grove Formation" to "Council Grove Group."]
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, August 28 to Sept. 3, expanded *Council Grove group* by including in it Eskridge shale, Neva limestone, Elmdale shale, and Americus limestone; and Moore and G. E. Condra in their October 1932 revised classification chart of Pennsylvanian rocks of Kansas and Nebraska followed this definition, as did G. E. Condra, 1935 (Nebraska Geological Survey, Paper No. 8), and R. C. Moore, 1936 (1935) (Kansas Geological Survey, Bulletin 22).
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 45–49. As defined in Kansas, includes: Speiser Shale, Funston Limestone, Blue Rapids Shale, Crouse Limestone, Easly Creek Shale, Bader Limestone, Stearns Shale, Beattie Limestone, Eskridge Shale, Grenola Limestone, Roca Shale, Red Eagle Limestone, Johnson Shale, Foraker Limestone. Thickness 310–330 ft (94–100 m). Overlies Ardmire Group; underlies Chase Group.
H. V. Beck, 1959, Kansas Geological Survey, Bulletin 135, p. 25–28. Divided into three units for convenience in mapping and description: "lower unit"= Americus–Legion shale member of Grenola limestone; "middle unit"= Burr limestone member of Grenola limestone–Eskridge shale; and "upper unit"= Beattie limestone.
D. L Baars, S. C. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary upward to base of Neva Limestone Member of Grenola Limestone; raised Neva Limestone to formational rank; reassigned Foraker Limestone, Johnson Shale, Red Eagle Limestone, Roca Shale, and Sallyards Limestone, Legion Shale, Burr Limestone, and Salem Point Shale Members of the Grenola Limestone to the Admire Group (Virgilian Series, Upper Pennsylvanian) to conform. Council Grove Group (revised) comprises: Speiser Shale, Funston Limestone, Blue Rapids Shale, Crouse Limestone, Easly Creek Shale, Beattie Limestone, Eskridge Shale, Neva Limestone. Overlies Admire Group; underlies Chase Group; base of Wolfcampian Series (Lower Permian).
Type locality: Named for Council Grove, Morris County, Kansas.

"Cowley A"
Mississippian.
M. W. Lambert, 1988, Kansas Geological Survey, Open-file Report 88–37, p. 3. The informally named "Cowley formation" is not present in the Salina basin, but was encountered along the Kansas–Oklahoma state line; this cherty interval appears to replace the Kinderhookian through Meramecian formations found to the north; in places it is possible to distinguish "Cowley A" (limestone>dolomite) from the underlying "Cowley B" (limestone>dolomite>shale).

"Cowley B"
Mississippian.
M. W. Lambert, 1988, Kansas Geological Survey, Open-file Report 88–37, p. 3. The informally named "Cowley formation" is not present in the Salina basin, but was encountered along the Kansas–Oklahoma state line; this cherty interval appears to replace the Kinderhookian through Meramecian formations found to the north; in places it is possible to distinguish "Cowley A" (limestone>dolomite) from the underlying "Cowley B" (limestone>dolomite>shale).

Cowley Formation
Mississippian: subsurface of south-central tier of counties in Kansas.
W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 66–79, pl. 2. *Cowley formation*—Dark and gray silty dolomite; dark cherty dolomite and limestone; dark, matted chert locally, very glauconitic at base; 0–464 ft (0–141 m) thick (greater thicknesses may include equivalents of part of the Warsaw formation); base is in contact with Keokuk, Burlington, Reeds Spring, and St. Joe limestones of Osage age; in some areas, rests on Northview shale, Compton limestone, Chattanooga shale, and even on pre-Chattanooga rocks; at most places, unconformably overlain by Pennsylvanian rocks; but, in some places, conformably overlain by the Warsaw. North of the southernmost tier of counties in Kansas, the Cowley formation is absent or thin and erratic in distribution. In some places it is represented only by the

of a massive fossiliferous limestone in the lower part and locally shale in the middle and upper parts. Echinoid spines and other fossils are plentiful in the lower massive limestone. The shaly middle part commonly contains calcareous concretions, geodes and some chert. Cavernous weathering is characteristic. Throughout a considerable distance the lower massive ledge is about 3 ft (0.9 m) thick. South of Butler County the lower part of the Cresswell consists of two massive beds of hard gray limestone separated by a thin limy shale; these have an aggregate thickness of 8–10 ft (2.4–3 m). Near the state line this part of the Cresswell is a single massive bed about 12 ft (3.6 m) thick. Above the massive part of the Cresswell, rocks consisting of a thin-bedded limy shale and shaly limestone have been called the "Luta limestone," but these are now considered to be a part of the Cresswell. The boundary between the Cresswell and the Odell Shale is not distinct. The maximum thickness of the member is 25 ft (7.6 m).

Type locality: East side of golf course in NE sec. 18, T. 34 S., R. 4 E., on north side of Arkansas City, Cowley County, Kansas.

Crete Formation

Crete Formation (of Sanborn Group)

Crete member (of Sanborn formation)

Crete sand and gravel member (of Sanborn formation)

Pleistocene Series (Illinoian Stage): Nebraska and north-central Kansas.

G. C. Condra, E. C. Reed, and E. D. Gordon, 1947, Nebraska Geological Survey, Bulletin, v. 15, p. 24, 25. A channel-fill deposit that rests unconformably on Upland formation or older Pleistocene deposits and is believed to be Illinoian in age. Consists of sand, light-pinkish-brown in upper part, brownish-gray in middle, light-brownish-gray in lower part; medium- to coarse-grained sand with fairly common fine to medium gravel in lower part, grades upward to fine to medium sand with rare fine gravel and fairly common silt in upper part; thin zone (1–2 inches [2.5–5 cm]) of red-brown iron-stained sand at base. Underlies Loveland formation at type locality; 8–9.5 ft (2.4–2.9 m) thick.

J. C. Frye and A. B. Leonard, 1949, Kansas Geological Survey, Bulletin 81, p. 41, 43; 1952, Kansas Geological Survey, Bulletin 99, p. 52, 110–115. Extended into Kansas where it is basal member of Sanborn formation; underlies Loveland member.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 12, 14, 16. Crete sand and gravel member is basal member of Sanborn formation. Sand, gravel, and silt, in terrace position along some valleys; locally grades upward into Loveland silt member; in southeastern Kansas predominantly chert gravels; Illinoian age; commonly 50 ft (15 m) thick.

C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55. Formation at base of Sanborn group.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Crete formation; Sanborn group not recognized in Kansas.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed. Kansas Geological Survey, Bulletin 189, p. 60, 66, 67. Recognized in central and western area only; silt, sand, and gravel. In larger valleys the gravel is primarily arkosic, reflecting derivation from Pliocene and older Pleistocene rocks, but in some tributary valleys the deposits may be derived almost entirely from the Paleozoic and Mesozoic bedrock. Silts in the upper part of the formation that resemble loess probably are the valley equivalent of the Loveland Formation that occurs in the uplands. Thickness as much as 60 ft (18 m), but commonly about 40 ft (12 m) thick.

Type locality: In roadcuts along State Highway 33, about 1.5 miles west of main intersection at Crete, Saline County, Nebraska, in NE sec. 32, T. 8 N., R. 4 E.

Crisfield sandstone bed (of Salt Plain Formation)

Crisfield sandstone member (of Salt Plain Formation)

Permian (Leonardian Series): southern Kansas.

G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,788; R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 159. Sandstone about 29 ft (8.8 m) thick, occurring about 115 ft (34.8 m) below top of formation. Name credited to G. L. Knight.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 51. Considered this unit as Crisfield sandstone bed in Salt Plain Formation.

Crops out in Harper and Barber counties, Kansas.

Critzer Limestone Member (of Hertha Limestone)

Critzer Limestone Member (of Shale Hill Formation)

Critzer Limestone Member

Pennsylvanian (Missourian Series): eastern Kansas and western Missouri.

J. M. Jewett, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 99, 100, 103; R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 90, 97. Named unit and established type section.

J. M. Jewett, 1940, Kansas Geological Survey, Bulletin 30, p. 9. Reallocated to member of Hertha Limestone.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 11. The Hertha differs from previous usage of Missouri Survey by inclusion of Critzer Limestone and Mound City Shale Members.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 85. Defined as lower member of the Hertha Limestone. Underlies Mound City Shale. Commonly forms rimrock of Hertha Limestone along Hertha escarpment. Thickness ranges from featheredge to 11 ft (3.3 m).

R. C. Moore J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 90. Consists of massive brownish-gray granular partly algal limestone and thin wavy-bedded gray limestone.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 6. Overlies the Unity Farm shale member and underlies the Guthrie Mountain Shale Member of the Shale Hill Formation of the Pleasanton Group. Thickness ranges up to 12 ft (3.6 m) in Bourbon County, Kansas, and is commonly 1 or 2 ft (0.3–0.6 m) consisting of shaly nodular algal calcilutite in east-central Kansas.

Type section: Sec. 17, T. 22 S., R. 23 E., just south of the former town of Critzer, 5 mi (8 km) west of Mound City, Linn County, Kansas.

Reference section: Hill west of Pleasanton, center north line of NW sec. 34, T. 21 S., R. 24 E.

Crusher Hill alternating shales and limestones (in Council Grove group)

Permian: central Kansas.

L. C. Wooster, 1905, The Carboniferous rock system of eastern Kansas, Kansas State Teachers College, Emporia, p. 9. Thickness is 140 ft (42 m); beds form lower part of Strong City beds, underlie Strong flints [=Wreford Limestone] and overlie 12 ft (3.6 m) of shale [=Florena Shale] which rests on Cottonwood Limestone. Derivation of name not stated. [Same as Wooster, 1905, Kansas Academy of Science, Transactions, v. 20, p. 80.]

Cullom limestone

Pennsylvanian: southeastern Nebraska and eastern Kansas

G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science, Publication, v. 9, no. 2, p. 7, 11, 20, 35. Massive fossiliferous limestone 4–8 ft (1.2–2.4 m) thick. Overlies Kanwaka shale and lies 6–8 ft (1.8–2.4 m) below Cedar Creek limestone; all included in Platt shale.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 45. Two limestones separated by about 1 ft (0.3 m) of bluish-gray argillaceous, calcareous fossiliferous shale. Upper limestone is 2 ft (0.6 m) thick, gray, massive. In most places the lower limestone is somewhat thinner than the upper one and weathers orange brown.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 10, 11, 13. Cullom limestone abandoned because another name has priority. The so-called Cullom limestone of Condra (1927) is the DeKalb limestone member. However, on p. 10, the name Beil is substituted for Cullom.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 100, 173. Cullom limestone is equivalent to lower part of Westerville limestone.

G. E. Condra and E. C. Reed, 1937, Nebraska Geological Survey, Bulletin 11, 2nd series, p. 57. Condra (1927) erroneously correlated Beil limestone as Cullom. At Cullom Station, the bed so named is part of the Westerville limestone.

Named for Cullom Station, Cass County, Nebraska.

Curzon Limestone Member (of Topeka Limestone)

Curzon Limestone (of Shawnee Formation)

Pennsylvanian (Virgilian Series): northwestern Missouri, southwestern Iowa, northeastern Kansas, and southeastern Nebraska.

J. A. Gallaher, 1898, Missouri Bureau Geology and Mines, Biennial Report, p. 57. Underlies Forest City sand rock and overlies shale. Higher limestone than Forbes Limestone. Included in Permian.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 42, 52, 53. Years ago Missouri Survey used name Curzen for what seems to be basal 5–8 ft (1.5–2.4 m) of Topeka Limestone Member of Shawnee Formation. It consists of bluish-gray to brownish limestone interbedded with thin shales. Is overlain by Turner Creek Shale and underlain by Iowa Point Shale; top bed of Calhoun Shale Member of Shawnee [this is definition followed by R. C. Moore and G. E. Condra, 1932].

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 11. Hartford (Curzon) Limestone, basal member of Topeka Limestone, usually consists of four or five uneven, dark-gray beds separated by shale seams, but in places consists of two beds separated by shale. Thickness 6–7 ft (1.8–2 m). Underlies Turner Creek Shale Member and overlies Iowa Point Shale Member of Calhoun Shale.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 195. Rock to which Gallaher referred as "Curzen's limestone" is unidentifiable; therefore Condra is author of name. Condra gives no type locality, but presumably it is in vicinity of Curzon, Holt County, Missouri. Name is discarded. Condra agrees (personal communication, July 8, 1934) Hartford is preferable to Curzen.

G. E. Condra and E. C. Reed, 1937, Nebraska Geological Survey, Bulletin 11, 2nd series, p. 20, 46, 50–51. Reallocated to member status in Topeka Limestone; underlies Jones Point Shale Member; overlies Iowa Point Shale Member. Iowa occurrences noted. Restricted Curzen Limestone as explained in June 1937 entry under Topeka Limestone. On p. 51, they state: "Type locality described. Reason for apparent change in spelling of name of railroad station since Gallaher worked there has not been learned."

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035; G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 21; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 18. Member of Topeka Formation. Overlies Iowa Point Shale Member; underlies Jones Point Shale Member. This classification agreed upon by State Geological Surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 1, v. 5, p. 16, fig. 5. Variable in texture; commonly divided into two or three units by thin shale partings. Near Thurman, Fremont County, a fine-grained sublithographic brecciated bed that contains soft green shale within the fractures is common near top of member; in Mills County, to the north, upper beds are thicker and contain dark-brown chert; near Howe, Adair County, to the northeast, it is made up of light-gray Osagia-bearing bed overlying fine-grained massive fossil-bearing limestone; west of Macedonia, Pottawattomie County, it is composed of alternating shales and limestones. Thins northeastward; thickness 9 ft (2.7 m) near Thurman; 6 ft (1.8 m) near Macedonia; about 3 ft (0.9 m) near Howe. Member of Topeka Limestone. Underlies Jones Point Shale Member; overlies Iowa Point Shale Member.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 38, and pl. 1. Curzon Limestone Member of the Topeka Limestone is readily identifiable throughout northeastern Kansas but is not differentiated or is doubtfully identified in southeastern Kansas. It consists of two or more beds of massive bluish-gray, brown-weathering limestone that is mostly hard and resistant, forming a prominent escarpment. Nodules of chert are common. Fusulinids are sparse to abundant in the lower and middle parts of the member, together with some brachiopods and other invertebrates; bryozoans and echinoid remains are common in the upper layers. Thickness ranges from 5 to 12 ft (1.5–3.6 m).

Type locality: East of Curzon Station, southeast of Forest City, Holt County, Missouri.

B. F. Latta, 1941, Kansas Geological Survey, Bulletin 37, p. 68–79. Group includes all strata from base of Cheyenne Sandstone to base of Graneros Shale. They comprise (ascending) Cheyenne Sandstone, Kiowa Shale, and Cockrum Sandstone.

N. Plummer and J. F. Romary, 1942, Kansas Geological Survey, Bulletin 41, p. 315–348. Dakota formation of Kansas, as here defined, has been called variously "Dakota group," "Dakota formation," Ellsworth and Solomon formations, Rocktown channel sandstone member, and "Dakota sandstone." Dakota formation is here defined to include Cretaceous strata from top of Kiowa shale below to top of Graneros shale above. Subdivided into Terra Cotta clay and Janssen clay members. Dakota/Kiowa contact placed at base of beds of siltstone or fine-grained sandstone containing ellipsoidal masses of well-cemented rock. Included mushroom rocks at Mushroom Rock State Park, Ellsworth County, Kansas, within the basal Dakota Formation.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 15, 18–20. Type locality designated. Thickness at type locality is 392 ft (119 m). Name Omadi sandstone proposed for the so-called Dakota formation (at top of Dakota group), to include section lying between Fuson and Graneros shales. Dakota group then includes (ascending) Lakota, Fuson, and Omadi.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, part 4, p. 153–155. Formation consists of clay, shale, siltstone, and sandstone, interbedded and lenticular; contains carbonaceous material, lignite, concretions of hematite and limonite, and locally quartzitic sandstone. Average thickness 215 ft (65 m). Comprises (ascending) Terra Cotta Clay and Janssen Clay Members. Underlies Graneros Shale; overlies Kiowa Shale. Gulfian Series.

K. M. Waagé, 1955, U.S. Geological Survey, Professional Paper 274–B, p. 15–49. Several sources of confusion in usage of pre-Benton Cretaceous terminology are apparent in the history of subdivision and nomenclature of the Dakota. First source is taxonomic change from use of terms formation and group as synonyms to their use as terms for separate ranks of rock units. More critical source was tendency to separate the Early Cretaceous from the Late Cretaceous parts of the pre-Benton Cretaceous sequence, a tendency that influenced, and is reflected in, Stose's formal subdivision of Dakota formation. Use of age as criterion for subdivision of rock units, a practice at the root of many nomenclatural problems, can lead only to confusion in correlation and to ambiguity in terminology when applied to complex transgressive deposits like the pre-Benton Cretaceous sequence. Much of the confusion associated with name Dakota stems from this cause. An unfortunate nomenclatural practice, that of retaining name Dakota for Late Cretaceous part of sequence in those areas where Early Cretaceous rocks can be identified and separated, has served to crystallize the confusion. This practice has been applied in Kansas and in Colorado, making it impossible to use name Dakota in a single sense for physical correlation between areas in which Early Cretaceous strata are separated from the Dakota and areas in which occurrence of Early Cretaceous rocks has not been sufficiently well established to permit their separation from the Dakota. Introduction of terminologies from other areas is a recent source of confusion in Colorado pre-Benton Cretaceous classification. Usage of Dakota in present report follows that of Meek and Hayden (1862) inasmuch as it includes all pre-Benton Cretaceous strata. In type area along Missouri River in Nebraska, the Dakota rests on Paleozoic rocks so its lower contact is unequivocal. The characteristic twofold lithogenetic division is present in type area where sharp break separates sandstone with variegated clay below from sandstone with dark-gray clay, carbonaceous clay, and lignite above. In light of previous attempts to make name Dakota reflect opinion on age of rock that it includes, it is emphasized that Dakota group, as used herein, is strictly a rock term, and whether or not the group contains both Lower and Upper Cretaceous rocks, is entirely Lower Cretaceous, or varies in age from region to region is irrelevant to this definition.

D. F. Merriam, 1957, Kansas Geological Survey, Oil and Gas Investigations 14, 25 p. The Dakota Formation is renamed the Omadi Formation and is subdivided into three members which are in ascending order: the Cruise sandstone, the Hunstman shale, and the Gurley sandstone. These members are correlated with the Huntsman Shale and other informal stratigraphic units in the Denver basin of Nebraska and the Terra Cotta and Janssen Clay Members in the central Kansas outcrop belt.

H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 55–56. Thickness ranges 200–300 ft (61–91 m) in north-central and western Kansas. Boundary between Lower and Upper Cretaceous cannot be located accurately, and should be placed within the Dakota Formation.

P. C. Franks, 1975, The transgressive-regressive sequence of the Cretaceous Cheyenne, Kiowa, and Dakota Formations of Kansas: p. 469–521; *in,* W. G. E. Caldwell, ed., The Cretaceous System of the Western Interior of North America, Geological Association of Canada, Special Paper 13. The sediments comprising the Dakota Formation were deposited by southwestward-flowing streams in progradational alluvial-plain and deltaic complex. Nonmarine deposits grade westward and upward into shallow and marginal marine sediments near the contact with the overlying Graneros Shale (Late Cretaceous age). The uppermost Dakota Formation sediments grade laterally and vertically into the Graneros Shale in Kansas. These changes reflect the influence of sea-level rise during the later part of the Early Cretaceous. The Janssen and Terra Cotta Clay Members do not constitute readily mappable units statewide.

V. Hamilton, 1994; *in,* G. W. Shurr, G. A. Ludvigson, and R. H. Hammond, eds., Geological Society of America, Special Paper 287, p. 79–96. The Lower and Upper Cretaceous strata that belong to the Cheyenne Sandstone, Kiowa Formation, and Dakota Formation in Kansas are divisible into three unconformity-bounded sequences. In ascending order these are the Cheyenne–Kiowa, the J, and the D. All three sequences can be traced into the center of the basin in Colorado and are equivalent to sequences defined by Weimer (1984). Each consists of landward-stepping progradational events of fluvial and nearshore to marine siliclastics belonging to: the Cheyenne Sandstone and Longford Member (Kiowa Formation) in the lower sequence, the lower part of the Dakota Formation ("J" sandstone) and Huntsman Shale in the middle sequence, and the upper part of the Dakota Formation ("D" sandstone) in

Uppermost member of Woodward formation; overlies Whitehorse sandstone member; underlies Greer formation; hard, white dolomite; 4 ft (1.2 m) thick.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 37. Dense dolomite, about 2 ft (0.6 m) thick in Kansas. Overlies Whitehorse Sandstone; underlies Taloga Formation of Quartermaster Group, Oklahoma.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford; *in*, D. E. Zeller, ed., 1968, Kansas Geological Survey, Bulletin 189, p. 53. Light-gray to pink, dense, fine-grained, locally cherty dolomite cropping out in Clark and southern Comanche counties. Overlies Whitehorse Formation; underlies Big Basin Formation. Thickness 2–3 ft (0.6–0.9 m).

Named for Day Creek, Clark County, Kansas.

Dbj coal bed (in Krebs Formation, Cherokee Group)

Pennsylvanian (Desmoinesian Series).

An informal unit used for subsurface correlation of an unnamed coal in the lower part of the Cherokee Group. First used in an unpublished M.S. thesis by J. W. Harris, 1984, University of Kansas, p. 29–30, 41–42. The Dbj coal bed is a persistent coal below the Cbj and the Seville Limestone of Kansas. Both the Dbj and the overlying Cbj coals are above the Bluejacket Sandstone Member.

L. L. Brady, L. M. Nuelle, D. B. Haug, D. C. Smith, J. L. Bostic, and J. C. Jaques, 1994, U.S. Geological Survey, Miscellaneous Investigations Series I–2426–A. General stratigraphic relations of the Dbj coal bed with other Cherokee units is shown.

Decorah shale

Decorah Formation

Decorah Shale Member (of Galena Formation)

Middle Ordovician: northeastern Iowa, western Illinois, northeastern Kansas, southern Minnesota, northern Missouri, and southwestern Wisconsin.

Samual Calvin, 1906, Iowa Geological Survey, v. 16, p. 60, 84. Decorah (Green) shale is a vary calcareous, green shale, with numerous bands and nodules of limestone, 25–30 ft (7.6–9 m) thick, forming top shaly member of Platteville stage; overlies Platteville limestone (lower formation of Platteville stage) and underlies Galena limestone.

Wallace Lee, 1943, Kansas Geological Survey, Bulletin 51, 142 p. Decorah Shale in the Forest City basin is characteristically a sandy dolomite interstratified with dark and gray-green shale. Black to cinnamon-brown clay is widely present near the base. Relationship of Decorah to overlying Kimmswick (Viola) Limestone is obscure but in many cases the Decorah appears to be represented by slightly clastic or sandy and shaly member at the base of the Kimmswick.

Constance Leatherock, 1945, Kansas Geological Survey, Bulletin 60, pt. 1, p. 7. Correlates Decorah in Missouri to upper Platteville in Kansas.

Hall Taylor, 1947, American Association of Petroleum Geologists, Bulletin, v. 31, p. 1,242–1,282. Decorah of Iowa is equivalent to the lowest informally named unit in the Viola Formation in central Kansas (i.e., Zone 6, the "lower cherty" or "basal clastic" member).

H. A. Ireland, 1966, Tulsa Geological Society, v. 34, p. 31–32. Decorah consists of green shales, sandstones, and local carbonate rocks of early Trentonian and possibly Blackriveran age. Commonly mapped as part of the Platteville and referred to as upper Simpson in Kansas. A carbonate sequence locally present in the upper part of the Decorah in Kansas is usually mapped as basal Viola. Decorah is generally not recognized on eastern edge of Central Kansas uplift and in much of western Kansas.

W. C. Sweet and S. M. Bergstrom, 1976; *in*, M. G. Bassett, ed., The Ordovician System, University of Wales Press, p. 121–151. Decorah in central Kansas contains Kirkfeldian conodont faunas.

First described in city and vicinity of Decorah, Winneshiek County, Iowa.

Deer Creek Limestone (of Shawnee Group)

Deer Creek Limestone Member (of Pawhuska Formation)

Deer Creek Limestone Member (of Shawnee Formation)

Deer Creek system

Pennsylvanian (Virgilian Series): southwestern Iowa, eastern Kansas, northwestern Missouri, southeastern Nebraska, and north-central Oklahoma.

J. Bennett, 1896, Kansas University Geological Survey, v. 1, p. 117. Three limestones separated by shales; 26.5 ft (8 m) thick; separated from overlying Topeka limestone by 60 ft (18 m) of shale and from underlying Lecompton limestone by about 100 ft (30 m) of shale with some thin limestones.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 48. Deer Creek subdivided into (bottom to top): Rock Bluff limestone, Larsh shale, Haynies limestone, Mission Creek shale, and Ervine Creek shale.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Deer Creek limestone subdivided into (bottom to top): Ozawkie limestone, Oskaloosa shale, Rock Bluff limestone, Larsh-Mission Creek shale, and Ervine Creek limestone; 35 ft (10.6 m) thick; overlies Tecumseh shale; underlies Calhoun shale.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 27, 48, 181–190. Thickness in most places 40+ ft (12+ m); overlies Rakes Creek shale member of Tecumseh shale; underlies Jones Point shale member of Calhoun shale.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 126 (fig. 22), 142 (fig. 29), 156. Deer Creek Formation in Shawnee Group; underlies Calhoun Formation; overlies Tecumseh Formation. Includes: Ervine Creek Limestone Member, Burroak Shale Member, Haynies Limestone Member, Larsh Shale Member, Rock Bluff Limestone Member, Oskaloosa Shale Member, Ozawkie Limestone Member. Classification agreed upon by State Geological Surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma. In Kansas, the shale between the Rock Bluff and Ervine Creek limestones is called Larsh and Burroak.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 62, 65, 66, 70, 71. Persistent, escarpment-making formation comprising three limestone members and two shale members (bottom to top): Ozawkie limestone, Oskaloosa shale, Rock Bluff limestone, Larsh–Burroak shale, and Ervine Creek limestone; thickness 20–80 ft (6–24 m); underlies Calhoun shale; overlies Tecumseh shale.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37–38. Thickness 20–80 ft (6–24 m).

Named for exposures near Deer Creek, east of Topeka, Shawnee County, Kansas.

in Labette County, Kansas. The term "Weiser" is used more commonly for subsurface sandstone bodies in the Bandera shale, but Bandera Quarry sandstone is the more acceptable term.

Desmoinesian Series
Desmoinesian Stage
Des Moines Series
Des Moines Group
Middle Pennsylvanian: Iowa, Arkansas, Kansas, Missouri, Nebraska, and Oklahoma.

C. R. Keyes, 1893, Iowa Geological Survey, v. 1, p. 86–114. Shales, sandstones, limestones, clays, and coals of the Lower Coal Measures that underlie Missouri formation, or Upper Coal Measures, and unconformably overlie Lower Carboniferous in Iowa; thickness 400 ft (121 m).

R. C. Moore, 1932, Geological Society of America, Bulletin, v. 43, p. 279. Divided Pennsylvanian system into four series (bottom to top): Bend, Des Moines, Pottawatomie, and Virgil. Des Moines series is a huge thickness of sandstone, conglomerate, and shale in Oklahoma and Arkansas, but to north and south the thickness is much reduced and there are limestones in the upper part; top and bottom of series unconformable.

C. [R.] Keyes, 1932, Pan-American Geologist, v. 57, p. 346. Des Moines was first used by D. D. Owen (1851, American Association for the Advancement of Science, Proceedings, v. 5, p. 47).

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 602, 603. Des Moines group was adopted by the U.S. Geological Survey many years ago, for northwestern Missouri and southwestern Iowa, to include rocks from the base of the Kansas City formation to the top of the Mississippian. This was the commonly accepted definition. The group, as defined, included (top to bottom) Pleasanton formation, Henrietta formation, and Cherokee shale, and was overlain by Missouri group, the basal bed of which was Hertha limestone. Owing to the great number of named subdivisions of Pennsylvanian rocks in Kansas and southeastern Nebraska, the U.S. Geological Survey has been accustomed to treat the major subdivisions of Des Moines and Missouri age as groups, and therefore does not use Missouri group and Des Moines group in its rock classification of those states. Regarding suggestion by Keyes (1932) that Owen (1851) is the author of Des Moines, nowhere did he [Owen] apply the name Des Moines to any stratigraphic unit; Keyes is therefore the original proposer of the name Des Moines beds.

R. C. Moore, H. R. Wanless, J. M Weller, J. S. Williams, C. B. Read, G. H. Bell, G. H. Ashley, M. G. Cheney, L. M. Cline, G. E. Condra, R. H. Dott, C. O. Dunbar, M. K. Elias, L. C. Glenn, F. C. Greene, T. A. Hendricks, J. M. Jewett, J. H. Johnson, P. B. King, J. B. Knight, A. I. Levorsen, H. D. Miser, N. D. Newell, F. B. Plummer, M L. Thompson, C. W. Tomlinson, and J. Westheimer, 1944, Geological Society America, Bulletin, v. 55, p. 657–706, chart 6. In upward order, midcontinent time-rock divisions of Pennsylvanian System are Morrowan, Lampasan, Desmoinesian, Missourian, and Virgilian.

M. G. Cheney, R. H. Dott, B. F. Hake, R. C. Moore, N. D. Newell, H. D. Thomas, and C. W. Tomlinson, 1945, American Association of Petroleum Geologists, Bulletin, v. 29, p. 140 (chart 2). Chart shows classification and correlation of type Pennsylvanian System of Pennsylvania with co-standard sections of Appalachian and midcontinent regions. Midcontinent section comprises (ascending) Springer, Morrow, Lampasas, Des Moines, Missouri, and Virgil Series. Des Moines Series is equivalent to Allegheny Series in Appalachian region and Allegheny River valley. Co-standard section shown as east-central Oklahoma.

R. C. Spivey and T. G. Roberts, 1946, American Association of Petroleum Geologists, Bulletin, v. 30, p. 185. Atokan Series defined as below Des Moines Series; replaces term Lampasas Series.

C. A. Moore, 1947, Oklahoma Geological Survey, Bulletin 66, p. 50. Classification of Pennsylvanian rocks in Oklahoma places Atoka Formation in Des Moines Series.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,020–2,021. Series designated paleontologically as zone of *Fusulina*. Comprises Cherokee and Marmaton Groups. Spans interval between Atokan and Missourian Series.

R. C. Moore and M. L. Thompson, 1949, American Association of Petroleum Geologists, Bulletin, v. 33, p. 286. Oklan Series (new) comprises rocks of Atokan and Desmoinesian Stages.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,747–2,749. In northern midcontinent, Desmoinesian comprises Krebs, Cabaniss, and Marmaton Groups. Middle Pennsylvanian.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 20–22 (fig. 5). Term Cherokee revived for basal group of Desmoinesian. Terms Krebs and Cabaniss reduced in rank to subgroups within the Cherokee.

W. H. Bradley, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, p. 2,284–2,285. In midcontinent region, U.S. Geological Survey uses following series subdivisions of Pennsylvanian System: Morrow, Atoka, Des Moines, Missouri, and Virgil. Des Moines is Middle Pennsylvanian.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 23–27. Desmoinesian is upper stage in Middle Pennsylvanian Series; comprises Cherokee Group (Krebs and Cabaniss Formations) and Marmaton Group. Outcrop thickness 600–750 ft (182–227 m).

Named for exposures on Des Moines River, Iowa.

Dewey Limestone Member (of Drum Limestone)
Dewey Limestone (of Kansas City Group)
Dewey Limestone Member (of Skiatook Group)
Dewey limestone lentil
Pennsylvanian (Missourian Series): northeastern Oklahoma, northwestern Missouri, southwestern Iowa, southeastern Nebraska, and eastern Kansas.

D. W. Ohern, 1910, Oklahoma State University, Research Bulletin 4, p. 30, 37. Dewey limestone lentil is bluish, semicrystalline limestone, usually somewhat shaly but often massively bedded, 3–15 ft (0.9–4.5 m) thick. Stratigraphically 50–100 ft (15–30 m) above the Hogshooter limestone. Is above horizon of Drum limestone, but author cannot correlate it. In northern part of area, included in Copan member of Wann formation; in southern part of area is basal member of Ramona formation. Bluish, semicrystalline limestone, usually somewhat shaly, but often massively bedded; 3–15 ft (0.9–4.5 m) thick; 50–100 ft (15–30 m)

M. E. MacLachlan, 1972; *in*, W. W. Mallory, ed., Geologic atlas of the Rocky Mountain region, Rocky Mountain Association Geologists, p. 176. "Two formations are present in the Dockum Group of Late Triassic age in southeast Colorado. The basal formation, which is unnamed, consists of orange-red, fine- to medium-grained sandstone. Thin beds of coarse-grained sandstone, conglomeratic mudstone, limestone, and dolomite are common. The overlying Sloan Canyon Formation of Parker (1930) (Kansas Geological Society, Guidebook, 4th Annual Field Conference, p. 131–136) is variegated mudstone interbedded with sandy mudstone, marlstone, limestone, dolomite, and sandstone. Limestone and dolomite pebbles are abundant at some localities." On the lithofacies map of fig. 6 (p. 172), the Dockum Group is shown to extend into southwest Kansas and coincides with the outcrop and subsurface occurrences described by earlier authors.

Named for Dockum, Dickens County, Texas.

Dodds Creek Sandstone Member (of Galesburg Shale)
Dodds Creek sandstone bed (in Galesburg Shale)
Dodds Creek Sandstone Member (of Coffeyville Shale)

Pennsylvanian (Missourian Series): southeastern Kansas.

R. C. Moore, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 97. Galesburg shale contains Dodds Creek sandstone.

J. M. Jewett, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 99, 101–103. Name proposed for sandstone in upper part of Galesburg shale; sandstone and sandy shale.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 89. The sandstone [in the Galesburg shale] becomes increasingly prominent southward. It has been designated as the Dodds Creek sandstone by Jewett.

R. C. Moore, N. D. Newell, R. H. Dott, and J. L. Borden, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 40 (table). Included in Coffeyville Shale (restricted) in northeastern Oklahoma.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 83, 87. Massive to thin-bedded sandstone, seemingly of deltaic origin; thickness as much as 40 ft (12 m).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 10. Sandstone lowered to informal bed status. Widespread sandstone in Galesburg Shale between Mound Valley Limestone below and Canville Limestone Member above. Referred to as Upper Layton sandstone in subsurface. Occurs in Galesburg Shale in southern Kansas.

Named for Dodds Creek, Labette County, Kansas.

Dog Creek Formation (of Nippewalla Group)
Dog Creek Shale (of Nippewalla Group)
Dog Creek Shale (of Cimarron Group)
Dog Creek shale member (of Woodward formation)

Permian (Leonardian Series): south-central Kansas, western Oklahoma, and western Texas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 3, 39. Dull-red argillaceous shales, 30 ft (9 m) thick, with laminae of gypsum in basal part and one or two ledges of dolomite in upper part; basal formation of Kiger division; overlain by Red Bluff sandstones; underlain by Shimer gypsum member of Cave Creek formation.

F. W. Cragin, 1897, American Geologist, v. 19, p. 351–363. Suggested Stony Hills as more appropriate name for Dog Creek shale; removed from Kiger division and included in underlying Salt Fork division.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Basal member of Woodward formation; dull-red clay shale with some thin dolomitic limestone beds; average thickness 30 ft (9 m); maximum thickness 44 ft (13 m); underlies Whitehorse sandstone member of Woodward formation; overlies Shimer gypsum member of Cave Creek formation.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 158, 161 (fig. 4). Uppermost formation in Nippewalla Group. Consists of maroon shale, sandstone, thin layers dolomite, dolomitic sandstone, and gypsum. Thickness 14–53 ft (4.2–16 m). Overlies Blaine Formation; underlies Whitehorse Sandstone.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 52. Name changed from Dog Creek Shale to Dog Creek Formation.

Named for Dog Creek, Barber County, Kansas.

Donegal limestone (of Sumner group)

Permian: central Kansas.

R. C. Moore, 1936, Journal of Geology, v. 44, p. 5–9. Divided Sumner group into (top to bottom) Wellington, Donegal, and Nolans formations.

R. C. Moore, 1936 (1935), Kansas Geological Society, 10th Annual Field Conference, Guidebook, p. 12. Underlies Wellington shale, overlies Pearl shale, and is divided into (top to bottom): Strickler limestone, Newbern shale, and Hollenberg limestone members; total thickness 14.5± ft (4.4± m).

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 30. Term Wellington is used for the section between the top of the Herington limestone and the base of the Ninnescah formation. Of the 10 subdivisions listed, the Strickler limestone and Newbern shale members of the Donegal limestone are not very persistent; name Donegal limestone is not well founded.

Type locality and derivation of name not stated. Probably named for Donegal (previously Belle Spring), Dickinson County, Kansas.

Doniphan Shale Member (of Lecompton Limestone)

Pennsylvanian (Virgilian Series): northeastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin, 2nd series, p. 44, 47. Doniphan Shale is exposed in Missouri and Kansas, but probably not exposed in Nebraska. Is 14+ ft (4.2+ m) thick in Missouri and 7–8 ft (2–2.4 m) thick in Kansas. Underlies Big Springs Limestone and overlies Spring Branch Limestone, all in Lecompton Limestone. Named for exposures in north part of Doniphan County, Kansas.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig 5); 1949, Kansas Geological Survey, Bulletin 83, p. 126 (fig. 22), 153. Doniphan Shale Member of Lecompton Formation; underlies Big Springs Limestone Member; overlies Spring Branch Limestone Member. Classification agreed upon by

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 235–236. Abandoned McKissick Grove shale and treated its subdivisions as formations in Wabaunsee group.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 190–191. Closely resembles Tarkio limestone, but lacks distinctive brown weathering; 2–4 ft (0.6–1.2 m) thick in northern Kansas and Nebraska, but 15–20 ft (4.5–6 m) thick (three limestone beds) in southern Kansas.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 15. Consists of thin fossiliferous limestone and some shale. Thickness 2–4 ft (0.6–1.2 m) in Nebraska, southeastern Iowa, and northwestern Missouri; thicker in southern Kansas. Underlies Dry formation; overlies Langdon formation.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,275. Rank reduced to member status in Stotler limestone (new). Underlies Dry shale member; overlies Pillsbury shale (new).

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 12, fig. 5. Consists of two limestone beds separated by thin bed of gray shale. Upper limestone is dense, gray, unfossiliferous and weathers buff; lower limestone is dark gray to black, weathering to nodular form with many white fragments of *Derbyia, Chonetes,* and *Crurithyris*. Thickness about 3 ft (0.9 m). Underlies Dry shale; overlies Table Creek shale. Wabaunsee group.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 6, 7. Only uppermost limestone bed of Moore's (1949) three-limestone-bed Dover Limestone in southern Kansas correlates with the Dover Limestone in the type locality. Throughout Kansas the Dover Limestone Member is generally one bed of gray limestone that is massive but weathers blocky to nodular; brown weathering locally resembles weathered Tarkio Limestone, but differs in that Tarkio generally weathers into large, angular blocks, whereas the Dover weathers into small round blocks, nodules, and irregular plates; average thickness 3.5 ft (1.1 m) in northern Kansas, 1.6 ft (0.5 m) in southern Kansas.

Type locality: Exposures near Dover, Shawnee County, Kansas.

"Dover Shell limestone"

Upper Pennsylvanian.

Trade name. Five Point Limestone Member, Janesville Shale Formation, Admire Group. Name refers to the coquinal nature and the locality southwest of Dover in Wabaunsee County, where it is quarried. The limestone at this locality is denser than the above-mentioned locality in northern Pottawatomie County.

Downs limestone (of Greenhorn limestone)

Cretaceous (Upper): north-central Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 50. Limestone, 6–12 inches (15–30 cm) thick, in Russell formation (lower part of Benton division), quarried near Downs [Osborne County, Kansas] and extensively used for fence posts, so that it may appropriately be called Fencepost limestone.

W. W. Ruby and N. W. Bass, 1925, Kansas Geological Survey, Bulletin 10, p. 49–51. Cragin (1896) proposed Downs limestone for the fence-post limestone forming top bed of Greenhorn limestone in Russell County. Although this bed is unusually persistent, for one so thin, it does not merit classifications as a separate member, and its local name fencepost limestone is widely known and quite satisfactory.

Named for exposures in quarries near Downs, Osborne County, Kansas.

Doyle Shale (of Chase Group)

Permian (Wolfcampian Series): eastern Kansas, southeastern Nebraska, and central northern Oklahoma.

C. S. Prosser, 1902, Journal of Geology, v. 10, p. 715. Variously colored shales, 60 ft (18 m) thick, including a few beds of soft limestone; overlies Fort Riley limestone; underlies Winfield formation.

N. W. Bass, 1929, Kansas Geological Survey, Bulletin 12. Included all beds below top member of Winfield formation in the Doyle shale in Cowley County, Kansas.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series. Divided Doyle shale of Prosser (1902) into three members (bottom to top): Holmesville shale, Towanda limestone, and Gage shale; 66 ft (20 m) thick; underlies Stovall limestone member of Winfield limestone.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Dropped Doyle shale, treating members of Condra and Upp (1931) as formations in Kansas; combined thicknesses 81 ft (24.5 m).

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 80. Restored to formal nomenclature consisting of: Gage Shale Member, Towanda Limestone Member, Holmesville Shale Member. Members formerly given formation rank. Overlies Barneston Limestone; underlies Winfield Limestone.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 49. Thickness about 70 ft.

Named for exposures on Doyle Creek, southwest of Florence, Marion County, Kansas.

Drum Limestone (of Kansas City Group)

Drum Limestone Member (of Cherryvale Formation)

Drum Limestone (of Skiatook Group)

Drum Limestone Member (of Kansas City Formation)

Pennsylvanian (Missourian Series): southeastern Kansas

G. I. Adams, 1903, U.S. Geological Survey, Bulletin 211, p. 37, 63, 66. Fossiliferous limestone, 25–40 ft thick, overlying Cherryvale shale and underlying Chanute shale.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita. Underlies Chanute shale; overlies Quivera (sic) shale; consists of two members: Cement City limestone below (thin-bedded, wavy, fine-grained white limestone) and Corbin City limestone above (granular or oolitic drab limestone; prominent only around Independence, Kansas); average thickness 8 ft; maximum thickness 60 ft.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 37, 45, 98, 100–110. Provides nomenclatural history of use and misuse of Drum limestone in Kansas and adjacent states.

R. C. Moore, N. D. Newell, R. H. Dott, and J. L. Borden, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 40 (table), 42. Included in Skiatook

Dry–Friedrich shale
Pennsylvanian (Virgilian Series): northeastern Kansas and southeastern Nebraska.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 236, 239. Grandhaven limestone not present north of Shawnee County; therefore the shale lying between the Dover and Jim Creek limestones may be called Dry–Friedrich shale.
R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 191, 193. The overlying Grandhaven limestone disappears northward from Shawnee County, Kansas, and the Dry shale is directly overlain by the Friedrich shale; this may be designated as the Dry–Friedrich shale.

Dry Wood coal bed (in Krebs Formation, Cherokee Group)
Drywood coal bed
Pennsylvanian (Desmoinesian Series): southeastern Kansas, southwestern Missouri, and northeastern Oklahoma.
W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 76. Drywood coal seam was used in northern Crawford County for the Bevier coal bed. (Note: The Bevier coal bed is in the Cabaniss Formation, which differs from other references on Dry Wood or Drywood, which are much lower stratigraphically in the Krebs Formation.)
W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as Dry Wood formation. Includes Dry Wood coal at top. Underlies Bluejacket formation; overlies Rowe formation (new). Included in Krebs group.
W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22, p. 38–39. A formation in Krebs Subgroup of Cherokee Group. In southeastern Kansas, includes (ascending) basal dark shale containing lenticular limestone, thin irregular silty limestone and clay ironstone, underclay, and Dry Wood coal. This total sequence thickens from 6 to 8 ft (1.8–2.4 m) in Crawford County to maximum of somewhat more than 15 ft (4.5 m) in Cherokee County. Overlies Rowe Formation; underlies Bluejacket Formation. (Howe also notes [p. 80] that Drywood coal was used locally for the Bevier coal bed.)
W. V. Searight and W. B. Howe, 1961, Missouri Geological Survey and Water Resources, v. 40, 2nd series, p. 82–83. Missouri recognizes Drywood Formation and Drywood coal bed. (This differs from Dry Wood as used in Kansas and as proposed by Searight et al. (1953) in the Nevada Conference.)
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. Irregular in thickness, the Dry Wood coal bed ranges up to about 1.7 ft (0.5 m) in thickness, and is present several feet above the Rowe coal bed.
Type locality: Below spillway of the artificial lake on a tributary of Dry Wood Creek in SE NE sec. 4, T. 32 N., R. 33 W., 1 1/2 mi (2.4 km) west of Liberal, Barton County, Missouri.

Dry Wood formation
Drywood formation
Pennsylvanian (Desmoinesian Series): southeastern Kansas, southwestern Missouri, and northeastern Oklahoma.
W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as Dry Wood formation. Includes Dry Wood coal at top. Underlies Bluejacket formation; overlies Rowe formation (new). Included in Krebs group.
W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22, p. 38–39. A formation in Krebs Subgroup of Cherokee Group. In southeastern Kansas, includes (ascending) basal dark shale containing lenticular limestone, thin irregular silty limestone and clay ironstone, underclay, and Dry Wood coal. This total sequence thickens from 6 to 8 ft (1.8–2.4 m) in Crawford County to maximum of somewhat more than 15 ft (4.5 m) in Cherokee County. Overlies Rowe Formation; underlies Bluejacket Formation. (Howe also notes [p. 80] that Drywood coal was used locally for the Bevier coal bed.)
W. V. Searight and W. B. Howe, 1961, Missouri Geological Survey and Water Resources, v. 40, 2nd series, p. 82–83. Missouri recognizes Drywood Formation and Drywood coal bed. (This differs from Dry Wood as used in Kansas and as proposed by Searight et al. (1953) in the Nevada Conference.)
Type locality: Below spillway of the artificial lake on a tributary of Dry Wood Creek in SE NE sec. 4, T. 32 N., R. 33 W., 1 1/2 mi (2.4 km) west of Liberal, Barton County, Missouri.

Du Bois Limestone Member (of Topeka Limestone)
Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, northeastern Kansas, and northwestern Missouri.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 42, 52, 53. One or two dark-blue, dense, fossiliferous limestones forming large flat blocks. Thickness 2 5/8 ft (0.8 m) near DuBois, Nebraska; 1 ft (0.3 m) in Kansas and Missouri. Underlies Holt Shale and overlies Turner Creek Shale, all included in Topeka Limestone. Named for exposures on Turner Creek southeast of DuBois, Nebraska. [This is definition followed by R. C. Moore and G. E. Condra in their October 1932 revised classification chart of Pennsylvanian rocks of Kansas and Nebraska and by R. C. Moore in his 1936 classification (Kansas Geological Survey, Bulletin 22).]
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5); 1949, Kansas Geological Survey, Bulletin 83, p. 126 (fig. 22), 164; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 18. Du Bois Limestone Member of Topeka Formation; underlies Holt Shale Member; overlies Turner Creek Shale Member. Classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 21. Type locality stated.
H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 15–16, fig. 5. Commonly single bluish-gray bed; locally divided into two limestone beds separated by shale; fossiliferous. Thickness seldom more than 1 ft (0.3 m); lenses out in some localities. Underlies Holt Shale Member; overlies Turner Creek Member.
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 39, and pl. 1. Du Bois Limestone Member consists of one or

Earlham limestone (of Kansas City formation)
Pennsylvanian: eastern Kansas and western Iowa and Missouri.
H. F. Bain, 1897, Iowa Geological Survey, v. 7, p. 511–517. The first heavy limestone above Fragmental limestone (No. 3 of exposure) is equivalent to bed quarried at Earlham and hence may be called Earlham limestone.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 88. The Bethany Falls is traced from south-central Iowa, where it was called the Earlham limestone by the Iowa Geological Survey, to southern Kansas not far from the Oklahoma boundary.
Type locality: Earlham, Madison County, Iowa, in sec. 22 of Lincoln Township.

Earlton limestone
Pennsylvanian: eastern Kansas.
G. I. Adams, 1898, Kansas University Quarterly, v. 7, p. 96. Limestone that makes prominent escarpment west of Earlton and Chanute; occurs between the Chanute shale below and the Vilas shale above.
E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 51, 103. Name proposed by G. I. Adams for limestone near summit of Thayer shales, which in local areas is relatively prominent; separated from overlying Iola limestone by shales.
G. I. Adams, 1903, U.S. Geological Survey, Bulletin 211, p. 39. Notes that Haworth and Piatt (1894, Kansas University Quarterly, v. 2, p. 115) described this limestone at Altoona, but confused it with Erie limestone.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 107, 127. Through miscorrelation the Earlton limestone has commonly been supposed to be older than the Iola limestone, but it actually is younger; synonymizes it with Plattsburg limestone.
Named for exposures west and northwest of Earlton, Neosho County, Kansas.

Easley Group
Mississippian.
J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, no. 2, p. 101, chart 5; J. M. Weller, 1948, (abs.) American Journal of Science, v. 246, no. 3, p. 150. Proposed for upper Kinderhook strata of Mississippian age. In type area, in Mississippi Valley, group consists of Hannibal shale and Chouteau limestone and related formations or members. At least locally, these are separated by unconformities from underlying Fabius group (new) and overlying Osage series.
M. G. Mehl, 1960, Denison University, Journal of Laboratories, v. 45, article 5, p. 94. Weller and others (1948) proposed that the Kinderhook be considered a series and divided into two groups, the Easley and Fabius. The Easley was to include all Kinderhookian strata which are almost universally recognized to be of Mississippian age, and the Fabius to include all those Kinderhookian strata which are believed by some to be Mississippian and by others to be Devonian. Position of the committee in establishing two Kinderhook groups based on above distinction does not appear tenable. Recommended that terms Easley and Fabius groups be dropped from list of stratigraphic designations in Missouri.
Named for exposures around Easley, Boone County, Missouri.

Easly Creek Shale (of Council Grove Group)
Permian (Wolfcampian Series): southeastern Nebraska and eastern Kansas.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 229–237. *Easly Creek shale*, in Garrison shale, consists of (descending): 1) shale, in blue, gray, greenish-gray, and reddish bands, in part quite calcareous, 12 ft (3.6 m); 2) gray limestone, 2–4 ft (0.6–1.2 m); 3) shale, with one limestone band 2–3 inches (5–7.5 cm) thick, 10–12 ft (3–3.6 m). Total thickness 26 ft (7.9 m). Overlies Eiss limestone and underlies Sabetha limestone.
G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 19, 21. Easly Creek shale of Condra (1927) is here divided into (descending): *Easly Creek shale restricted*, Middleburg limestone, and Hooser shale. The Easly Creek shale as now constituted is about 14 ft (4.2 m) thick in Nebraska and northern Kansas and about 11 ft (3.3 m) near Oklahoma line. At places there is a bed of gypsum in this member as in vicinity of Blue Rapids, Kansas. It underlies Crouse limestone (same as "Sabetha limestone" and has 10 years priority).
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 46. Consists of red, green, and gray shale, partly calcareous, containing local limestone beds; upper part is light colored and calcareous; lower part largely red shale; locally contains gypsum bed near base. Thickness 15–20 ft (4.5–6 m). Underlies Crouse Limestone; overlies Bader Limestone.
M. R. Mudge and R. H. Burton, 1959, U.S. Geological Survey, Bulletin 1068, p. 13 (table 2), 81–82. Follows terminology of Condra and Upp; (1931, Nebraska Geological Survey, Bulletin 6, 2nd series) as Easly Creek Shale between Bader Limestone and Crouse Limestone in Wabaunsee County, Kansas. Thickness 10–18 ft (3–5.4 m).
Type locality: On Easly Creek, in NE sec. 35, T. 1 N., R. 13 E., about 10 mi (16 km) south and 1 1/4 mi (2 km) east of Humboldt, Richardson County, Nebraska.

Ediger limestone
Devonian: central Kansas (Harvey County).
L. A. Johnston, 1934, Tulsa Geological Society, Digest, 1934, p. 12–17. Dense, microcrystalline to coarsely crystalline, fossiliferous limestone that is sandy and glauconitic at the base; in places lower part is white calcareous sand; upper part may contain some chert and usually has intercalated thin light-green shale seams. Unconformably overlies Hollow dolomite, or, where absent, Maquoketa shale; unconformably underlies Sylamore sandstone in Hollow field, Harvey County, Kansas. Footnote indicates name first used by F. A. Bush in an unpublished paper delivered before the Tulsa Stratigraphic Society in 1933.
Derivation of name not stated.

Edson beds (in Ash Hollow formation)
Edson beds (in Ogallala formation)
Pliocene (Lower): western Kansas.
M. K. Elias, 1931, University of Kansas, Bulletin, v. 32, no. 7, p. 161, 162. Unconsolidated fine silty beds in Sherman County, which are called by H. T. Martin "Edson beds," that probably occur about 50–80 ft (15–24 m) below the bed from which the fauna of the Rhinoceros Hill section was collected. Pierre shale must not be far below the Edson beds of Sherman County and at a somewhat lower elevation than the fossiliferous sand of Rhinoceros Hill.

Elk Falls limestone
Pennsylvanian (Virgilian): southern Kansas.
E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 65, 66, 105. Proposed by G. I. Adams in field notes for two well-defined limestones separated by a thin bed of arenaceous shales with here and there developed into well-formed sandstone. Overlies Lecompton shales and underlies Severy shales in Greenwood and Chautauqua counties. Corresponds to Deer Creek limestone, Tecumseh shales, and Lecompton limestone, the two limestones being brought closer together in the south.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 172, 182, 194. Included with Lecompton, Deer Creek, and Topeka limestones.
Named for Elk Falls, Elk County, Kansas.

Ellsworth Formation
See Dakota Formation

Elm Branch Shale (of Kansas City Group)
Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.
R. C. Moore, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 85 (fig. 2), 90, 97. For the shale underlain by the Sniabar limestone and overlain by the Middle Creek limestone. Cited N. D. Newell (in manuscript) as author of name. Derivation of name not stated.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 80, 82. Synonymized Elm Branch shale with Ladore shale; discarded Elm Branch shale.
W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 7 (fig. 3). Use of Elm Branch Shale as unit overlying Sniabar Limestone and underlying Middle Creek Limestone.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 8. Elm Branch defined in type section as shale overlying Hertha Limestone and underlying Swope Limestone. Shale is widespread along outcrop ranging in thickness from 0.5 ft to 12 ft (0.15–3.6 m). Elm Branch reinstated for unit previously called Ladore Shale. Ladore Shale as defined in its type section is shale above Bethany Falls Limestone and below Mound Valley Limestone (new).
Type section: Along steep roadcut near Elm Branch along east side of road, center east line NE sec. 19, T. 28 S., R. 24 E., Miami County, Kansas.

Elmdale Shale (of Wabaunsee Group)
Pennsylvanian (Virgilian): eastern Kansas, southeastern Nebraska, and central to northern Oklahoma.
J. W. Beede, 1902, Kansas University, Scientific Bulletin, v. 1, p. 178. *Elmdale formation* proposed in unpublished manuscripts by C. S. Prosser and J. W. Beede. Consists of shales with occasional thin limestones; 111–118 ft (33.6–35.8 m) thick; containing many fossils in lower part. Underlies Neva limestone and overlies limestone which is probably Americus limestone.
C. S. Prosser, 1902, Journal of Geology, v. 10, p. 708. *Elmdale formation*—Yellowish to bluish shales, with thin beds of alternating limestone, including two or three thicker ones. Thickness 130 ft (39 m). Underlies Neva limestone and overlies Americus limestone.
L. C. Wooster, 1905, The Carboniferous rock system of eastern Kansas. *Elmdale beds*, 150 ft (45 m) thick, overlie Americus limestone and shales and underlie Crusher Hill alternating shales and limestones. They include a friable fusulina limestone 24 ft (7.3 m) above base; the Neva and Cottonwood limestones and intervening beds; and, at top, 12 ft (3.6 m) of shale [also Kansas Academy of Science, Transactions, v. 20, p. 80.]
A. J. Smith, 1905, Kansas Academy of Science, Transactions, v. 19, p. 150–154. *Elmdale formation* underlies Neva limestone and overlies Americus limestone. [This definition of Elmdale was followed for many years.]
N. W. Bass, 1929, Kansas Geological Survey, Bulletin 12, p. 38, 52. As defined by Prosser and subsequently used in Kansas, the *Elmdale shale* included a series of beds of shale and limestone above Americus limestone and below Neva limestone, with a total thickness of 130 ft (39 m). The strata between same limiting beds are but little less than 130 ft (39 m) thick in Cowley County, Kansas, but lower third of this thickness combined with Americus (?) limestone is herein called *Foraker limestone, thus restricting Elmdale shale* to strata between Foraker and Neva limestones, having a total thickness of about 80 ft (24 m). The lowermost third of Elmdale formation as thus defined is mostly shale and is succeeded by 20 ft (6 m) of thin-bedded gray limestone, of which the uppermost 2–3 ft (0.6–0.9 m) is deep buff and soft, the whole 20 ft (6 m) constituting the Red Eagle limestone member.
R. C. Moore, 1929, Kansas Geological Survey, Bulletin 12, p. 50, footnote. The section east of Elmdale exhibits clearly all subdivisions of Elmdale shale differentiated and named by Condra (1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 84) in Nebraska, with Americus limestone at base and Neva limestone at top. The Foraker probably includes equivalents of Americus limestone, Stine shale, Houchen Creek limestone, Hughes Creek shale, and Long Creek limestone. In view of known remarkable lateral persistence of minor stratigraphic units from Nebraska to central Kansas, it is likely detailed stratigraphic work will afford basis for definite determination of relations of type Foraker to Americus and Elmdale.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 50 and 251. Dropped *Elmdale shale* from his revised classification, treating its many subdivisions as formations. (See Kansas–Nebraska chart compiled by M. G. Wilmarth, 1936).
Named for exposures east of Elmdale, Chase County, Kansas.

Elmo coal bed (in Scranton Shale, Wabaunsee Group)
Pennsylvanian (Virgilian Series).
Persistent coal bed in Kansas from Brown County to Chautauqua County.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 212. Elmo coal is described as a very persistent bed near the top of the Cedar Vale Shale.
W. H. Schoewe, 1940, Kansas Geological Survey, Bulletin 63, p. 41–48. A persistent coal in the Cedar Vale Shale that ranges up to 30 inches (75 cm) in thickness, but more commonly is 1 to 16 inches (2.5–40 cm). The Elmo coal is known to be mined in six counties—Atchison, Brown, Chautauqua, Elk, Jackson, and Shawnee.

Maximum thickness 250 ft (75.8 m); average about 200 ft (60.6 m). Overlies Potosi Dolomite and rests on Precambrian; unconformably underlies Gunter Sandstone Member of Van Buren (Gasconade) Formation. Fauna described.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 106, 119, 122. Very cherty buff to white, very coarsely crystalline dolomite; vitreous semitranslucent chert intermixed with dolomite; a low angular unconformity separates the Eminence from underlying Bonneterre dolomite; unconformably underlies Van Buren formation. Occurrence of Eminence deposits in eastern Kansas is confined mostly to a belt three counties wide bordering Missouri, but it is recognized also in western Kansas. The formation thickens eastward from a beveled edge to more than 150 ft (45 m) at the Missouri line. Thicknesses of 40 to 87 ft (12–26 m) are reported in west-central Kansas.

R. D. Knight, 1954, Missouri Geological Survey and Water Resources, Report of Investigations 17, p. 57. Reprinted from Kansas Geological Society, Guidebook, 17th Annual Field Conference, 1954. Underlies Gunter Member of Gasconade Formation.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 13. Formation is cherty, buff to white, very coarsely crystalline dolomite. Angular unconformity separates the Eminence from the Bonneterre. Formation present in easternmost Kansas, 0 to more than 150 ft (0–95 m) thick; occurs in west-central Kansas.

V. E. Kurtz, J. L. Thacker, K. H. Anderson, and P. E. Gerdemann, 1975, Missouri Department of Natural Resources, Geological Survey, Report of Investigations 55, 118 p. The Lower Ordovician–Upper Cambrian boundary is located in the upper part of the Eminence Dolomite. In southeast Kansas and adjoining areas, the lower part of the Eminence Dolomite is thought to be Potosi Dolomite.

Named for exposures at Eminence, Shannon County, Missouri.

Emma Creek formation

Pliocene/Pleistocene: central Kansas.

S. W. Lohman and J. C. Frye, 1939, Economic Geology, v. 34, p. 943. Sands, gravel, clays, and silts of middle and upper Pliocene age. Underlies McPherson formation (redefined); formerly referred to McPherson formation.

S. W. Lohman and J. C. Frye, 1940, Economic Geology, v. 35, p. 849–851. Brown, buff, and gray channel sand and gravel with floodplain sandy silt and clay; 10–180 ft (3–55 m) thick; interfingers with Ogallala formation to southwest. Derivation of name not stated.

C. C. Williams and S. W. Lohman, 1949, Kansas Geological Survey, Bulletin 79, p. 56. Name abandoned. Beds at type locality are Pleistocene. Some beds assigned to Emma Creek have proved to be of Pliocene age and are here designated Delmore formation.

Named from exposures along Emma Creek, southeastern McPherson County, Kansas.

Emporia beds

L. C. Wooster, 1905, The Carboniferous rock system of eastern Kansas, Kansas State Teachers College, Emporia. *Emporia beds*—All rocks between top of Burlingame limestone and top of his Emporia reservoir shales; includes the Humphrey shale (including the Columbia ford lime), Emporia blue limestone, Olpe shales, Emporia buff limestones, and Emporia reservoir shales [making three different uses of *Emporia*; also Kansas Academy of Science, Transactions, v. 20, p. 79].

Probably named for Emporia, Kansas.

Emporia Limestone (of Wabaunsee Group)

Pennsylvanian (Virgilian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

M. Z. Kirk, 1896, Kansas University Geological Survey, v. 1, p. 72–85. Equivalent to bed No. 10 of Haworth and Kirk (1894, Kansas University Quarterly, v. 2, p. 111). Limestone quarried at Emporia and to the northeast, disappearing under river near Emporia waterworks; separated from overlying Americus limestone by an extensive bed of shale and from underlying Wyckoff limestone by a bed of shale 40–50 ft (12–15 m) thick.

G. I. Adams, 1903, U.S. Geological Survey, Bulletin 211, p. 52–53. Equivalent to bed No. 10 of Haworth and Kirk (1894, Kansas University Quarterly, v. 2).

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 61–91. The Kansas Geological Survey applies Emporia limestone to beds underlying Admire shale and overlying Willard shale. The Willard shale and so-called Emporia limestone have been difficult to work out. The beds called by these names in Kansas need redefining in order to establish a basis for correlation in Nebraska. Emporia, if it is retained, should apply to No. 3 of the Nemaha beds of southeast Nebraska. This name has priority over Beede's Elmont limestone.

R. C. Moore and G. E. Condra, 1932, Kansas Geological Society, Sixth Annual Field Conference, classification chart. Adopted definition of Condra (1927) for Kansas; restricting Admire shale to uppermost Admire shale of previous reports.

G. E. Condra, 1935, Nebraska Geological Survey, Paper 8, p. 10. Preston ("Emporia") limestone formation is 9–11 ft (2.7–3.3 m) thick, underlies Willard shale formation, overlies Auburn shale formation, and includes (descending): Elmont limestone (2–5 ft [0.6–1.5 m] thick), Harveyville shale (3–7 ft [0.9–2 m] thick), Reading limestone (3± ft [0.9± m] thick).

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 49, 223, 226. Elmont limestone is same as "upper Emporia" of previous authors; Emporia limestone discarded; Elmont, Harveyville, and Reading treated as formations.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,276. Emporia comprises beds between Willard Shale above and Auburn Shale below. Thickness 7–40 ft (2–12 m). Includes: Elmont Limestone Member, Harveyville Shale Member, Reading Limestone Member. Reference section given.

Type locality: Exposures near Emporia, Kansas. Reference section exposed in roadcut on K–10 in NW sec. 31, T. 11 S., R. 14 E., Shawnee County, Kansas.

Emporia blue limestone

Pennsylvanian: northeastern Kansas.

A. J. Smith, 1903, Kansas Academy of Science, Transactions, v. 18, p. 100. *Emporia blue limestone*—Hard blue limestone, 3 ft (0.9 m) thick, with 6-inch (15-cm) layer at top that makes a good flagstone extensively used in Emporia.

Equus beds

Pleistocene: western Kansas, Oklahoma, Texas, and Nebraska, eastern Colorado and Wyoming, and southwestern South Dakota.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 694. A paleontologic name applied to Pleistocene deposits containing *Equus* remains. Replaced by different geographic names in different areas: in Kansas by McPherson formation; in western Texas by Tule formation; in Nebraska and adjacent states the name Sheridan formation has been used. The U.S. Geological Survey in general calls the beds containing *Equus* remains the *Equus* zone, but McPherson formation and Tule formation are also in good standing in their respective regions.

Erie limestone

Pennsylvanian (Missourian): eastern Kansas.

E. Haworth and M. Z. Kirk, 1894, Kansas University Quarterly, v. 2, p. 108, 118. System of limestones, few feet to 60 ft (18 m) thick, overlying Laneville shales and underlying Chanute shales.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 75, 77, 81, 83,88, 90, 109, 110. Noted that the name Erie was preoccupied by the Erie beds in the Devonian of New York (E. Emmons, 1842, Geology of New York, pt. 2, div. 4, geol. 2nd. dist., p. 100, 429), and synonymized Erie limestone with Bronson group. Includes units from top of Dennis limestone down to base of Hertha limestone.

Named for Erie, Neosho County, Kansas.

Ervine Creek Limestone Member (of Deer Creek Limestone)

Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, northeastern Kansas, and northwestern Missouri.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 40, 43, 49, 50. Top unit in Deer Creek Limestone. It is 24–28 ft (7–8 m) thick in southeast Nebraska, 22 1/2 ft (6.8 m) thick in southwest Iowa, 16 ft (4.8 m) thick at Forbes, Missouri, and 12 ft (3.6 m) thick in Kansas River valley east of Topeka, Kansas. Thickest and best-known development is near Louisville, Nebraska. Overlies Mission Creek Shale (Nebraska) and underlies Jones Point Shale, the basal bed of Calhoun Shale. Named for Ervine Creek, northeast of Union, Nebraska.

R. C. Moore and G. E. Condra, 1932, Revised classification chart of Pennsylvanian rocks of Kansas and Nebraska. Excluded from Calhoun Shale, Jones Point Shale, and overlying limestone and included them in Deer Creek Limestone.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 11. Transferred Jones Point Shale and overlying limestone to Calhoun Shale, leaving Ervine Creek Limestone the top bed of Deer Creek Limestone. Classification was adopted by R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 48, but on p. 187–194, he proposed to redefine Ervine Creek Limestone, Jones Point Shale, and Sheldon Limestone on a cyclothem basis. (*See* 1936 entry under Sheldon ls.) For Condra's latest interpretation of stratigraphic position of this limestone, see 1937 entry under Topeka Limestone.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5). Uppermost member of Deer Creek; overlies Burroak Shale Member; underlies Calhoun Formation. Virgilian series. Classification agreed upon by State Geological Surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 22. Member persists from Adair County, Iowa, to Oklahoma. Thickness 14–18 ft (4–5.5 m).

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, pl. 17–19, fig. 3. In Missouri, interval between Bock Bluff Limestone Member and uppermost limestone of the Deer Creek is occupied by shale. This shale has been treated by Missouri Geological Survey as occupying the Rock Bluff–Ervine Creek interval, with implication that intervening Haynies Limestone is absent in Missouri. This shale interval is here termed Larsh–Burroak. Missouri Geological Survey recognizes the possibility the Burroak Shale Member may be absent in Missouri and that uppermost limestone of Deer Creek Formation may include both Haynies and Ervine Creek Limestone Members.

H. G. Hershy, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 17, fig. 5. Massive- to wavy-bedded fossiliferous light-gray limestone, often chert bearing; algal and oolitic beds near top. Thickness 10–14 ft (3–4 m). Overlies Burroak Shale Member; underlies Calhoun Shale.

H. G. O'Connor, 1960, Kansas Geological Survey, Bulletin 148, p. 46, pl. 1. Member in Douglas County is 13–17 ft (3.9–5 m) thick. Overlies Larsh–Burroak Shale Member; underlies Calhoun Shale.

J. M Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 38, and pl. 1. Member is composed mainly of light-gray to nearly white or bluish-gray, fine-grained limestone characterized by thin, wavy bedding. Locally chert nodules are present. It contains a large assemblage of fossils, including fusulinids, corals, echinoid and crinoid fragments, bryozoans, brachiopods, and mollusks. Shale partings contain ostracodes and small foraminifers. Above the basal wavy-bedded limestone is a less persistent limestone, generally massive, that is variable in lithology. Locally it is oolitic; elsewhere it is coquinoidal, nodular, very fine grained, or sandy, and contains Osagia. This upper limestone bed, which ranges from 0 to about 6 ft (0–1.8 m), is generally separated from the underlying limestone by 1–2 ft (0.2–0.6 m) of yellowish-gray, clayey to sandy shale. Thickness ranges from about 5 to 32 ft (1.5–9.7 m).

Type locality: On Ervine Creek about 5 mi (8 km) northeast of Union, Cass County, Nebraska.

Eskridge Shale (of Council Grove Group)

Permian (Wolfcampian Series): eastern Kansas, southeastern Nebraska, and central northern Oklahoma.

J. W. Beede, 1902, Kansas University, Science Bulletin, v. 1, p. 181. *Eskridge shale*—Name suggested by C. S. Prosser, in unpublished manuscript, for 30± ft (9± m) of shales overlying Neva limestone and underlying Cottonwood limestone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 47. Shale and minor amount of limestone and locally thin coal beds; red and green shale predominate; in central Kansas, a persistent limestone, up to 2 ft (0.6 m) thick, occurs a few feet from the base. Thickness 20–40 ft (6–12 m). Underlies Beattie Limestone; overlies Grenola Limestone. Wolfcampian Series.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 215. Name preoccupied by Ordovician formation in Nevada; equivalent to Burlingame limestone.
Named for Eureka, Greenwood County.

Excello shale bed (of Fort Scott Limestone)
Excello Formation (of Cabaniss Group)
Excello Formation (of Cherokee Group)
Excello Shale Member (of Senora Formation)
Pennsylvanian (Desmoinesian Series): eastern Kansas, western and northern Missouri, southwestern Iowa, and northeastern Oklahoma.
W. V. Searight, 1953; *in*, W. B. Howe and W. V. Searight, Missouri Geological Survey and Water Resources, Report of Investigations 14, pl. 1. Shown on stratigraphic column as uppermost formation in Cabaniss Group. Underlies Blackjack Creek Limestone Member of Fort Scott Formation; overlies Lagonda Formation. Exposed in Carroll and Livingston counties.
W. V. Searight , W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, no. 12, p. 2,748 (fig. 1). Shown on northern midcontinent composite stratigraphic section as formation in Cabaniss Group. Underlies Fort Scott Formation of Marmaton Group; overlies Mulky Formation.
C. C. Branson, 1954, Oklahoma Geological Survey, Guidebook 2, p. 3, 5, 14 (fig. 4). Geographically extended into Oklahoma where it is at top of Senora Formation. Overlies Breezy Hill Limestone. Cabaniss Group.
W. V. Searight, 1955, Missouri Geological Survey and Water Resources, Report of Investigations 20, p. 31 (fig. 20), 35. Formation composed largely of black fissile shale which contains abundant flattened, phosphatic concretions and large biscuit-shaped concretions which measure a few feet in diameter. Thickness at type section about 4 ft (1.2 m). Underlies Blackjack Creek Limestone Member of Fort Scott; overlies Mulky Formation. Type section designated.
W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22 (fig. 5), 88–89. Geographically extended into Kansas. Thickness 2–5 ft (0.6–1.5 m). Uppermost division of Cabaniss Subgroup of Cherokee Group. Consists of a single black fissile shale unit.
R. L. Ravn, J. W. Swade, M. R. Howes, J. L. Gregory, R. R. Anderson, and P. E. Van Dorpe, 1984, Iowa Geological Survey, Technical Information Series 12, p. 42 (fig. 24). Excello Shale in Iowa is reclassified into Mouse Creek Formation at base of Marmaton Group.
R. L. Brenner, 1989, Kansas Geological Survey, Geology Series 3, p. 8, 11. Proposes placing the Excello shale with the Fort Scott Formation in the Marmaton Group.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 1. Excello is major marine marker closely linked in distribution to the overlying strata of the Fort Scott. Excello Shale is reclassified to Fort Scott and removed from Cherokee Group.
Type section: NW sec. 30, T. 56 N., R. 14 W., 2.6 mi (4.2 km) west of US–63, west of Excello, Macon County, Missouri, in highwall of coal strip pit.

Exline Limestone Member (of Shale Hill Formation)
Pennsylvanian (Missourian Series): eastern Kansas, western Missouri, southwestern Iowa.
L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, no. 1, p. 62, 65–66. Limestone at top of Henrietta Group. Upper 3 inches (7.5 cm) laminated, lower 1 ft (0.3 m) massive; dark-blue-gray, earthy, medium-grained; well-jointed, weathers brown and slabby; fossiliferous with *Chonetes* and white crinoid stems which contrast strongly with weathered yellow-brown matrix. Separated from underlying Cooper Creek Limestone (new) by underclay, coal, and shale. Traced into northern Missouri. Named and cited type section.
R. C. Moore, H. R. Wanless, J. M. Weller, J. S. Williams, C. B. Read, G. H. Bell, G. H. Ashley, M. G. Cheney, L. M. Cline, G. E. Condra, R. H. Dott, C. O. Dunbar, M. K. Elias, L. C. Glenn, F. C. Greene, T. A. Hendricks, J. M. Jewett, J. H. Johnson, P. B. King, J. B. Knight, A. I. Levorsen, H. D. Miser, N. D. Newell, F. B. Plummer, M. L. Thompson, C. W. Tomlinson, J. Westheimer, 1944, Geological Society of America, Bulletin, v. 55, no. 6, chart 6 (column 31). Shown on chart at top of Appanoose Group in Iowa.
F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. v (fig. 1), 10. In Pleasanton Group, Missouri Series.
R. M. Kosanke, J. A. Simon, H. R. Wanless, and H. B. Willman, 1960, Illinois Geological Survey, Report of Investigations 214, p. 38, 49 (table 1). Member of Modesto Formation (new). In northern western Illinois, overlies Lonsdale Limestone Member and underlies Trivoili Sandstone Member. Presentation of new rock-stratigraphic classification of Pennsylvanian strata in Illinois; cyclical classification independent of rock-stratigraphic classification.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 6. Overlies the Hepler Formation and underlies the Unity Farm Shale Member of the Shale Hill Formation of th Pleasanton Group. Thickness ranges around 1 ft (0.3 m).
Type section: Streambed exposure 1.5 mi (2.4 km) of southwest corner of Exline, Appanoose County, Iowa. Well exposed in west-flowing tributary ravine of North Shoal Creek, SE sec. 6, T. 67 N., R. 17 W.
Reference section: Roadcut east of Turkey Creek, 3 mi (4.8 km) northeast of Uniontown in Bourbon County (north side NW NW NW sec. 12, T. 25 S., R. 22 E.).

F

"F bed"
Mississippian.
G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. Limestone or flint 12–15 ft (3.6–4.5 m) thick [in Tri-state mining district]; generally barren of ore; overlain by "E bed" and underlain by "G bed." Considered to be part of the Boone formation in the area.
Semi-formal mining terminology; not formally recognized by Kansas Geological Survey.

Fairport Chalk Member (of Carlile Shale)
Fairport chalky shale member
Cretaceous (Upper): western Kansas and southeastern Colorado.
W. W. Rubey and N. W. Bass, 1925, Kansas Geological Survey, Bulletin 10, p. 16, 40. Chalky shale and thin beds

Type locality: Near Farley, Platte County, Missouri, north of bridge just north of center sec. 34, T. 52 N., R. 35 W.
Neostratotype section: Western Miami County along east line NE SE sec. 9, T. 19 S., R. 21 E.

Fargo limestone
Pennsylvanian: southeastern Nebraska and southwestern Iowa.
G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science, Publication, v. 9, no. 2, p. 15, 26, 27. *Fargo limestone*—Exposed between Weeping Water Valley and Walnut Creek, from 4 mi (6.4 km) northwest of Fargo to near Rulo, and in spur south of Rulo. Makes prominent cliff in valley side near Fargo, the type locality. One-half mile north of Fargo it consists of: 1) bluish, massive, brittle limestone, 1 1/2–2 ft (0.5–0.6 m) thick, which makes a natural riprap along river bank; 2) dark-blue, carbonaceous, clayey to sandy shale, 5 ft (1.5 m); 3) limestone, 4 ft (1.2 m) in three beds. Separated from overlying Preston [Emporia] limestone by 14–34 ft (4.2–10.3 m) of shale and from underlying Burlingame limestone by 11–29 ft (3.3–8.8 m) of shale. Classed as a member of the Nemaha formation.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 63, 66, 67. "Fargo" limestone of Condra and Bengston is Wakarusa limestone, which has priority.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 220. Equivalent to Wakarusa limestone.
Type locality: Prominent cliff in valley side near Fargo, Richardson County, Nebraska. Exposed between Weeping Water Valley and Walnut Creek, from 4 mi (6.4 km) northwest of Fargo to near Rulo, and in spur south of Rulo, Richardson County, Nebraska.

Fencepost limestone bed (in Pfeifer Shale Member of Greenhorn Limestone)
Fence-post limestone bed
Fence-post limestone member
fence-post limestone
Fencepost limestone
Cretaceous (Upper): north-central Kansas.
F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 50. Limestone, 6–12 inches (15–30 cm) thick, in Russell formation (lower part of Benton division), quarried near Downs [Osborne County, Kansas] and extensively used for fence posts, so that it may appropriately be called Fencepost limestone.
R. C. Moore, J. C. Frye, J. M Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 111. Bed at top of Pfeifer shale member; blue-gray, weathers to light tan.
Name derived from use of limestone bed as fence posts in central and western Kansas; extensively quarried for fence posts near Downs, Osborn County, Kansas.

Ferguson sand
Pennsylvanian (Missourian): eastern Kansas.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 81. Used for the highest of three productive sandstones that occur in the Lane–Vilas shale (Lansing group) in Elk and Montgomery counties, Kansas (also known as the "Bush–Denton sand").

Fern Glen Limestone
Lower Mississippian.
S. Weller, 1906, St. Louis Academy of Science, Transactions, v. 16, p. 438. *Fern Glen formation*—Red limestone, with greenish blotches; chert band at top and some chert scattered through it; 8 1/2 ft (2.6 m) thick; containing Kinderhook fossils and underlain by 6 ft (1.8 m) of probably softer red calcareous shale, which is not exposed but which probably belongs to Fern Glen formation and is separated from underlying Bushberg sandstone (Missouri) by 4 ft (1.2 m) of hard, somewhat crystalline yellow or gray limestone. The Fern Glen is overlain by crystalline greenish-gray limestone which probably belongs to Burlington limestone.
S. Weller, 1909, Geological Society of America, Bulletin, v. 20, pp. 265, 269, 322. *Fern Glen formation*—Near Fern Glen Station, 20 mi (32 km) west of St. Louis, central eastern Missouri, consists of (descending): 1) greenish calcareous shales with much chert, 14 ft (4.2 m); transition beds to overlying Burlington limestone, but contains same fauna as beds 2 and 3, below; 2) red calcareous shales, with 6-inch (15-cm) persistent chert band at top, 12 ft; 3) hard, red, crystalline limestone, with many crinoid stems and other fossils, 14 ft (4.2 m). Rests on [so-called] Chouteau limestone. Included in Kinderhook. Lithologically and faunally closely resembles St. Joe marble.
E. O. Ulrich, 1911, Geological Society of America, Bulletin, v. 22, pl. 29. Assigned Fern Glen to Osage group, and defined it as underlying Lower Burlington, as younger than Chouteau limestone, and as an unconformity, overlying his Sulphur Springs formation.
S. Weller, 1926, Journal of Geology, v. 34, pp. 320–335. Fern Glen is a manifestation of the very lowest Burlington.
S. Weller and S. St. Clair, 1928, Missouri Bureau of Geology and Mines, v. 22, 2nd series, table opposite p. 30, p. 155, 166. Assigned Fern Glen to Osage group, but stated: "A consideration of all data would seem to indicate that it would not do serious violence to facts to consider the Fern Glen as earliest member of Osage division, but faunas do seem to indicate that it is older than any of typical Burlington, and if it is transferred from Kinderhook to Osage it may be necessary to transfer some portion of upper Chouteau limestone also to the Osage."
R. C. Moore, 1928, Missouri Bureau of Geology and Mines, v. 21, 2nd series, opposite p. 282. Showed Fern Glen of eastern Missouri as unconformably on Bushberg sandstone, the unconformity representing Chouteau limestone and most of underlying Hannibal shale. In 1935 (Report, 9th Annual Field Conference, Kansas Geological Society, p. 245), Moore showed Fern Glen of Missouri and Illinois as unconformably on Glen Park formation.
R. C. Moore, 1935, Kansas Geological Survey, Open-file Report 35–1, chart. Fern Glen listed as lower part of Valmeyer Series; described as bluish noncherty limestone and greenish-blue or in part reddish shale.
T. C. Hiestand, 1938, American Association of Petroleum Geologists, Bulletin, v. 22, p. 1,588–1,599. Stratigraphic studies using insoluble residues indicate that the "Mississippi lime" can be subdivided into zones that closely correspond with members of the Boone limestone of Missouri. Zone "C" is correlated with the Fern Glen formation of Missouri.
E. B. Branson, 1944, Missouri University Studies, v. 19, no. 3, p. 198–199. Interpreted as member of Chouteau formation.

conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva Limestone to conform, including Five Point Limestone Member.

D. R. Boardman II, D. M. Work, R. H. Mapes, and J. E. Barrick, 1994, Kansas Geological Survey, Bulletin 232, p. 10, 12–17. Discussed placement of the Permian–Pennsylvanian boundary in Kansas and elsewhere; recommended base of Five Point Limestone Member as provisional base of the Asselian (=basal Permian) boundary in the midcontinent until a formal boundary stratotype is selected in the former Soviet Union.

Type locality: Five Point Creek, near Five Point School, sec. 25, T. 1 N., R. 15 E., 2 mi (3.2 km) south and 4 1/2 mi (7.2 km) west of Falls City, Richardson County, Nebraska.

Fleming coal bed (in Cabaniss Formation, Cherokee Group)
Fleming formation
Fleming cyclothem

Pennsylvanian (Desmoinesian Series): southeastern Kansas, southwestern Missouri, and northeastern Oklahoma.

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 22; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 195. Cherokee Group is divided into 15-cyclic formational units. The Fleming, 10th in the sequence (ascending), overlies the Mineral and underlies the Coalvale. Average thickness 24 ft (7.3 m). Contains coal bed ranging from 12 to 20 inches (30–50 cm) in thickness.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 98, 101. In ascending order, the following units are present in the Fleming cyclothem sandstone, under coal (Fleming), dark-gray shale. Thickness from 15 to 20 ft (4.5–6 m).

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37. Shown on northern midcontinent composite stratigraphic section as Fleming formation in Cabaniss group. Under lies Croweburg formation; overlies Robinson Branch formation.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22, 66–68. Formation in Cabaniss subgroup of Cherokee Group. Where complete succession is present, formation includes (ascending) calcareous shale and thin beds of limestone, dark shale, sandstone, underclay, and Fleming coal. Over most of outcrop in Kansas consists of Fleming coal and its underclay, lying on underclay or dark shale properly included in Robinson Branch formation.

J. M Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. Separated from the Croweburg coal bed above by about 20–25 ft (6–7.6 m) of underclay, shale, and sandstone, the Fleming coal bed is quite variable in thickness up to about 2 ft (0.6 m).

Named from exposures in strip pits just north of the town of Fleming in southern Crawford County, Kansas, between Pittsburg and Cherokee. The Fleming coal is exposed in the walls of the strip pits (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 73).

Flint Hills division

Permian: central Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 3, 6–9. *Flint Hills division*—Lower division of Big Blue series. Divided into Chase limestones above (265 ft [80 m] thick) and Neosho shales below (130 ft [39 m] thick). Overlain by Sumner division.

Not used in later classifications of Kansas Geological Survey. Named for Flint Hills, Cowley and Butler counties, Kansas.

Florena Shale Member (of Beattie Limestone)

Permian (Wolfcampian Series): eastern Kansas, northern Oklahoma, and southeastern Nebraska.

C. S. Prosser, 1902, Journal of Geology, v. 10, p. 712. *Florena shales*—Yellowish fossiliferous shales, 2–13 ft (0.6–3.9 m) thick, heretofore called "Cottonwood shales" (preoccupied). Underlies Neosho member and forms lower part of Garrison formation. Overlies Cottonwood limestone.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, 2nd series, Bulletin 6, p. 17. Ranges from Oklahoma to Nebraska; usually thin where underlying Cottonwood limestone is thick.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 47. Middle Member of Beattie limestone. Underlies Morrill limestone member; overlies Cottonwood limestone member. Consists of highly fossiliferous gray shale containing thin limestone beds in southern Kansas. Thickness 3–18 ft. Wolfcampian series.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 53. Florena generally thins northward; ranges from 2 ft (0.6 m) to over 15 ft (4.5 m) thick.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in,* D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 47. The Florena Shale Member is a highly fossiliferous, calcareous, gray to tannish-gray shale containing thin nodular limestone beds in southeastern Kansas. Dolomitic shale occurs in the Florena from southern Wabaunsee County to northern Greenwood County. *Neochonetes granulifer* is abundant in the Florena. In southern outcrops the variety of fossils is greater than in the north. The assemblage contains numerous species of pelecypods and brachiopods, and well-preserved specimens of a small trilobite are common locally. The thickness ranges from about 3 to 18 ft (0.9–5.5 m).

Type locality: Exposures in quarries near Florena, Marshall County, Kansas.

Florence Limestone Member (of Barneston Limestone)

Permian (Wolfcampian Series): eastern Kansas, southeastern Nebraska, and central northern Oklahoma.

C. S. Prosser, 1895, Journal of Geology, v. 3, p. 771–786, 798. *Florence flint*—Two beds, each 10 ft (3 m) thick, of massive fossiliferous limestone with prominent layers of flint, separated by 2 ft (0.6 m) of white cellular limestone. Included in middle of Chase formation. Underlain by 31 ft (9.4 m) of yellowish, chocolate, and greenish shales and overlain by buff shaly limestone. *Fort Riley or Florence limestone*—Massive buff limestone, 5 or more feet (1.5 m) thick. Separated from overlying Marion flint by 22 ft (6.7 m) of buff shaly limestones overlain by 62 ft (18.8 m) of varicolored shale with thin limestone layers, and separated from underlying Florence flint by 15 ft (4.5 m) of buff shaly limestones.

C. S. Prosser, 1902, Journal of Geology, v. 10, p. 714. *Florence flint* is overlain by Fort Riley limestone and underlain by Matfield shales. In 1902 (Journal of Geology, v. 10), Prosser redefined *Fort Riley limestone* to include at

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 27 (fig. 5). Lowermost member of Cherryvale. Consists of gray calcareous silty micaceous shale. Thickness 10 ft (3 m). Underlies Block Limestone Member; overlies Winterset member of Dennis Limestone.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 11. Fontana Shale is lowermost member of Cherryvale Formation in eastern Kansas. Terrestrial shale is restricted to eastern Kansas and north. In southern Kansas the lower member is a marine shale named the Lower shale member.

Type exposures: In roadcuts at NE corner, sec. 11, T. 18 S., R. 23 E., now slumped, and at middle of west side of NW sec. 36, T. 18 S., R. 23 E., near Fontana, Miami County, Kansas.

Foraker Limestone (of Admire Group)
Foraker Limestone (of Council Grove Group)
Foraker Limestone (of Wabaunsee Group)
Foraker Limestone Member (of Sand Creek Formation)

Pennsylvanian (Virgilian Series): central and northern Oklahoma, southern Kansas, northwestern Missouri, and southeastern Nebraska.

K. C. Heald, 1916, U.S. Geological Survey, Bulletin 641, p. 21, 25. Chiefly soft, thin-bedded limestone, with some soft shale; heavy limestone is fusulinid rich; abundant chert concretions; thickness 74± ft (22± m) thick.

N. W. Bass, 1929, Kansas Geological Survey, Bulletin 12, p. 45+. Thick-bedded limestone containing chert and minor proportion of shale and shaly limestone, 50 ft (15 m) thick, in Cowley County, Kansas; lowermost bed of formation is Americus(?) limestone member, which is separated from upper thick-bedded limestone member by 10–13 ft (3–3.9 m) of soft shale; overlies Admire shale; underlies Elmdale shale.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 8. In Nebraska, Foraker limestone formation, 45–50 ft (13.6–15 m) thick; underlies Johnson shale formation; overlies Hamlin shale formation; divided into three members (bottom to top): Americus limestone, Hughes Creek shale, and Long Creek limestone.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Transferred to "Permian" in Kansas.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273. Overlies Janesville Shale of Admire Group.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 78–85, pl. 1. In Pawnee County, Oklahoma, includes: Long Creek Limestone Member, Hughes Creek Shale Member, Americus Limestone Member. Members traceable across Kansas and Nebraska. Basal formation of Council Grove Group; underlies Johnson Shale; overlies Admire Group. Wolfcampian Series.

M. R. Mudge and R. H. Burton, 1959, U.S. Geological Survey, Bulletin 1068, p. 14 (table 2), 53–58. Described in Wabaunsee County, Kansas; three members recognized. Averages 47 ft (14 m) thick.

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed raising of Virgilian–Wolfcampian boundary up to base of Neva Limestone; reassigned rocks below Neva, including Foraker Limestone, to Admire Group; Virgilian (Upper Pennsylvanian).

Named for Foraker, Osage County, Oklahoma.

Forbes limestone (of Shawnee formation)

Pennsylvanian: northwestern Missouri, southwestern Iowa, and southeastern Nebraska.

C. R. Keyes, 1898, American Geology, v. 21, p. 349. Thick limestone, top exposed in top of bluffs of Missouri and Nodaway rivers, near town of Forbes, Holt County, Missouri, being highest heavy limestone in Missourian series until capping Cottonwood limestone is reached.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 181. Forbes limestone is poorly defined designation of limestone at Forbes, Holt County, Missouri recognizable from description as =Deer Creek. Term abandoned.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 749. In Missouri, the name Forbes Limestone was for many years applied to the beds beneath Calhoun Shale and above Tecumseh Shale, or to Deer Creek Limestone Member of present nomenclature.

Named for exposures in top of bluffs of Missouri and Nodaway rivers, near town of Forbes, Holt County, Missouri.

Fort Benton group

Cretaceous (Upper): southeastern Montana, eastern Colorado and Wyoming, western Kansas, southern Minnesota, Nebraska, northern New Mexico, South Dakota.

F. B. Meek and F. V. Hayden, 1862, Philadelphia Academy of Natural Sciences, Proceedings, v. 13, p. 419, 421. Fort Benton group (Formation No. 2 of Cretaceous) is dark-gray laminated clays, sometimes alternating near upper part with seams and layers of soft gray and light-colored limestone; fossiliferous; 800 ft (242 m) thick in vicinity of Fort Benton, on Upper Missouri River. Overlies Dakota group; underlies Niobrara division.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 164. Is lower formation of Colorado group. For many years the "Fort" has been dropped from the name, and Benton shale has been used.

Named for Fort Benton, on Missouri River, about 40 mi (6.4 km) below Great Falls, Montana.

Fort Hays division
Fort Hays group

Cretaceous (Upper): western Kansas.

B. F. Mudge, 1876, U.S. Geologic and Geographic Survey of the Territories, Bulletin 2, p. 218–221. Upper part massive limestone or yellow chalk 60 ft (18 m) thick; lower part varicolored shales and thin limestones 140 ft (42 m) thick. Included in Niobrara, but lower part may be equivalent to the upper part of Benton. Underlies Niobrara proper and overlies Dakota group.

Named for old Fort Hays in Ellis County, Kansas.

Fort Hays Limestone Member (of Niobrara Chalk)

Cretaceous (Upper): western Kansas, eastern Colorado, northeastern New Mexico, and southeastern South Dakota.

S. W. Williston, 1893, Kansas Academy of Science, Transactions, v. 13, p. 108, 109. The very characteristic heavy stratified chalk, or soft white limestone, at base of this [Niobrara] formation, about 80 ft (24 m) thick, extends

L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, p. 25–26 (fig. 2), 36–37, measured sections. Basal formation in Henrietta Group. From Missouri River northward, formation includes parts of three cyclothems. Predominantly limestone in southeastern Kansas, grading to mostly shale in northeastern Missouri. Three limestone members persist into Iowa (ascending): Blackjack Creek, Houx, and Higginsville. Underlies Labette Shale; overlies Cherokee Group.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, part 11, p. 302–309. Changed term Houx to Little Osage Shale Member, Houx considered bed in Little Osage. Designated type section; 28 ft (8.5 m) thick.

J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. Columnar section, Jackson and Cass counties, shows formation.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. v (fig. 1), 5–6. Name Henrietta Group suppressed; Fort Scott reallocated to Marmaton Group. Includes: Higginsville Limestone Member, Little Osage Shale Member, Blackjack Creek Limestone Member.

W. B. Howe, 1951, American Association of Petroleum Geologists, Bulletin, v. 35, no. 9, p. 2,093. Fort Scott Limestone is next limestone unit above the Breezy Hill Limestone of northern Oklahoma.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748 (fig. 1). Fort Scott Formation, Marmaton Group, shown on northern midcontinent composite stratigraphic section above Cabaniss Group.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 33, fig. 5. Classification of Marmaton Group used in this report is that agreed upon by State Geological Surveys in northern midcontinent region (Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11).

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 25. Fort Scott Limestone, Marmaton Group; two limestones and intervening shale about 33 ft (10 m) thick.

G. W. Krumme, 1981, Oklahoma Geological Survey, Bulletin 131, p. 7, 9. Name Oswego is not acceptable for formal use because of prior usage. Suggest base of Fort Scott be extended to include Breezy Hill Limestone. Oswego [Fort Scott] thins abruptly at latitude of Tulsa.

R. L. Ravn, J. W. Swade, M. R. Howes, J. L. Gregory, R. R. Anderson, and P. E. Van Dorpe, 1984, Iowa Geological Survey, Technical Information Series 12, p. 42 (fig. 24). Fort Scott equivalent in Iowa renamed and reclassified to include in ascending order: Mouse Creek Formation (Excello Shale and Blackjack Creek Limestone Members), Morgan School Shale (including Sumnit Coal), Stephan Forest Formation (including Little Osage Shale, Houx Limestone, unnamed shale, and Higginsville Limestone).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 1. Excello Shale added as lowest member of the Ft. Scott Limestone. Members now include: Higginsville Limestone, Little Osage Shale, Blackjack Creek Limestone, Excello Shale.

Type exposure: Cement plant quarry NE sec. 19, T. 25 S., R. 25 E., northeast of Fort Scott, Bourbon County, Kansas.

Fort Scott flagstones
Pennsylvanian: southeastern Kansas.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 759. Trade name of sandstone in Pleasanton group (Pennsylvanian), quarried near Fort Scott, Kansas. Is younger than Fort Scott limestone.

Fort Scott marble (in Fort Scott marble series)
Pennsylvanian: eastern Kansas.
G. C. Swallow, 1866, Kansas Geological Survey, Preliminary Report, p. 26. Black marble, weathering brown, with numerous yellowish veins and crystallized shells; thickness 1.5 ft (0.5 m). Constitutes bed No. 227 of geological section of eastern Kansas.

Fort Scott marble series (of Cherokee shale)
Pennsylvanian: eastern Kansas.
G. C. Swallow, 1866, Kansas Geological Survey, Preliminary Report, p. 26. Series of limestones, shales, and slates, 22 ft 8 inches (6.9 m) thick, including beds Nos. 224 to 230, inclusive, of geological section of eastern Kansas. Underlies Fort Scott coal series and overlies Lower coal series. Includes Fort Scott marble.

Fort Wallace Ash Bed (in Ash Hollow Member of Ogallala Formation)
Pliocene Series: northwestern Kansas
A. Swineford, J. C. Frye, and A. B. Leonard, 1955, Journal of Sedimentary Petrology, v. 25, p. 244, 253, 254. Volcanic ash bed, 1.5 ft (0.5 m) thick at type locality. Occurs 29 ft (8.8 m) above Ogallala–Pierre contact and 65.5 ft (19.8 m) below top of "algal limestone." Occurs stratigraphically above Rawlins ash bed.
Type locality: South of old Fort Wallace in tributary canyons along south side of Smoky Hill River valley in west line of SW sec. 7, T. 14 S., R. 38 W., Wallace County, Kansas.

Forty-foot lime
Pennsylvanian (Desmoinesian): southeastern Kansas.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 82. Used to designate the Pawnee limestone, especially in Montgomery County, Kansas; "Pink lime" and "Big lime" are used as names for the same rock.

Four-foot (4-foot) coal bed (in Cherokee Group)
Pennsylvanian (Desmionesian Series).
A local coal-bed name for the Weir–Pittsburg coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 48).

Fourmile limestone member (of Wreford limestone)
Permian: eastern Kansas, southeastern Nebraska, and northern Oklahoma.
G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, series 2, p. 31. Basal member of Wreford limestone. Thickness in Nebraska about 7.5 ft (2.3 m), increasing southward to 20 or more feet (6 m) at Strong, Cambridge, and Dexter, Kansas. With exception of about 1 ft (0.3 m) of gray shale above a thin basal cherty limestone, the Fourmile member is massive gray to bluish-gray chert-bearing limestone, but its chert content decreases somewhat from southern Kansas into Oklahoma. Underlies Havensville shale member of Wreford limestone.

Type locality: Friedrich Creek, sec. 6, T. 22 S., R. 11 E., Greenwood County, Kansas.

Frisbie Limestone Member (of Wyandotte Limestone)
Pennsylvanian (Missourian Series): northeastern Kansas and northwestern Missouri.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 92, 97. Basal, blue dense limestone member of Wyandotte limestone.
N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 18, 59. Basal member of Wyandotte limestone; 1–3 ft (0.3–0.9 m) of gray, even, blocky limestone, in one layer; derivation of name and type section given.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 45, 120. Newell is author of name.
J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. Shown on columnar section of Jackson and Cass counties, Missouri, as limestone member of Iola Formation; underlies Quindaro Shale Member; overlies Liberty Memorial Shale Member (new) of Chanute Shale.
R. C. Moore, 1948, American Association of Petroleum Geologists, v. 32, no. 11, p. 2,031 (fig. 4), 2,032, 2,033; 1949, Kansas Geological Survey, Bulletin 83, p. 103. Settlement of the "Iola problem" has led to a number of changes in the Missouri Survey's classification of middle and upper Kansas City beds so as to bring interstate agreement in nomenclature. Frisbie Limestone, Quindaro Shale, and Argentine Limestone, which were indicated as members of Iola Limestone in western Missouri, are classified with overlying Island Creek Shale and Farley Limestone as members of the Wyandotte.
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 35. Thickness 1–3 ft (0.3–0.9 m) in Kansas, 2/3 ft (0.2 m) in Cass County, Nebraska, and a few inches on Middle River, southwest of Winterset, Iowa.
H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 25, fig. 5. In Madison County, Iowa, the Frisbie is a blue, dense, locally fossiliferous limestone. Thickness 0.5 ft (0.15 m). Basal member of Wyandotte; underlies Quindaro Shale Member; overlies Lane Shale.
W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 106, 109 (fig. 3–2, b). Frisbie Limestone with small phylloid algal buildups in Johnson County, Kansas.
Type section: From outcrop just east of Frisbie, north-central Johnson County, Kansas (E line NE NW sec. 17, T. 12 S., R. 23 E.). One to 3 ft (0.9 m) of calcilutite to 5 ft (1.5 m) of phylloid algae.

Frog Cemetery limestone bed (in Pawnee Limestone, Marmaton Group)
Pennsylvanian (Desmoinesian Series): eastern Kansas.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 2–3. The Frog Cemetery Limestone bed overlies the black Anna Shale and underlies the black Joe shale bed beneath the Laberdie Limestone Member. Type section defined according to Price (1981).
Type section: Half mile (0.8 km) south of Frog Cemetery in southwest Crawford County, Kansas, along north bank of Hickory Creek in SW corner of SE sec. 14, T. 30 S., R. 21 E. (originally described as Frog Limestone bed by Price, 1981, thesis).

Fullerton Formation
Fullerton Member (of Blanco Formation)
Fullerton Member (of Chase Channel Formation)
Fullerton Member (of unnamed formation in Meade Group)
Pleistocene Series (Nebraskan Stage): central and western Kansas and southern, central, and northern Nebraska.
A. L. Lugn and G. E. Condra, 1932, Geological Society of America, Bulletin, v. 43, no. 1, p. 190. Silt and clay, 8–60 ft (2.4–18 m) thick; rests conformably on Holdrege formation; Aftonian.
A. L. Lugn, 1934, Nebraska State Museum, Bulletin 41, v. 1, p. 326, 343–345. Largely fluvial inwash-outwash deposits of dark calcareous silt and clay with some sand; Aftonian age; 0–65 ft (0–19.7 m) thick; covers 15,000± mi² (39,000± km²); extends continuously under Platte River valley and plains to north and south, but exposed only in northern part of state and at Fullerton, Nance County. Occurs also in southern central Nebraska. Rests conformably on Holdrege formation and is overlain unconformably by Grand Island formation.
O. S. Fent, 1950, Kansas Geological Survey, Bulletin 85, p. 64, 65. Gray silty clay containing much sand. Top member of Chase Channel formation, a subsurface unit in western Kansas. Maximum thickness 30 ft (9 m). Underlies Meade formation; gradationally overlies Holdrege member.
O. S. Fent, 1950, Kansas Academy of Science, Transactions, v. 53, p. 83. The character of the Fullerton member, the more widespread silty clay overlying the Holdrege gravels, is more consistent throughout central Kansas. It is composed of gray and buff silt and clay, partly thinly laminated, and contains much sand in the lower part. The upper, usually buff part, contains nodules of calcium carbonate.
G. E. Condra and E. C. Reed, 1950, Nebraska Geological Survey, Bulletin 15–A, p. 12, 16. Silt and calcareous clay grading locally into fine sand; occurs between Holdrege and Grand Island formations in Loess Plains area; thickness a few feet to >50 ft (15 m), average 20–30 ft (6–9 m). Grades westward into "Aftonian formation" which was developed generally on the Holdrege sand and gravel plain where subdrainage was not active.
J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 52, 59–61, 64. Upper member of Blanco formation in Kansas. Where exposed in Sedgwick County, is 8 ft (2.4 m) of gray to greenish-gray silt and sand that overlies Permian shale; underlies red sandy silts and silty sands tentatively classed as Crete–Loveland.
C. W. Hibbard, 1958, American Journal of Science, v. 256, no. 1, p. 55. Shown as member of unnamed formation in Meade group; overlies Holdrege member; occurs below Afton soil.
J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shown as formation in Kansas. Nebraskan–Aftonian.
C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 60, 66. Clay, silt, and sand, in part derived from Pliocene deposits, but locally containing much material from Paleozoic and Mesozoic bedrock. Uppermost formation in Nebraskan Stage; overlies Holdrege Formation; underlies Afton Soil; shown in central and western area; thickness commonly less than 25 ft (7.6 m).
Named for exposures in vicinity of Fullerton, Nance County, Nebraska.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 87. Thickness 3–75 ft (0.9–22.7 m). In southern Kansas, includes Dodds Creek Sandstone in lower part. Overlies Swope Limestone; underlies Dennis Limestone. In Bronson Subgroup of Kansas City Group.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 29. Contains gray and yellow marine shale, sandy nonmarine shale, sandstone, and coal.

W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 8–9. In southern Kansas, Galesburg overlies Mound Valley Limestone. In northern Kansas, Galesburg overlies Bethany Falls Limestone. Dodds Creek Sandstone Member lowered to bed status.

Named for Galesburg, Neosho County, Kansas. Galesburg Shale makes the slope south of town in sec. 5, T. 30 S., R. 19 E.

Garnett limestone

Pennsylvanian: eastern Kansas.

E. Haworth and M. Z. Kirk, 1894, Kansas University Quarterly, v. 2, p. 110, 120, 121. Hard compact limestones, separated into two parts by 8–10 ft (2.4–3 m) of shale; called Burlington or Garnett limestone, ultimate choice of name being left to future. Overlies Le Roy shales. Separated from higher Strawn limestone by 75–100 ft (22.7–30 m) of shale.

H. Hinds and F. C. Greene, 1915, Missouri Bureau of Geology and Mines, v. 13. Garnett limestone of Kansas includes (descending) Stanton limestone, Vilas shale, and Plattsburg limestone.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 70. Moore's restricted use of Lansing group corresponds to Garnett limestone of early Kansas Survey. The revival of Garnett might not be desirable, however, inasmuch as the term has been used for several different units and has never had wide acceptance.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 116–118, 121, 124, 126, 131, 139, 145, 160. Mostly a synonym for Lansing group, which is defined as strata from base of Plattsburg limestone to top of Stanton limestone. Presents other misuses of Garnett limestone (for Wyandotte limestone and Oread limestone) in other synonymies.

Named for Garnett, Anderson County, Kansas.

Garnett sand

Pennsylvanian (Desmoinesian): eastern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 82. Used in Anderson County, Kansas, for sandstone in the upper part of the Cherokee section; also known as the "800-foot sand."

Garrison Shale (of Council Grove Group)

Permian: eastern Kansas, northern Oklahoma, and southeastern Nebraska.

C. S. Prosser, 1902, Journal of Geology, v. 10, p. 712. Florena shales below (2–13 ft [0.6–3.9 m] thick) and Neosho member above (130 ft [39 m] thick), with aggregate thickness of 140–145 ft [42–43.9 m], are now united to form *Garrison formation*, so named because of good exposures from Garrison South in Big Blue Valley.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, 2nd series, Bulletin 6, p. 13–15. There is no valid reason for separating the [Council Grove] group as the Garrison formation and the Cottonwood limestone [even though Condra and Upp used Garrison in chart on p. 13].

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 50, 251. Discarded the name. In diagram showing comparison of old and revised classification of beds referred to lower part of Big Blue series of "Permian" age, Garrison shale is replaced by (ascending) Beattie limestone (includes Florena and Morrill limestone members), Stearns shale, Bader limestone (includes Eiss limestone, Hooser shale, and Middleburg limestone members), Easly Creek shale, Bigelow limestone (includes Crouse limestone, Blue Rapids shale, and Funston limestone members), and Speiser shale.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 103–105. As used in this report, Garrison shale is top unit of Council Grove group. Includes beds upward from top of Cottonwood limestone to base of Wreford limestone. Name was discarded by Moore (1936), who raised various members of Garrison formation to formation rank. Formations constituting Garrison section in Kansas cannot be identified in Pawnee County, and general term Garrison shale has been retained. Interval consists of poorly exposed heterogeneous sequence of red shale and red to tan lenticular sandstones. Thickness difficult to determine. About 140 ft (42 m) in subsurface, slightly west of outcrop.

Named for exposures at Garrison, Pottawatomie County, Kansas.

Gasconade Dolomite (of Arbuckle Group)

Gasconade Dolostone and Van Buren Formation (of Arbuckle Group)

Gasconade limestone

Lower Ordovician: Missouri and eastern Kansas.

F. L. Nason, 1892, Missouri Geological Survey, v. 2, p. vii, 12, 93, 114–115, pl. 3. Great series of limestone beds interstratified with thin beds of sandstone that underlie Roubidoux sandstone in Ozark uplift and compose lower formation of Ozark series; includes third and fourth magnesian limestones and separating sandstones of earlier reports.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 106, 119, 120. Deposits in Kansas that correspond to the Gasconade and Van Buren formations at outcrops in Missouri are not clearly separable in the subsurface. They consist mainly of very cherty coarse granular dolomite. The chert in the upper part, which is dense and gray to dark bluish, grades downward to white dense and quartzose chert.

O. R. Grawe, 1954, Missouri Geological Survey, 2nd series, v. 30, p. 52 (fig. 2), 55–57. Basal part of formation contains pebbles of chert and sometimes of Precambrian igneous rocks derived from older formation, but commonly it is marked by sandstone or sandy dolomite, 15–25 ft (4.5–7.6 m) thick. This basal zone is known as Gunter Sandstone Member (found only in Missouri). It is overlain by 80–125 ft (24–37.9 m) of thin- to medium-bedded cherty dolomite, and this in turn is overlain by massively bedded cherty dolomite, 141–200 ft (42.7–60.6 m) thick. Term Gasconade is used in its earlier unrestricted sense to include all strata between the Eminence and the Roubidoux.

Loveland Loess; underlies Peoria Loess; top of formation marked by a "weak" soil horizon that is believed to represent Farmdale Interstadial Soil and marks the contact between Early and Middle Wisconsinan deposits.

C. K. Bayne and H. G. O'Connor, 1968, Kansas Geological Survey, Bulletin 189, p. 60–62, 64. At some localities the Sangamon Soil formerly was considered to include an abnormally thick A-horizon and a double A-horizon at some other localities. The upper part of the thick Sangamon A-horizon or the upper Sangamon A-horizon, where a double A-horizon occurs, is now recognized as a distinct depositional unit that is younger than Sangamonian and older than the Wisconsinan Peoria Formation. This unit, which is separated from the Peoria by a weakly developed soil horizon, is named the Gilman Canyon Formation in Nebraska. It has been recognized in northeastern Kansas and the name is adopted herein. The Gilman Canyon Formation is typically exposed in the south bank of a draw which parallels a private road near the center of sec. 12, T. 3 S., R. 21 E., Doniphan County, Kansas, where it overlies the Sangamon Soil and underlies the Peoria Formation. The lower part is light-gray to nearly white, displaying faint bedding; the upper part is dark-gray, silty clay generally representing the A_1-horizon of an accretion gley. Thickness 2–4 ft (0.6–1.2 m).

Type locality: In west fork of Gilman Canyon in Buzzard's Roost section in roadcut extending from center of SW SE sec. 8, to SW SE sec. 7, T. 10 N., R. 26 W., Lincoln County, Nebraska.

Gilmore City Limestone

Gilmore City Limestone (of Easley Group)

Gilmore City Formation

Mississippian (Kinderhookian Series): north-central Iowa, and northeast and west of Central Kansas uplift.

F. M. Van Tuyl, 1922, Iowa Geological Survey, v. 30, p. 113–114. [Author does not state that he is naming the beds described, but he uses Gilmore City limestone in three places, and it is in index to volume.] As described, the beds in Gilmore Portland Cement Co.'s quarry, 1.5 mi (2.4 km) northwest of Gilmore City, Pocahontas County, consist of about 41 ft (12.4 m) of limestone of Kinderhookian age, which is said to be probably older than Humboldt oolite, to resemble lithologically Alden limestone (Oklahoma), to rest on brownish dolomitic limestone assigned to Kinderhook group, and to be possibly equivalent to Iowa Falls dolomite, but "correlation is uncertain."

L. R. Laudon, 1931, Iowa Geological Survey, v. 35, p. 349, 416–417. Alden limestone of Hardin County and Gilmore City limestone of Humboldt and Pocahontas counties suggest Spergen both lithologically and faunally. The large crinoid fauna in base of Gilmore City limestone carries large number of Kinderhook genera. Alden limestone, which is correlated with Gilmore City limestone, lies unconformably on upper surface of Iowa Falls member of Hampton formation. This relation seems to suggest they should not be considered of Kinderhook age. [p. 349.] Alden limestone is correlated with oolitic limestone exposed near Humboldt and Gilmore City. Exact age of fauna of Gilmore City limestone is doubtful, but it is considered younger than the Kinderhook because of the fauna and the marked unconformity which separates it from upper beds of the Kinderhook. Fauna as a whole resembles certain parts of fauna of Madison limestone of the West. Type section of Gilmore City beds consists of (descending): 1) thin-bedded white oolitic limestone, numerous joints filled with green shale (*Cyathophyllum* zone), 14 ft (4.2 m); 2) very massive hard grayish-white crystalline crossbedded oolitic limestone, fossiliferous throughout, more so near the base (*Streptorhynchus* zone), 18 ft (5.5 m); 3) massive greenish limestone, interbedded with green shale (*Rhodocrinus* zone), 8 ft (2.4 m); 4) soft blue shaly limestone (*Camarotoechia* zone), 3 ft (0.9 m); 5) brecciated limestone, 2 ft (0.6 m).

L. R. Laudon, 1933, University of Iowa Studies, new series, no. 256, v. 15, no. 2. Gilmore City formation consists almost entirely of gray, white, or blue crossbedded sandstone. Thickness 210 ft (63.6 m). Is unconformably underlain by St. Louis limestone and unconformably overlain by Iowa Falls member of Hampton formation. Writer believes the formation represents an eastward invasion of some portion of Madison sea of the West. [Listed fauna, described and discussed it.] At first glance one is impressed with similarity of this fauna with that of Spergen formation. A close examination, however, will reveal that it is not the Spergen fauna and that it is far older. It has its closest affinities with the molluscan fauna of the Wassonville member of Hampton formation (Kinderhook).

R. C. Moore, 1935, Report, 9th Annual Field Conference, Kansas Geological Society, p. 245, 247. Alden limestone of northern central Iowa is unconformably overlain by St. Louis limestone, unconformably underlain by Hampton formation, and is equivalent to Salem [Spergen] limestone. Moore revives old term Alden and correlates the formation with Spergen. A careful study of Gilmore City fauna shows more of Spergen species are present. The abundant crinoid fauna is typically late Kinderhook and very closely related to fauna at LeGrand.

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 35, 36, 40–46, pl. 2. Soft white non-cherty limestone; contains oolitic or pseudo-oolitic limestone in some places; disconformable upper and lower contacts; not definitely referable to either Kinderhookian or Osagean series.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, no. 2, p. 101, 146, 150, chart 5. Shown on standard Mississippian stratigraphic section as uppermost formation in Easley group (new) underlying Fern Glen formation and overlying Sedalia formation. In Iowa overlies Iowa Falls dolomite. Also termed Alden formation.

J. R. Clair, 1948 [1949], Kansas Geological Society, p. 12–13, pl. 1 [World Oil, v. 129, no. 8, p. 62, 66]. The use of the term Chouteau [for the lowest Mississippian limestone in western Kansas] is in part an arbitrary device to get away from the use of the term "Gilmore City" to denote the basal Mississippian, and in part to indicate the writer's belief that this basal section is correlative in age and time of deposition to the Northview Shale and Compton Limestone.

M. P. Carlson, 1963, Nebraska Geological Survey, Bulletin, no. 21, p. 17–18, 26. Noted miscorrelations of Gilmore City Formation by Laudon (1933) and Wells (1960). Gilmore City Limestone is the upper of two oolitic limestone horizons (lower = Compton [Chapin]) above the "Chouteau Group." First to map Gilmore City from outcrop area in Iowa, across Nebraska, and into northwestern Kansas.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin, v. 189, p. 18–19, pl. 1. Uppermost Kinderhookian formation in subsurface northeast and west of Central Kansas uplift; consists of non-cherty, soft, chalky

series. Consists of chalks about 400 ft (121 m) thick. Underlies Wallace shale; overlies Apishapa shale of Pueblan series.

C. R. Keyes, 1941, Pan-American Geologist, v. 76, no. 5, p. 371, 372. Proposed for heavy chalk formation in northwestern Kansas, heretofore regarded as representing Niobrara chalk of upper Missouri River country. Occurs in Gove, Logan, and Wallace counties, Kansas.

Probably named for Gove County, Kansas.

Graham jasper (in Niobrara formation)

Cretaceous: northwestern Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 51. The horizon of jasper near upper limit of Smoky Hill chalk in Kansas.

Named for Graham County, Kansas.

Grand Falls chert member

Mississippian.

A. Windslow, 1894, Missouri Geological Survey, v. 7, p. 417–419. *Grand Falls chert*—Very dense, hard chert, 30 ft (9 m) thick in Shoal Creek section of southwest Missouri. Occurs in massive layers 6 or more feet (1.8 m) thick; has a gnarled and knotted structure, producing uneven surface.

C. E. Siebenthal, 1907, U.S. Geological Survey, Joplin folio, no. 148. *Grand Falls chert member of Boone formation*—Almost wholly heavy beds of solid chert, but is not persistent and in many areas its stratigraphic horizon is occupied by limestone. Its distinctive characters are heavy bedding, "live" splintery fracture, fine brecciation and cementation, and spotting. Thickness 15–120 ft (4.5–36 m). Lies about 100 ft (30 m) below Short Creek oolite member of the Boone, and from 25 to 100 ft (7.6–30 m) above base of Boone. Fossils [listed] include species distinctly suggestive of Keokuk and not particularly suggestive of Burlington. Named for development around Grand Falls, Newton County, Missouri.

R. C. Moore, G. M. Fowler, and J. P. Lyden, 1939, Geological Society of America, Special Paper 24, p. 3, 10. Named subdivisions of Keokuk are Grand Falls chert, at base, and Short Creek oolite near top. Grand Falls is an irregularly bedded mass of dense "butcher knife" chert, mostly light gray but appears light yellowish brown or dark brown in weathered exposures. Thickness at type locality (including beds below water level) 35 ft (10.6 m). Locally discontinuous but identified over hundreds of square miles in Tri-state district. Osagean series.

E. B. Branson, 1944, Missouri University Studies, v. 19, no. 3, p. 197, 204. Report refers to Grand Falls chert at top of Reeds Spring member of Chouteau formation. Also refers to Reeds Spring limestone and quotes at length from unpublished manuscript by Clark (1941) who classed the Grand Falls as member of Reeds Spring.

E. L. Clark and T. R. Beveridge, 1952, Kansas Geological Society, Guidebook, 16th Field Conference p. 13 (fig. 1), 14–15 (fig. 2), 38 (fig. 12), 40 (fig. 15), 41 (fig. 16), 53 (fig. 26), 72 (fig. 1). Report refers to Grand Falls formation. Overlies Reeds Spring formation or Pierson formation; underlies Burlington formation or Keokuk formation.

C. H. Behre, Jr., and A. V. Heyl, Jr., 1959, Deutsche Geologische Gesellschaft, Zeitschrift, v. 110, pt. 3, p. 517 (fig. 2). Chart shows Grand Falls member of Boone formation below Short Creek member and above Reeds Spring member. Thickness 6–38 ft (1.8–11.5 m).

C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, 62 p. Name "Grand Falls chert" restricted to distinctive body of massive chert that crops out in vicinity of Grand Falls south of Joplin. Recommended that name "Grand Falls" be discontinued except for this limited chert unit, and that the widespread, mappable, sedimentary unit that immediately overlies Reeds Spring Formation and which has been previously referred to as "Grand Falls Formation" in southwestern Missouri be given name "Elsey Formation."

W. J. Seevers, 1975, Kansas Geological Survey, Geology Series No. 1, p. 2–3. The upper part of the Reeds Spring Limestone Member in Cherokee County, about 45 ft (13.6 m) thick, has been called the Grand Falls Chert; although not formally recognized in Kansas, the deposits of lead and zinc that have been mined throughout the Tri-state district (Missouri–Kansas–Oklahoma) occur primarily in the Grand Falls Chert and overlying rocks of Mississippian age.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 87–89. Restricted Grand Falls to immediate area of type locality near the center of sec. 28, T. 27 N., R. 34 W., Newton County, Missouri.

Named for exposures around Grand Falls, Newton County, Missouri.

Grandhaven Limestone Member (of Stotler Limestone)

Pennsylvanian (Virgilian Series): northeastern Kansas, northwestern Missouri, southeastern Nebraska, southwestern Iowa.

R. C. Moore, 1935, Kansas Geological Survey, Bulletin 20, table opposite p. 14. *Grandhaven limestone* underlies Friedrich shale and overlies Dry shale.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 10. Applied *Grandhaven* to 1 ft (0.3 m) of gray, nodular, arenaceous limestone, forming a member in lower part of his Friedrich–Dry shale, and lying 3 ft (0.9 m) above his Dover limestone formation. Derivation of name not stated.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 49, 237–238. *Grandhaven limestone* overlies Dry shale and underlies Friedrich shale. Commonly consists of two limestone members separated by a few feet of shale. The lower limestone is 1/2–5 ft (0.15–1.5 m) thick, gray to bluish, and unlike the older Dover limestone, weathers brown. Contains many fusulinids in some exposures. The upper limestone is 1–8 ft (0.3–2.4 m) thick, very light-gray, weathering almost white, and is characterized by abundant algal deposits, and closely resembles upper member of Dover limestone. The shale between the two limestones is mostly bluish gray, clayey to calcareous, and 4–10 ft (1.2–3 m) thick. The Grandhaven limestone is recognized from Shawnee County south to Oklahoma, but is not seen north of Kansas River.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 192. Thickness averages about 10 ft (3 m); lower limestone 2–5 ft (0.6–1.5 m) thick in the north, but only 0.5 ft (0.15 m) in the south; upper limestone usually 1–2 ft (0.3–0.6 m), but up to 8 ft (2.4 m) or more in places; intermediate shale is 4–10 ft (1.2–3 m) thick.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,275. Rank reduced to member status in Stotler limestone (new). Overlies Dry shale member; underlies Friedrich shale member of Root shale (new).

seams of fossiliferous limestone near top in most sections. Thickness 15 or 16 ft (4.5 or 4.8 m) in Nebraska and in northern central Kansas, but decreases southward toward Winfield and plays out between there and Arkansas City, Kansas. In many exposures it carries a thin pebbly subzone near top. Named for Grant Township, Marion County, Kansas. Type locality between 5 to 6 mi (8–9.6 km) north of Florence, Kansas. Overlies Stovall Limestone Member and underlies Cresswell Limestone Member.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 44. Member of Winfield Limestone. Consists of gray calcareous, fossiliferous shale; a distinct unit except in southern Kansas where it probably has been included in lower part of Cresswell Limestone Member. Thickness in northern part about 10–12 ft (3–3.6 m); in central about 6 ft (1.8 m). Overlies Stovall Limestone Member. Wolfcampian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 49, and pl. 1. This member is a gray, calcareous and fossiliferous shale. It is a distinct unit except in southern Kansas. The Grant is abundantly fossiliferous at some exposures. Thickness in northern outcrops is about 10–12 ft (3–3.6 m); in central outcrops it is about 6 ft (1.8 m).

Type locality: Between 5 and 6 mi (8–9.6 km) north of Florence, Marion County, Kansas. Named for Grant Township in Marion County.

"Gray group"

Pennsylvanian (probably Atokan Stage): subsurface of southwestern Kansas.

J. C. Youle, 1991, Kansas Geological Survey, Open-file Report 91–52, p. 142–153, 144, 157, 159, 161–170. Name given to undifferentiated rocks of probably Atokan age; includes rocks from the top of the "F" sequence (Cherokee Group) down to the top of the Kearny Formation or the sub-Pennsylvanian unconformity surface; includes rocks correlative with the "Thirteen Finger lime" of Oklahoma; about 150 ft (45 m) thick at type locality.

Type locality: From depths 4,877 to 4,958 ft (1,478–1,502 m) in the Pendleton #1 Schauf core (SW SW NE sec. 16, T. 27 S., R. 29 W.), Gray County, Kansas. Corresponds to log depths 4,871–4,952 ft (1,476–1,501 m) on the Pendleton #1 Pendleton (between coring and logging, the well name was changed from #1 Schauf to #1 Pendleton). Entire section not present in the Pendleton #1 Schauf core, consequently wireline-log interval from 5,416 to 5,554 ft (1,641–1,683 m) in the Anadarko Production #1–A Milhon (SW NE sec. 9, T. 33 S., R. 32 W.), Seward County, Kansas, noted as reference section.

Grayhorse Limestone Member (of Wood Siding Formation)

Pennsylvanian (Virgilian Series): eastern Kansas and north-central Oklahoma.

K. C. Heald, 1918, U.S. Geological Survey, Bulletin 686K, p. 130. The stratigraphic section of rocks exposed in T. 27 N., R. 7 E., Osage County, shows a thin limestone, called *Grayhorse limestone*, lying 85 ft (25.8 m) below Foraker limestone and 57 ft (17.3 m) below a micaceous sandstone. [This limestone was named by C. F. Bowen in Bulletin 686L, but Heald's chapter in Bulletin 686K was released before Bowen's report in Bulletin 686L.]

C. F. Bowen, 1918, U.S. Geological Survey, Bulletin 686L, p. 138. *Grayhorse limestone*—Dark-brownish-gray crystalline conglomeratic limestone, usually 2± ft (0.6± m) thick but locally 4 ft (1.2 m) thick. Contains numerous small pebbles ranging in size from mere grains to that of a large pea, which weather dirty white and give rock a mottled appearance. In most places contains numerous large specimens of *Myalina subquadrata*, some of which are 3 or 4 inches (7.5–10 cm) in longest dimension. The outcrops on steep slopes break off in large slabs as much as 10 ft (3 m) across which strew the slope below. Is older than Foraker limestone and younger than Stonebreaker limestone (Oklahoma). Named for excellent exposure on crest of Little Grayhorse anticline, Osage County, Oklahoma.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 172. Classed as member of Caneyville limestone in Kansas. Overlies unnamed shale; underlies Pony Creek shale.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 195. Medium- to coarse-grained, fragmental or coquinoid, strongly ferruginous limestone; ranges in thickness from about 0.5 to 5 or 6 ft (0.15–1.5 or 1.8 m), average thickness about 1 ft (0.3 m).

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273, 2,274 (fig. 1). Reallocated to Wood Siding formation herein redefined. Overlies Plumb shale member (new); underlies Pony Creek shale member.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 14–16. In the northern outcrop area, the Grayhorse is present only in the southern part of Pottawatomie and Jackson counties and in the northern part of Jackson and Nemaha counties; persistent elsewhere except small areas in southern Lyon and northern Greenwood counties where thin pelecypod-bearing limestones beds are present; hard, grayish-brown conglomeratic limestone in northern outcrop belt; most characteristic fossil in Kansas is *Orthomyalina*; average thickness about 0.8 ft (0.24 m), ranges from 0 to 2.8 ft (0–0.8 m) thick.

C. G. Bisby, 1986, Kansas Geological Survey, Open-file Report 86–4, p. 14–15. Reports "clay-ball" clasts up to 5 cm (2 inches) in diameter.

Type locality: Exposure on crest of Little Grayhorse anticline in NW sec. 11, T. 24 N., R. 6 E., Osage County, Oklahoma.

Greeley gypsum (of Sumner group)

Permian: central Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 10. A gypsum bed in Geuda salt measures, about 100 ft (30 m) higher stratigraphically than Hope gypsum.

Named for Greeley Township, Saline County, Kansas.

Greenhorn Limestone (of Colorado Group)

Greenhorn Member (of Colorado Shale, Cody Shale, or Mancos Shale)

Greenhorn Member or Formation (in Benton Formation or Group)

Upper Cretaceous: eastern Colorado, northwestern Iowa, western Kansas, southeastern Montana, Nebraska, northeastern New Mexico, and South Dakota.

G. K. Gilbert, 1896, U.S. Geological Survey, 17th Annual Report, part 2, p. 564. Limestone beds, 3–12 inches (7.5–30 cm) thick, separated by somewhat thicker shale beds; 25–40 ft (7.6–12 m) thick; middle formation of Benton group in

Guadalupe Mountains; characterized by its unique fauna (distinct from Mississippian and Pennsylvanian).

J. E. Adams, M. G. Cheney, R. K. Deford, R. I. Dickey, C. O. Dunbar, J. M. Hills, R. E. King, E. R. Lloyd, A. K. miller, and C. E. Needham, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,675–1,676, 1,678. Rank raised to series. Rests on Bone Spring Limestone of Leonardian age. Includes Delaware Mountain Sandstone (Word) and Capitan Limestone. Underlies Ochoan Series. Includes Whitehorse Group and equivalent beds in Texas, Oklahoma, and Kansas. Cimarron Series of northern midcontinent region should be abandoned and its strata reclassified as belonging to Leonardian and Guadalupian Series.

P. B. King, 1942, American Association of Petroleum Geologists, Bulletin, v. 26, p. 575–608, 699–709. Series in Glass Mountains consists of Word Formation followed by Altuda Formation, Capitan Limestone, and Gilliam Limestone; in Delaware Basin constitutes Delaware Mountain Group including (ascending) Brushy Canyon, Cherry Canyon, and Bell Canyon Formations, higher part replaced by Goat Seep and Capitan Limestones away from the basin. In shelf area, reef masses grade into Carlsbad and Chalk Bluff Formations.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 37. Rocks of Guadalupian Series crop out in southern Kansas. They comprise unfossiliferous deposits that seem to have been laid down partly on land and partly in shallow basins occupied by strongly saline waters. Thickness about 290 ft (87.9 m); subsurface thickness averages 400 ft (121 m) in southwestern part of state.

J. M. Jewett, 1959, Graphic column and classification of rocks of Kansas: Kansas Geological Survey. As shown on correlation chart, Guadalupian Stage is Middle Permian.

G. V. Cohee, 1960, American Association of Petroleum Geologists, Bulletin, v. 44, p. 1,578–1,579. U.S. Geological Survey recognizes a two-fold subdivision of the Permian. Reference section for United States as outcrops on northwestern Trans-Pecos Texas where approximate faunal boundary is between Cherry Canyon and Bell Canyon Formations which are encompassed by Guadalupian Series.

C. C. Branson, 1960, Oklahoma Geology Notes, v. 20, n. 9, p. 233 (table 1). In Oklahoma, series includes El Reno and Whitehorse Groups.

H. G. O'Connor, 1963, American Association of Petroleum Geologists, Bulletin, v. 47, p. 1,873–1,877. Three-fold subdivision of the Permian as used in Kansas is abandoned for two-fold subdivision, Lower and Upper Series; divided at base of Whitehorse Group. West Texas series Wolfcampian, Leonardian, Guadalupian, and Ochoan are abandoned in preference to locally derived stage names. Depositional environments of Permian rocks of the Glass Mountains, Texas, differ from those of Kansas. Reef rocks cannot be related to shelf rocks of Kansas with any degree of confidence. Name Custerian Stage replaces formerly used Guadalupian Series, and includes Whitehorse through Big Basin Formations. Custer is Upper Permian.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 52. Custer Stage adopted for rocks from base of the Whitehorse to top of Big Basin Formations; thickness about 315 ft (95 m).

B. Rascoe, Jr., and D. L. Baars, 1972, Rocky Mountain Association of Geologists, Geologic Atlas of Rocky Mountain Region, p. 143–165. Whitehorse Group, Day Creek Dolomite, and Big Basin Formation assigned to Guadalupian Series.

J. B. Waterhouse, 1978, American Association of Petroleum Geologists, Studies in Geology No. 6, p. 299–303, table 2. Study of chronostratigraphy for the World Permian, correlated Guadalupian Series with Kungurian, Kazanian, Punjabian, and lower Djulfian (Urushtenian Substage) Stages of the World standard Permian section.

Type locality: South end of Guadalupe Mountains. Named for Guadalupe Point, El Paso County, Texas.

Gunter Sandstone Member (of Gasconade Dolomite)

Gunter Sandstone (of Arbuckle Group)

Ordovician (Lower): eastern Kansas, northeastern Oklahoma, central and southern Missouri, and northern Illinois.

S. H. Ball and A. F. Smith, 1903, Missouri Bureau of Geology and Mines, v. 1 series 2, p. 26. Fine- to coarse-grained sandstone, 0–18 ft (0–5.4 m) thick; unconformably overlies Proctor limestone; underlies Gasconade limestone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 106, 119. Sandy dolomite at the base of the Van Buren formation in Kansas; unconformably overlies Eminence dolomite and probably also Bonneterre, Lamotte, and Precambrian.

R. D. Knight, 1954, Kansas Geological Society, Guidebook, 17th Annual Field Conference, p. 57–59. Member of Gasconade formation; sandstone and sandy dolomite; average thickness 25–30 ft (7.5–9 m); maximum thickness 50 ft (15 m); subsurface member of Arbuckle group in parts of Kansas and Oklahoma.

Type section: At Hahatonka, Camden County, Missouri. Named from abandoned Gunter post office in Miller County, Missouri.

Gurley Sandstone Member (of Omadi Formation)

Gurley Member (of Omadi Formation)

Cretaceous (Lower): eastern Colorado, southeastern Wyoming, southwestern Nebraska, and western Kansas.

M. J. Boreing, 1954, Proceedings of the Third Subsurface Geological Symposium, p. 75, 77–78. Cited unpublished work of C. W. Sternberg and A. J. Crowley (The Denver–Cheyenne Basin, American Association of Petroleum Geologists, Los Angeles, March 27, 1952) in which Gurley Member is uppermost member of Omadi Formation; overlies Huntsman Member; underly Mowry Shale.

D. F. Merriam, 1957, Kansas Geological Survey, Oil and Gas Investigations, no. 14, p. 2, 8, 11–13. Two sandstones separated by a thin shale unit in extreme northwestern Kansas; other places, a series of alternating thin sandstones and shales; sandstone mostly is light-gray, fine- to medium-grained, locally carbonaceous; in some places the sand is coarse grained to conglomeratic; thickness ranges from a featheredge to about 120 ft (36 m); generally thins to east and south; corresponds to the "D" and "G" sands of the Denver basin.

Type locality: No type locality formally established. However, Boreing (1954, p. 75) noted that, "The Ohio Oil #1 Cruise log [Huntsman Field, Cheyenne County, Nebraska] is representative of the section as drilled within the main

Hancock sand

Pennsylvanian (Desmoinesian): Chautauqua County, Kansas.

D. W. Williams, 1921, American Association of Petroleum Geologists, Bulletin, v. 5, p. 293–297. Subsurface producing sand in Chautauqua County, Kansas; occurs about 100 ft (30 m) below Peru sand in Chautauqua County; lies within the Bandera shale, above the Pawnee limestone, and below the Altamont limestone; same as Weiser sand of Montgomery County, Kansas, consequently the interval is referred to as "Weiser-Hancock" throughout text and in figures.

M. E. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 905. A subsurface sand in the Pennsylvanian (probably in the Bandera shale) of Chautauqua County, Kansas. Is said to occur 100± ft (30± m) below the Peru sand and at the approximate horizon of the Weiser sand of Montgomery County, Kansas.

Hancock shale

Pennsylvanian (Desmoinesian): southern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 82. Used to designate the Little Osage shale member of the Fort Scott formation in the subsurface in Chautauqua County, Kansas, where it bears gas.

Hannibal Shale (of Cowley Formation)

Mississippian (Kinderhookian Series): subsurface of northeastern Kansas, northwestern Missouri, and Nebraska. Surface of northeastern Missouri.

C. R. Keyes, 1892, Geological Society of America, Bulletin, v. 3, p. 289. *Hannibal shales*—Fossiliferous shales, 70–100 ft (21–30 m) thick; upper portion sandy in places and often forms rather compact shaly sandstone; lower portion bluish or greenish clay shales. Underlies Chouteau limestone and overlies Louisiana limestone. All included in Kinderhook group.

R. C. Moore, 1928, Missouri Bureau of Geology and Mines, v. 21, 2nd series, table opposite p. 282, showed Glen Park limestone as underlying Hannibal shale and overlying Louisiana limestone in Jersey and Calhoun counties, southwestern Illinois, and that elsewhere (Pike County, central western Illinois, and Pike and other counties in Missouri) the Hannibal is unconformably on Louisiana limestone, the Glen Park being absent. In 1935 (Report, 9th Annual Field Conference, Kansas Geological Society, p. 245), Moore shows Hannibal shale as present in only western Illinois and northeast Missouri, and that in southern Illinois and southeast Missouri the Fern Glen is unconformably on Glen Park, through absence of Chouteau limestone and Hannibal shale.

J. M. Weller, 1948, (abs.) American Journal of Science, v. 246, no. 3, p. 150. In type area in Mississippi Valley, Easley group (new) consists of Hannibal shale and Chouteau limestone and related groups or formations.

L. E. Workman and Tracy [Tracey] Gillette, 1956, Illinois Geological Survey, Report of Investigations 189, p. 8 (fig. 1), 20-28. Rank raised to group. Includes formations that lie above Louisiana limestone and beneath the Chouteau. Comprises (ascending) Glen Park siltstone, Maple Mill shale, and English River siltstone in Iowa. Where the Louisiana is absent, group rests on the Saverton, and where Saverton is absent it lies on Grassy Creek shale. In small area in westernmost Illinois, McCraney formation in North Hill group overlies the Hannibal and where neither the Chouteau nor McCraney is present, the Hannibal is overlain by Osage strata.

T. J. Laswell, 1957, Missouri Geological Survey and Water Resources, Report of Investigations 22, p. 9 (fig. 2), 34-39, pl. 1. Formation described in Bowling Green quadrangle where it is 90–121 ft (27–36.7 m) thick. Composed of two lithologies: upper siltstone to fine-grained sandstone and lower silty shale. Unconformably overlies Louisiana wherever latter is present; where Louisiana is absent, formation lies unconformably on Saverton. Underlies Chouteau formation; where Chouteau is absent, underlies Burlington formation.

M. G. Mehl, 1960, Journal of the Scientific Laboratories, Denison University, v. 45, p. 57-107. Cuiver Shale equivalent to basal part of Hannibal Shale on outcrop, not recognized in Kansas.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 19-23, 26, 57, 63, 64. The base of the Hannibal is early Kinderhookian; westward and southwestward from the type area, the upper part of the Hannibal is replaced by limestone of the Chouteau Group; the Chouteau continues to thicken southward and westward at the expense of the Hannibal until Hannibal becomes difficult to distinguish from "Kinderhook shale."

M. W. Lambert, 1988, Kansas Geological Survey, Open-file Report 88-37, p. 2. Included black shale [=Chattanooga] and overlying red and green shale [?=Hannibal] found at the base of the Mississippian carbonates in the Chattanooga.

C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–69, 73. Followed usage of Thompson (1986) and recommended that Hannibal Shale, as the older, more established surface-stratigraphic term, be used to replace Boice Shale.

Type locality: Exposures in the lower part of Lover's Leap, western bluffs of the Mississippi River valley above railroad yard at the southern edge of Hannibal, Missouri; NW SE sec. 28, T. 57 N., R. 4 W., Hannibal East 7 1/2-min quadrangle, Missouri.

Happy Hollow Limestone Member (of Scranton Shale)

Pennsylvanian (Virgilian Series): eastern Kansas, northeastern Oklahoma, southeastern Nebraska, northwestern Missouri, southwestern Iowa.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, p. 40, 58. *Happy Hollow limestone*—Limestone in the White Cloud shale member of the Scranton shale (see under White Cloud shale).

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, p. 53. Restricted White Cloud shale to beds below Happy Hollow limestone, named the shale overlying Happy Hollow limestone the Cedar Vale shale, and stated that Happy Hollow limestone persists from Nebraska to Oklahoma with several feet of shale between it and Rulo limestone. Classed Happy Hollow limestone as a member of the Scranton shale.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 49 (fig. 11), p. 211-212. *Happy Hollow limestone* is traceable from Cass County, Nebraska, across Kansas, and at least to southern part of Osage County, Oklahoma. Thickness 1–8 ft (0.3–2.4 m). Overlies White Cloud shale and underlies Cedar Vale shale. Typically it is a single massive bed of pinkish-brown, somewhat impure limestone that weathers in rounded or irregularly porous surfaces; in

R. C. Moore, 1936, Kansas Geological Society, 20th Annual Field Conference, Guidebook, p. 41. Introduced two members into Topeka Limestone beneath Hartford Limestone, as explained under Jones Point Shale and Dashner Limestone. This name was discarded by U. S. Geological Survey in 1912, because then stated to be same as Topeka Limestone.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig, 5); 1949, Kansas Geological Survey, Bulletin 83, p. 142 (fig. 29), 162; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 18. Hartford Limestone Member of Topeka Formation. Underlies Iowa Point Shale Member, overlies Calhoun Formation. Classification agreed upon by State Geological Surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 21. Condra and Reed, 1937, Nebraska Geological Survey, Bulletin 11, 2nd series. Uncertain regarding relation of the Hartford of southern Kansas to lower member of the Topeka in northeastern Kansas, southeastern Nebraska, northwestern Missouri, and southwestern Iowa so proposed name Wolf River for basal member of Topeka in that area. Nebraska Survey will drop name Wolf River if it proves to be correlative with the Hartford, which was loosely defined by Kirk (1896) and may have priority if it does not include beds of Du Bois, Iowa Point, and Wolf River age. Type locality stated.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 16-17, fig. 5. Commonly one bed of light- to blue-gray massive limestone; locally contains thin shale bed. Thickness 1 ft (0.3 m) near Thurman, Fremont County; 0.5 ft (0.15 m) near Howe, Adair County. Basal member of Topeka Limestone; underlies Iowa Point Shale Member; overlies Calhoun Shale. Called Wolf River in Nebraska.

H. G. O'Connor, 1960, Kansas Geological Survey, Bulletin 148, pl. 1. In Douglas County, member is 6–8 ft (1.8–2.4 m) thick and consists of two limestone beds separated by thin shale bed just below middle of member. Underlies Iowa Point Shale Member; overlies Calhoun Shale.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 38, and pl. 1. Member is a massive, light bluish-gray limestone that weathers yellow-brown; commonly contains numerous fusulinids. In upper part, Osagia is abundant. Lower beds are characterized by the sponge *Amblysiphonella*. Upper limestone ranges in thickness from 0 to 12 ft (0–3.6 m) . Thickness ranges from about 3 to 13 ft (0.9–3.9 m).

Type locality: Where member passes under Neosho River at Hartford, Coffey County, Kansas. Well exposed just North of Hartford.

Hartland Shale Member (of Greenhorn Limestone)

Cretaceous (Upper): western Kansas and southeastern Colorado.

N. W. Bass, 1926, Kansas Geological Survey, Bulletin 11, p. 203. Chalky shale with a few thin beds of chalky limestone; thickness 28–40 ft (8.5–12 m); underlies Jetmore chalk member of Greenhorn limestone; overlies Lincoln limestone member of Greenhorn limestone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 25. Chalky shale with a few thin beds of chalky limestone and bentonite; thickness 23 ft (6.9 m) in Kearny County to 35 ft (10.6 m) in Ellis County.

H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 56. Becomes more chalky southwestward; fossils include *Inoceramus* and ammonites.

Named for exposures along Arkansas River from a short distance west of Hartland, Kearny County, to Kendall, Hamilton County, Kansas.

Harveyville Shale Member (of Emporia Limestone)

Pennsylvanian (Virgilian Series): eastern Kansas, northern Oklahoma, northwestern Missouri, southeastern Nebraska, southwestern Iowa.

G. E. Condra, 1935, Nebraska Geological Survey, Paper, no. 8, p. 10. *Harveyville shale*, middle member of Preston ("Emporia") limestone formation. Consists of greenish, bluish shale, locally a subzone nearly black, argillaceous to calcareous, quite fossiliferous, 3–4 ft (0.9–1.2 m) thick to west, 7 ft (2 m) thick to east. Underlies Elmont limestone and overlies Reading limestone. [Derivation of name not stated.]

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 226. *Harveyville shale*, which is first defined in this report, includes beds overlying Reading limestone and underlying Elmont limestone. It is mostly bluish or yellowish brown and clayey, but locally contains sandy shale and thin platy sandstone, with a coal bed locally above the sandstone. Thickness 1–25± ft (0.3–7.6± m). Identified at many places from Nebraska to Oklahoma and is undoubtedly continuous across Kansas.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,276. Rank reduced to member status in Emporia limestone (redefined). Overlies Reading limestone member; underlies Elmont limestone member.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 57-58. Described in Pawnee County where it is 35–53 ft (10.6–16 m) thick. Overlies Reading limestone member; underlies Elmont limestone member. Extends southward across Pawnee County into Payne County; southern extent not known.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 13, fig. 5. Geographically extended into southwestern Iowa where it is classified as formation in Wabaunsee group. Where exposed in Fremont County consists of gray shale in lower part, limy nodules near center, and brown shale in upper part. Thickness 3 ft (0.9 m). Underlies Elmont limestone; overlies Reading limestone.

Type locality: Near Harveyville, southeastern Wabaunsee County, Kansas; well exposed in sec. 25, T. 15 S., R. 13 E.

Haskell Limestone Member (of Lawrence Formation in Douglas Group)

Pennsylvanian (Virgilian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.

R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference, Guidebook, correlation chart. Haskell Limestone, new name; underlies Lawrence Shale [restricted]

Society. *Hawxby shale* shown as underlying Falls City limestone and overlying Aspinwall limestone, all included in Admire shale. Derivation of name not stated.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 9. *Hawxby shale formation*—Light bluish-gray calcareous shale cut by thin-bladed material, 10 ft (3 m), underlain by 2 1/2 ft (0.76 m) of bluish-gray and locally red shale with an argillaceous subzone. Underlies Falls City limestone formation and overlies Aspinwall limestone formation; all included in Admire group.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22. Transferred all beds above Brownville limestone to Permian.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 37. Member of Chicago Mound formation (new). Underlies Falls City member; overlies Aspinwall member. Thickness 10–12 ft (3–3.6 m). Type section described.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273, 2,274 (fig. 1). Reallocated to member status in Onaga shale (new). Overlies Aspinwall limestone member; underlies Falls City limestone.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 232, p. 22–23. Hawxby shale member poorly exposed, mostly gray to olive-drab clayey shale in Kansas; some lapse of limestone present; thickness 4–19 ft (1.2–5.8 m), average 9.5 ft (2.9 m).

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva to conform. Admire Group (revised) assigned to Virgilian Series (Upper Pennsylvanian). As redefined includes: Grenola Limestone, Roca Shale, Red Eagle Limestone, Johnson Shale, Foraker Limestone, Janesville Shale, Falls City Limestone, Onaga Shale.

Type locality: Hawxby Farm, SE sec. 7, T. 4 N., R. 15 E., about 5 mi (8 km) west of Nemaha, Nemaha County, Nebraska.

Haynies Limestone Member (of Deer Creek Limestone)
Haynies limestone

Pennsylvanian (Virgilian): southeastern Nebraska and southwestern Iowa.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 40, 43, 49, 50. Limestone, 8–12 inches (20–30 cm) thick in southeast Nebraska, 9 inches (22.5 cm) in southwest Iowa, 20 inches (50 cm) in northwest Missouri, and 2+ ft (0.6+ m) thick in northeast Kansas. Underlies Mission Creek shale; overlies Larsh shale.

R. C. Moore, 1935, Rock formations of Kansas: Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Larsh–Mission Creek shale shown on chart overlying Rock Bluff limestone and underlying Ervine Creek limestone. Explanation box for Larsh–Mission Creek states, "The Haynies limestone appears here to north."

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 184–186. In Nebraska and Iowa, Condra (1927) designated by the name Haynies a blue dense limestone that occurs persistently between the Rock Bluff limestone below and the Ervine Creek limestone above. The shales above and below the Haynies limestone are in part black and somewhat slaty. The Haynies member seems exactly to correspond to the upper bed of the Plummer limestone as originally defined and it is possible that the Rock Bluff limestone, Larsh shale, and Haynies limestone, taken together, are equivalent to the original Plummer limestone. The Haynies is somewhat lighter in hue than the Rock Bluff, is slightly nodular and appears to lack fusulinids. [Haynies does not appear in the Kansas stratigraphic column shown on p. 48.]

Named for outcrop in foot of bluffs southeast of Haynies Station, Mills County, Iowa.

Hays limestone member (of Niobrara Formation)

Cretaceous (Upper): western Kansas and eastern Colorado.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 756. As originally defined, Fort Hays limestone was tentatively included in the Benton. In 1896, however, Cragin, also Williston, included it in the Niobrara, as its basal member, underlying Smoky Hill chalk member. This is commonly accepted definition. The limestone is top member of Fort Hays division or group of Mudge. In 1933 the U.S. Geological Survey and the Kansas Geological Survey agreed to change the name to Hays limestone, "the name of the town having been changed from Fort Hays to Hays, and geologists working Kansas having become accustomed to calling the limestone Hays limestone." (*See* AAPG Bulletin, v. 18, 1934, p. 1,494.) Later the Kansas Geological Society reported that the beds were named for old Fort Hays, a well-known landmark in western Kansas, and Fort Hays limestone member was therefore restored.

Heck sand

Pennsylvanian (Missourian): eastern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 82. Applied to the middle of three sandstones that occur in the Lane–Vilas shale in northwestern Montgomery County, Kansas; also known as the "Longton" and as the "Webb sand."

Heebner Shale Member (of Oread Limestone, Shawnee Group)

Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, eastern Kansas, and northwestern Missouri.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 32, 33, 37. Heebner Shale, of Oread Limestone Member, underlies Plattsmouth Limestone and overlies Leavenworth Limestone. Top part is bluish and argillaceous; lower part is black, finely bedded, and somewhat carbonaceous. Thickness 5 ft (1.5 m) or more. Named for Heebner Creek and Heebner farm, west of Nehawka.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 11. The so-called Heebner Shale of Condra (1927) is Galesburg Shale Member.

G. E. Condra, 1935, Nebraska Geological Survey, Paper 8, p. 12. Continued to use Heebner Shale as underlying Plattsmouth Limestone and overlying Leavenworth Limestone, and R. C. Moore also used it in Kansas in his 1936 classification.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5); 1949, Kansas Geological Survey, Bulletin 83, p. 126 (fig. 22), 148-149.

base). [This is presently approved definition of U. S. Geological Survey.]

R. C. Moore, J. C. Frye, J. M Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 41. Member of Nolans Limestone. Consists of limestone and dolomite, yellowish-tan, soft and dense, more dolomitic in southern and central Kansas than in northern part of state. Outcrops characterized by siliceous and calcareous geodes and concretions and cauliflowerlike masses of drusy flint weathered from matrix; molluscan fauna abundant. Thickness 7–10 ft (2–3 m) in northern part and about 30 ft (9 m) in southern Kansas. Overlies Paddock Shale Member; underlies Wellington Formation of Sumner Group. Wolfcampian Series.

H. D. Miser, 1954, Geologic map of Oklahoma (1:500,000): U. S. Geological Survey. Mapped as Herington Limestone in Chase Group.

C. C. Branson, 1960, Oklahoma Geology Notes, v. 20, no. 9, p. 229-235. Term Lyon series (Lyonian epoch) proposed for Sakmarian rocks of Oklahoma. Series would include rocks from top of Brownville limestone to top of Herington limestone.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 50 and pl. 1. The Herington is composed of yellowish-tan, dolomitic limestone and dolomite. It is more dolomitic in southern and central Kansas outcrops than in the northern outcrops. The Herington is characterized by siliceous and calcareous geodes and concretions, and cauliflowerlike masses of chert and quartz. Fossil mollusks are locally abundant. Thickness ranges from 6 to 10 ft (1.8–3 m) in the northern part of the outcrop area and is about 30 ft (9 m) in the southern part of Kansas.

Named for Herington, Dickinson County, Kansas.

Hertha Limestone (of Kansas City Group)
Hertha Limestone (of Bronson Group)
Hertha Limestone Member (of Kansas City Formation)

Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.

G. I. Adams, 1899, Kansas Academy Sciences, Transactions, v. 16, p. 58-59. Limestone composing lower member of Erie formation and forming escarpment extending west from Hertha, crossing Labette Creek south of Galesburg and following its west bluff for considerable distance, terminating in mounds west of Altamont; overlain by Mound Valley limestone.

E. Haworth, 1898, University Geological Survey of Kansas, v. 3, p. 45, 46. Probably a continuation of Bethany Falls Limestone named in northwest Missouri.

G. I. Adams, G. H. Girty, and D. White, 1903, U.S. Geological Survey, Bulletin 211, p. 35. Named section for limestones exposed in vicinity of Hertha, Kansas. Lower member of the Erie limestone. Thickness about 10–20 ft (3–6 m).

G. I. Adams, E. Haworth, and W. R. Crane, 1904, U.S. Geological Survey, Bulletin 238, pl. 1. Hertha underlain by Dudley Shale and overlain by Ladore Shale.

E. Haworth and J. Bennett, 1908, Kansas University Geological Survey, v. 9, p. 89. Applies the name Bethany Falls to the limestone between Pleasanton and Ladore shales.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 78. Stabilized type Hertha.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt 4, p. 193. Hertha Limestone, in Bronson Group, includes: Sniabar Limestone Member, Mound City Shale Member, Critzer Limestone Member. Featheredge to 30 ft (9 m).

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,028-2,029, 2,031 (fig. 4). Underlies Ladore Shale; overlies Pleasanton Group. Bronson reduced in rank to subgroup of Kansas City Group; Hertha is basal formation in group. Classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 10, 11. In Missouri, Hertha includes (ascending) Critzer Limestone, Mound City Shale, and Sniabar Limestone members.

W.L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 8. Hertha Limestone restricted to Mound City Shale and Sniabar Limestone members. Mound City Shale is restricted to black to green-gray shale underlying Sniabar. Type locality of the Hertha (as stabilized by Moore [1936]) was incorrectly identified. Limestone referred to as Hertha is Bethany Falls as originally suggested by Haworth (1898). Hertha is underlain by Shale Hill Formation of Pleasanton Group; overlain by Elm Branch Shale (new).

Named for occurrence near former town of Hertha, Neosho County, Kansas.

Neostratotype: Near Hertha (center N/2 NE sec. 32, T. 29 S., R. 20 E.) along western tributary to Bachelor Creek in Neosho County, Kansas.

Heumader Shale Member (of Oread Limestone)

Pennsylvanian (Virgilian Series): northwestern Missouri, southwestern Iowa, eastern Kansas, and southeastern Nebraska.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 94, 96. Thin shale near top of Oread Limestone, underlying Kereford Limestone Member and overlying Plattsmouth Limestone Member. [On p. 52, it is described as consisting of 2 ft (0.6 m) of dark-bluish shale with thin yellow streaks.]

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 48, 167-168. Few feet of shale that lies between base of Kereford Limestone, where that member is present, and top of Plattsmouth Limestone is termed Heumader Shale and classed as member of Oread Formation. Shale is clayey to sandy and usually appears dark gray. Thickness 0-10 ft (0–3 m). Where Kereford Limestone is absent, the Heumader and possibly shaly equivalents of the Kereford are not differentiated. Although stratigraphic continuity with units classifed as parts of Oread Formation is recognized, the shale next above the Plattsmouth is then included with Kanwaka Shale. Type locality, Heumader quarry, bluffs of Missouri River just north of St. Joseph, Missouri.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5). Heumader Shale Member of Oread Limestone; underlies Kereford Limestone Member; overlies Plattsmouth Limestone Member. Classification agreed upon by State Geological Surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

R. L Cullers, S. Ramakrishnan, P. Berendsen, and T. Griffin, 1985, Geochimica et Cosmochimica Acta, v. 49, p. 1,383–1,402. The peridotite is really a lamproite. The lamproites in Kansas intrude Pennsylvanian sedimentary strata and consist mainly of phlogopite, diopside, potassic richterite, olivine, and chrome spinel in a groundmass of mostly serpentine.

Type locality: Five hundred feet (152 m) east and 100 ft (30 m) south of center of north line of sec. 32, T. 26 S., R. 15 E., south of pond on Hill Farm in southern Belmont Township, Woodson County.

Hindsville Limestone

Upper Mississippian (Chesterian Series): some sinkholes in southeastern Cherokee County, Kansas.

A. H. Purdue and H. D. Miser, 1916, U.S. Geological Survey, Eureka Springs–Harrison, Atlas, Folio 202, p. 12. *Hindsville limestone member of Batesville sandstone*—Dark-gray limestone interbedded with some sandstone. Thickness 1 1/2–50 ft (0.45–15 m). In all previous reports on northern Arkansas has been included in underlying Boone limestone, but is here included in Batesville sandstone on paleontologic and lithologic grounds, and because of marked unconformity at its base. Named for exposure near Hindsville, Eureka Springs quadrangle.

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 89–90. Limestone of Batesville age probably referable to the Hindsville limestone member of the Batesville sandstone of Arkansas forms the upper part of the Mayes formation in Mayes county, northeastern Oklahoma (unpublished manuscript by G. H. Girty). These rocks extend northward into the extreme southeastern part of Kansas, where they were identified above the Warsaw in cuttings from the Ballard mine well.

E. B. Branson, 1944, University of Missouri Studies, v. 19, no. 3, p. 263–265. *Hindsville Limestone*—Essentially light- to dark-gray, fine- to medium-grained oolitic limestone with basal chert pebble conglomerate set in limestone matrix; thin mineral-gray to olive-drab calcareous shales, siltstones, and sandstones distributed irregularly through the limestone. Thickness about 47.5 ft (14.4 m). Conformable and in places transitional with overlying Batesville; unconformable on Keokuk Limestone and chert with limestone filling depressions in weathered Keokuk.

E. T. McKnight and R. P. Fischer, 1970, U. S. Geological Survey, Professional Paper 588, p. 13, 20, 57-61. Extended Hindsville Limestone from Oklahoma into Kansas near 94°45' longitude; 0–85+ ft (0–25.8+ m) thick in Wyandotte quadrangle; gray crinoidal to dense limestone, commonly oolitic, locally cherty, a little sandstone and green shale.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 94, 126, 147–154. Presents description and nomenclatural history of term "Hindsville."

Type locality: Exposures near the town of Hindsville, Madison County, Arkansas; the exposure nearest the town is on the north end of Keefer Mountain (NW NW sec. 22, T. 17 N., R. 27 W., Hindsville 7 1/2-min quadrangle).

Hodgemann shale member (of Solomon formation)

Cretaceous: central Kansas.

R. C. Moore, 1935, Rock formations of Kansas; *in,* Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Name used on chart; lower member of Solomon formation; underlies unnamed sandstone member of Solomon formation; overlies unconformably Rocktown sandstone member of Ellsworth formation.

Derivation of name not stated.

Holdenville Shale (of Marmaton Group)

Pennsylvanian (Desmoinesian Series): central Oklahoma, southeastern Kansas, and southwestern Missouri.

J. W. Taff, 1901, U.S. Geological Survey, Geologic Atlas, Folio 74. Blue and yellow clay shale, with thin siliceous limestones and sandstones; 260 ft (78.8 m) thick; underlies Seminole conglomerate; overlies Wewoka formation.

M. C. Oakes, 1952, Oklahoma Geological Survey, Bulletin 69, p. 42–47, pl. 11. Memorial Shale, by definition, extends upward from top of Lenapah Limestone to base of Seminole Formation, and likewise, Holdenville Shale extends upward from top of Wewoka to base of Seminole. As Lenapah has been traced into uppermost Wewoka, the Memorial and Holdenville lie between same stratigraphic limits and are equivalent. Holdenville has priority and is commonly used term. Thickness 40–200 ft (12–61 m) in Tulsa County. Includes Sasakwa and Homer Limestone [members]. In northern Oklahoma and in Kansas, unit occurs in thin ragged patches.

W. B. Howe, 1953, Missouri Geological Survey and Water Resources, Report of Investigations 9, p. 14–16. Uppermost formation in Marmaton Group. Lies between Lenapah Formation and base of Hepler Sandstone, basal Pleasanton, of Missouri Series. Term Memorial, formerly applies to post-Lenapah, pre-Pleasanton beds in Missouri, has been dropped. Use of name Holdenville follows recent work by Oklahoma Geological Survey. Formation in western Missouri is predominately gray shale. Thickness 0 to at least 15 ft (0–4.5 m).

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shown on chart at top of Marmaton Group. Overlies Lenapah Limestone; underlies Hepler Sandstone.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 27. Holdenville Shale (formerly Memorial Shale) is gray and yellowish-gray clay shale, generally unfossiliferous. In Labette County, it comprises dark-gray, fossiliferous shale and two coal beds. Overlies Lenapah Limestone; underlies Seminole Formation of Pleasanton Group. Locally absent due to pre-Missourian erosion; maximum thickness 30 ft (9 m).

P. H. Heckel, 1991, Kansas Geological Survey, Geology Series 4, 67 p. The Holdenville Shale was defined by Jewett (1959) as overlying the Lenapah Limestone and underlying the Hepler Sandstone. Heckel demonstrates that the Holdenville Shale in its type area in Oklahoma is also equivalent in part to the reinstated Memorial Shale, the Lenapah Limestone, and the Nowata Shale. The upper part of the Holdenville is equivalent to the Lost Branch Formation. The name Holdenville Shale is therefore dropped from use in Kansas.

Named for Holdenville, Hughes County, Oklahoma.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 49, and pl. 1. The Holmesville Shale Member is green, gray, yellow, and red, unfossiliferous shale containing argillaceous limestone. The thickness ranges from about 7 to 33 ft (2–10 m).

Type locality: One and one-half miles (2.4 km) west and 1/2 mi (0.8 km) north of Holmesville, Gage County, Nebraska.

Holt Shale Member (of Topeka Limestone)

Pennsylvanian (Virgilian Series): northwestern Missouri, southwestern Iowa, eastern Kansas, and southeastern Nebraska.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 42, 52, 53. Thin but persistent bed of shale in Topeka Limestone Member of Shawnee Formation. Is bluish above and black and fissile in middle and lower parts. Thickness in Nebraska 1–2 1/2 ft (0.3–0.8 m); in Iowa 1 5/6 ft (0.55 m); in Kansas, 2 1/2 ft (0.76 m); at Forest City, Missouri, 2 1/8 ft 90.64 m). Underlies Coal Creek limestone bed and overlies Dubois limestone bed, all included in Topeka Limestone. Named for good exposures in Holt County, Missouri, just below Forest City and northwest of Oregon.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5); 1949, Kansas Geological Survey, Bulletin 83, p. 128 (fig. 22), 164; F. C. Greene and W. V Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 18. Holt Shale Member of Topeka Formation; underlies Coal Creek Limestone Member; overlies Du Bois Limestone Member. Classification agreed upon by State Geological Surveys of Iowa, Kansas, Missouri, Nebraska and Oklahoma, May 1947.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 15, fig. 5. Fossiliferous dark- to light-gray shale with an underlying black fissile shale. Thickness 2–3 ft (0.6–0.9 m). Underlies Coal Creek Member; overlies Du Bois Limestone Member; where Du Bois is absent, overlies Turner Creek Shale Member.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 39, and pl. 1. Member is made up of a grayish-black shale in the lower part and a bluish-gray shale in the upper part. Member is not recognized with certainty south of the Kansas River. Inarticulate brachiopods and conodonts occur in the black shale. Thickness ranges from 1.5 to 3 ft (0.5–0.9 m).

Type locality: In Missouri River bluff southeast of Forest City, Holt County, Missouri.

Hooser Shale Member (of Bader Limestone)

Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 20, 25. *Hooser shale*—Name for basal part of Easly Creek shale of Condra, 1927. It consists of (descending): 1) olive shale, calcareous, argillaceous, fossiliferous, weathers buff, 2 ft (0.6 m); 2) shale, weathered buff, with boxwork at places, 1 ft (0.9 m); 3) shale, grayish, with calcareous concretionary sub-zone near base and reddish subzone below middle, 8 ft (2.4 m). Thickness averages about 11 ft (3.3 m) from Nebraska to Oklahoma. Underlies Middleburg limestone and overlies Eiss limestone.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 166.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 46. Member of Bader limestone. Consists of shale and impure limestones. Thickness across line of outcrop in Kansas about 10 ft (3 m). Underlies Middleburg limestone member; overlies Eiss limestone member.

M. R. Mudge and H. R. Burton, 1959, U.S. Geological Survey, Bulletin 1068, p. 13 (table 2), 79–80, pls. Member described in Wabaunsee County, Kansas, where it is 5 1/2–15 1/2 ft (1.7–4.7 m) thick, overlies Eiss limestone member and underlies Middleburg limestone member.

Type locality: Highway cut and ravine just east of Hooser, Cowley County, Kansas.

Hoover sand

Hoover series

Pennsylvanian (Virgilian Series): southern Kansas and northern Oklahoma.

B. Mills–Bullard, 1928, Oklahoma Geological Survey, Bulletin 40–Q, p. 180. Hoover series lies between the Grayhorse limestone and the Elgin sandstone; occurs at a depth of 990 ft (300 m) in the Burbank oil field, Osage and Kay counties, Oklahoma.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 82. Used in southern Kansas for sandstone believed to be equivalent or nearly equivalent to the Elgin sandstone of the Kanwaka formation or the name is applied to sandstone in the Douglas group.

Hope gypsum (of Sumner group)

Permian: central Kansas

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 10, 11. A gypsum bed in Geuda salt measures, about 100 ft (30 m) lower than Greeley gypsum.

Named for Hope, Dickinson County, Kansas.

Houchen Creek limestone bed (in Hamlin Shale)

Permian (Wolfcampian Series): northeastern Kansas and southeastern Nebraska.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 84, 89. *Houchen Creek limestone*—Massive to irregular, or separated by bluish shale partings; characterized in most exposures by presence of large masses of algal growth. Thickness 4–8+ ft (1.2—2.4+ m) in Nebraska, 3+ ft (0.9+ m) in northeast Kansas. Been traced to Kansas Valley, north of Belvue [Pottawatomie County, Kansas]. Underlies Hughes Creek shale and overlies Stine shale, all included in Elmdale shale member.

R. C. Moore and G. E. Condra, 1932 (October 1932 revised classification chart of Pennsylvanian rocks of Nebraska and Kansas), transferred Houchen Creek limestone and Stine shale to Admire shale, and introduced *Oaks shale* for the bed overlying Houchen Creek limestone. Whether Oaks shale is a part of Hughes Creek shale as originally defined, or a newly discovered unit, was not stated.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 50 (fig. 12). Permian.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273, 2,274

5 ft (0.6–1.5 m) in Wabaunsee County, Kansas. Overlies Bennett shale member; underlies Roca shale.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 40–41. Almost invariably one massive limestone bed that is nearly constant in lithology along its outcrop; weathered surfaces tan to yellow, fresh surfaces tan to gray; generally weathers porous and cavernous; thickness ranges from 1 to 6 ft (0.3–1.8 m), average about 3 ft (0.9 m).

G. R. Scott, F. W. Foster, and C. F. Crumpton, 1959, U.S. Geological Survey, Bulletin 1060–C, p. 121. Howe Limestone member is two massive beds in Pottawatomie County.

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva to conform, including Howe Limestone Member.

Type locality: Exposures south of Howe in T. 4 N., R. 14 E., Nemaha County, Nebraska.

Hughes Creek Shale Member (of Foraker Limestone)

Pennsylvanian (Virgilian Series): northeastern and south-central Kansas, southeastern Nebraska, and Oklahoma.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 84, 85, 89. *Hughes Creek shale*—Blue argillaceous shale, dark shales, and thin limestones. Thickness 35–50 ft (10.6–15 m) in Nebraska and northeast Kansas. Underlies Long Creek limestone and overlies Houchen Creek limestone, all included in Elmdale shale member.

R. C. Moore and G. E. Condra, 1932 (October 1932 revised classification chart of Pennsylvanian rocks of Nebraska and Kansas). Transferred Houchen Creek limestone and underlying Stine shale to Admire shale, and introduced *Oaks shale* for the bed overlying Houchen Creek limestone. This left Hughes Creek shale the basal member of Elmdale shale. Whether the Oaks shale is a part of Hughes Creek shale as originally defined, or a newly discovered unit, was not stated, but it appears that it and the true Americus limestone were included in Hughes Creek shale of previous reports.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 50. Transferred this unit to Permian.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 168. Reallocated to member status in Foraker limestone. In northern Kansas comprises light-gray to nearly black shale and thin limestone beds containing fusulines, and in lower part, a brachiopod fauna; in southern Kansas is a nearly continuous limestone section, massive in lower part and containing much light-blue flint. Thickness about 40 ft (12 m). Underlies Long Creek limestone member; overlies Americus limestone member.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 82–83, pl. 1. Described in Pawnee County, Oklahoma, where it is classified as member of Foraker limestone. Thickness 30–43 ft (9–13 m). Overlies Americus limestone member; underlies Long Creek limestone member.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 33–36. In the southern part of Kansas, the Hughes Creek shale member includes 4–8 ft (1.2–2.4 m) of shale overlain by a bed of limestone about 1 ft (0.3 m) thick previously included in the Americus limestone member. The Hughes Creek shale member is the only thick dark-gray shale in this part of the section. In northern Kansas, the Hughes Creek is about 92% shale and 8% limestone, whereas in the southernmost outcrop (Cowley County), it is about 35% shale and 65% limestone. Limestone beds fusulinid-rich in northern Kansas, becoming cherty south of Lyon County; quantity of fusulinids increases southward.

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva to conform, including Hughes Creek Shale Member.

Type locality: Hughes Creek, Nemaha County, Nebraska.

Hugoton Member (of St. Louis Limestone)

Mississippian (Meramecian Series): subsurface of southwestern Kansas.

F. E. Abegg, 1994, Kansas Geological Survey, Bulletin 230, p. 24, 39–50, 57–59, 62–63. *Hugoton Member*—Lower of two new members of St. Louis Limestone; predominantly dolomitic peloidal grainstone/packstone, dolomite, and anhydrite. Breccia, algal boundstone, and dolomitic lime mudstone are common facies elsewhere in southwestern Kansas. Overlying contact with Stevens Member placed at change from skeletal packstone/wackestone (commonly marked by a skeletal-ooid grainstone to packstone 3 ft [0.9 m] or less in thickness) to domomitic carbonate and anhydrite. Hugoton Member easily differentiated from skeletal and oolitic limestones of the uppermost Salem Limestone. Abundant peloids, anhydrite, and paucity of stenohaline marine organisms in Hugoton indicate deposition in a restricted lagoon.

C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–68, 71–73. Cited work of Abegg (1994) and adopted Hugoton Member as lower member of St. Louis Limestone.

Type locality: Subsurface; Mobil #1 Foster core (sec. 5, T. 34 S. R. 36 W.), Stevens County, Kansas, from 6,804 ft to 6,910 ft (1,987–2,073 m) core depth. Presumably named for Hugoton, Stevens County, Kansas.

Humboldt limestone

Pennsylvanian: southeastern Kansas

R. Hay, 1887, Kansas Academy of Science, Transactions, v. 10, p. 7. The immense bed we have called Dun limestone is probably same as the thick Humboldt limestone of Neosho Valley; it has same irregularity of structure and apparently the same fossils.

Probably named for Humboldt, Allen County, Kansas.

Humphrey Creek shale

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook. Name applied to beds designated *Humphrey shale member of Wabaunsee formation* by G. E. Condra (1927).

R. C. Moore and G. E. Condra, 1932, Revised classification chart of Pennsylvanian rocks of Kansas and Nebraska. Dropped term "Humphrey Creek shale" in favor of Humphrey shale.

and unconformably overlain by Woodford Formation. New stratigraphic interpretation, but previous names retained.

T. W. Amsden, W. M. Caplan, E. H. Hilpman, E. H. McGlasson, T. L. Rowlan, and O. B. Wise, 1967; *in*, D. H. Oswald, ed., Proceedings of the International Symposium on the Devonian System, Alberta Society of Petroleum Geologists, v. 1, p. 913–932. Devonian carbonate sequence in Kansas can be divided by conodont faunas into Eifelian, Givetian, and Frasnian age rocks (i.e., early Middle through early Late Devonian). Use of the term "Hunton" for Devonian carbonate rocks in Kansas is discouraged.

P. L. Hilpman, 1967, Tulsa Geological Society, Digest, v. 35, p. 88–98. Conodont faunas indicate oldest Devonian rocks in Kansas are Givetian in age (late Middle Devonian), substantiating correlations made by earlier workers. Youngest Devonian carbonates were deposited in latest Givetian time. Use of the term "Hunton" for Devonian carbonate rocks in Kansas is discouraged.

H. A. Ireland, 1967; *in*, C. Teichert and E. L. Yochelson, eds., University of Kansas, Department of Geology, Special Publication 2, p. 479–502. Paleontologic investigation reveals that Silurian zone 3 of Lee (1956) is the only zone containing lower Niagaran arenaceous Foraminifera which are directly correlable with those found in the Clarita Member of the Chimneyhill Formation (Lower Silurian) of the Arbuckle Mountains in Oklahoma. Silurian zones 1 and 2 of Lee (1956) are respectively correlated with the Keel–Ideal Members and the Cochrane Member of the Chimneyhill, although specific age evidence is not available. Zones 4 and 5 are probably upper Niagaran and may be equivalent to the upper part of the St. Clair Limestone near Stillwell, Oklahoma. Lower part of the St. Clair at that locality is considered to be equivalent to the Clarita of the Arbuckle Mountains.

K. H. Anderson and J. S. Wells, 1968, American Association of Petroleum Geologists, Bulletin, v. 52, p. 264–281. Northeast-southwest-trending zero isopach line of "Hunton" carbonates extends from northern Atchison County to northern Greenwood County. Silurian carbonates can be differentiated from overlying Devonian carbonates by subtle differences in the insoluble residues and the presence of the sparsely occurring foraminifer species *Ammodiscus* in the Silurian. A maximum of 500 ft (151.5 m) of Silurian carbonates are present in southern Nemaha county east of the Humboldt fault. Overlying Devonian carbonates are thickest in Doniphan County (in excess of 300 ft [90.9 m]) and continue to thicken northward into southwestern Iowa.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 15–16, pl. 1. Silurian and Devonian rocks are restricted to the subsurface of northeastern and north-central Kansas. Silurian rocks, the Chimneyhill Dolomite (light gray to buff, finely crystalline dolomite, with local interbedded dolomite), disconformaby overlie the Upper Ordovician Maquoketa Shale; Devonian rocks, unnamed limestone and dolomite, unconformably underlie the Devonian–Mississippian Chattanooga Shale; Silurian and Devonian sequences are separated by an unconformity and are distinguished by lack of sand grains in the Silurian section. Silurian rocks reach a maximum thickness of 435 ft (131.8 m) in Nemaha county.

E. D. Goebel, W. C. Sweet, and P. L. Hilpman, 1969, Geological Society of America, Abstracts with Programs, pt. 6, p. 18. Paleontological investigation of the Mobil #1 Cunningham Estate well in Stevens County records Devonian conodonts near the top of a limestone previously reported as being "Middle Ordovician Limestone" or "Simpson Group." Possibility exists that not all strata previously reported as Viola are really Viola. Instead, Devonian limestone could lie atop Viola Limestone, or perhaps "stratigraphic leaks" could occur in which Devonian and Mississippian conodonts have dropped into fractures in the underlying Viola.

F. J. Adler, 1971; *in*, I. H. Cram, ed., American Association of Petroleum Geologists, Memoir 15, p. 1,098–1,103. Silurian rocks attain a maximum thickness in southeast Nebraska and northeast Kansas of 500 ft (151.5 m). These rocks mostly consist of undifferentiated dolomite containing little chert and no sand. Middle Devonian rocks in the northern midcontinent, including Kansas, consist mainly of pure, dense limestone including some porous dolomite and locally a basal sandy zone. Well-rounded quartz grains are locally abundant in the lower part. Lower part of the Middle Devonian sequence, identified as being equivalent to the Wapsipinicon Formation in Iowa, can contain thin evaporite stringers in the deeper part of the Iowa basin but it is unclear if these evaporites extend into Kansas. Upper part of the Middle Devonian sequence is identified as being equivalent to the Cedar Valley Formation of Iowa and is more clayey, darker, and finer grained than the lower part.

J. S. Wells, 1971; *in*, I. H. Cram, ed., American Association of Petroleum Geologists, Memoir 15, p. 1,098–1,103. Middle Devonian part of section in Forest City basin in northeastern Kansas is identified as combined Wapsipinicon and Cedar Valley Formations, consisting of relatively pure lithographic limestone.

B. J. Witzke, B. J. Bunker, and F. S. Rogers, 1989; *in*, Proceedings of the Second International Symposium on the Devonian System, Canadian Society of Petroleum Geologists, Memoir 14, v. 1, p. 221–250. Devonian carbonate sequence in eastern Nebraska (contiguous with that in eastern and central Kansas) equates with part of the Middle Devonian Cedar Valley and Wapsipinicon Formations of Iowa.

Named for exposures near former townsite of Hunton (T. 1 S., R. 8 E.), Coal County, Oklahoma. Well exposed within Arbuckle complex and known to have wide distribution in subsurface.

Huntsinger coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Croweburg coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 74).

Huntsman Shale Member (of Omadi Formation)

Huntsman Member (of Omadi Formation)

Cretaceous (Lower): eastern Colorado, southeastern Wyoming, southwestern Nebraska, and western Kansas.

M. J. Boreing, 1954, Proceedings of the Third Subsurface Geological Symposium, p. 75, 77–78. Cited unpublished work of C. W. Sternberg and A. J. Crowley (The Denver–Cheyenne Basin, American Association of Petroleum Geologists, Los Angeles, March 27, 1952) in which Huntsman Member is meddle member of Omadi Formation; overlies Cruise Member and underlies Gurley Member.

D. F. Merriam, 1957, Kansas Geological Survey, Oil and Gas Investigations, no. 14, p. 2, 8, 11–13. Predominantly greenish-gray to gray, noncalcareous, micaceous, clayey, or

been called Iatan in country farther south is mostly a lower Virgilian unit, the Haskell, but some limestone outcrops may represent true Iatan. Pedee Group.

H. G. O'Connor, 1963, American Association of Petroleum Geologists, Bulletin, v. 47, p. 1,873–1,877. Kansas Geological Survey, based on comprehensive stratigraphic studies of Douglas and Pedee Group rocks in Kansas, Oklahoma, Nebraska, Missouri, and Iowa by S. M. Ball, abandoned the term Pedee and amended and redefined the Douglas Group to include all rocks between Stanton Limestone below and Oread Limestone above. Divided the redefined Douglas Group into two formations, the Stranger below and Lawrence above. Amended and redefined Stranger Formation to include (ascending): Weston Shale Member, Iatan Limestone Member, Tonganoxie Sandstone Member, Westphalia Limestone Member, and Vinland Shale Member. Amended and redefined the Lawrence Formation to include (ascending): Haskell Limestone Member, Robbins Shale Member, and a member to be named in the forthcoming report.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 34, and pl. 1. Iatan Limestone Member crops out in Kansas only in Leavenworth County, where it ranges in thickness from 0 to 14 ft (0–4.2 m). It is a dense, light-gray limestone, which locally contains *Archaeolithophyllum* and Osagia, as well as fusulinids, brachiopods, bryozoans, crinoids, and corals.

Type locality: Named for exposures at Iatan, Platte County, Missouri.

Idenbro Limestone Member (of Lenapah Limestone)

Pennsylvanian (Desmoinesian Series): southeastern Kansas northeastern Oklahoma, western Missouri, and southwestern Iowa.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, pt. 11, p. 339, 340. Light-gray nodular crystalline algal limestone. Thickness about 3 ft (0.9 m). Overlies Perry Farm Shale Member; underlies Memorial Shale.

J. M. Jewett, 1945, Kansas Geological Survey, Bulletin 58, p. 69–70. Discussed as cyclothem in Lenapah megacyclothem.

L. M. Cline and J. C. Greene, 1950, Missouri Geological Survey and Water Resources, Report of Investigations 12, p. 25; C. M. Cade III, 1953, Tulsa Geological Society, Digest, v. 21, p. 134. Idenbro Limestone can be traced into Sni Mills Limestone Member in Jackson County, Missouri; therefore, name Idenbro is suppressed as a synonym of Sni Mills.

J. M. Jewett, H. G. O'Conner, and D. E. Zeller, 1968; *in,* D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 26. Thickness ranges from 1 to 2 ft (0.3–0.6 m) in north to 6 to 9 ft (1.8–2.7 m) in south.

Type locality: Located along drainage near the southwest corner of sec. 2, T. 32 S., R. 19 E. about 4 mi (6.4 km) southwest of Parsons, Labette County, Kansas.

Illinoian Stage

Illinoisan stage
Illinoian stage of glaciation
Illinoian glaciation
Illinoian drift
Illinoian till

Pleistocene Series.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,006. Illinoian drift is name used for third drift of Labrador and Patrician parts of Laurentide ice sheet, the term Illinoian Stage used for time during which this drift was deposited. The name was proposed by F. Leverett, but was first published by T. C. Chamberlin (1896, Journal of Geology, v. 4, p. 872–876), who credited it to Leverett, as Illinois till sheet. Leverett later defined the term (1897, Chicago Academy of Science, Geology, and Natural History Survey Bulletin 2, p. 11–16; 1898, Journal of Geology, v. 6, p. 173). The Illinoian drift is underlain by Yarmouth soil and interglacial deposits and overlain by Sangamon soil and interglacial deposits.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 12–14. During Wisconsinan and Illinoian time continental glaciers advanced into states adjacent to Kansas but lacked by several hundred miles reaching the limits of Kansas. Eolian silt (loess) was deposited widely over the state, sand dune formation was active in the southwestern and south-central areas, and streams built extensive fills in many places. Important changes in major drainage lines occurred during this time.

J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 35, 52, 110. Illinois age (stage) is glacial interval next following Yarmouthian; followed by Sangamonian. Represented in Kansas by Crete and Loveland members of Sanborn formation.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 60, 63–66. During the Illinoian Stage the continental glaciers were more remote from Kansas than in any of the other glacial stages. Fluvial deposits of Illinoian age are quantitatively less than those in the preceding or succeeding stages.

Named for its development in Illinois.

Independence Formation

Pleistocene: northeastern Kansas.

J. S. Aber, 1991, Boreas, v. 20, p. 297–314. Abandon traditional terms of Pleistocene stratigraphy of Kansas and proposes Independence Formation, consisting of all diamicton and stratified sediment interbedded with diamicton in northeast Kansas. Formation typically 10's of meters thick in upland areas but may exceed 100 m in buried valleys.

Named for Independence Creek, a tributary of the Missouri River in southern Doniphan and northern Atchison counties, Kansas.

Independence limestone

Pennsylvanian: southeastern Kansas.

E. Haworth and W. H. H. Piatt, 1894, Kansas University Quarterly, v. 2, p. 115–117. Heavy limestone, 40 ft (12 m) thick at Independence; overlain by 80–150 ft (24–45 m) of shales with interbedded sandstones. May be same as Oswego limestone, but differs in character.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 103, 109. Synonymized with Drum limestone in Kansas. Noted that G. I. Adams (1896, Kansas University Geological Survey, v. 1, p. 24) applied name to miscorrelated limestone now called Dennis near Thayer.

Named for Independence, Montgomery County, Kansas.

J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. In Missouri, Iola Limestone comprises (ascending) Frisbie Limestone, Quindaro Shale, and Argentine Limestone members. Overlies Liberty Memorial Shale Member (new) of Chanute Shale; underlies Island Creek Shale Member of Lane Shale, Kansas City Group.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigation 11, p. 13. Iola Formation redefined for Missouri. Iola of Kansas was incorrectly correlated with higher limestone, the Argentine, in Missouri by Haworth and Bennett (1908), and the correlation was accepted by Hinds and Greene (1915). Error was discovered by Newell in 1932, but change was not made in Missouri until 1947, when Kansas and Missouri geologists traced the Paola, Muncie Creek, and Raytown Limestone members. Overlies Chanute Shale (redefined in Missouri); underlies Lane Shale (redefined for Missouri). Kansas City Group.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 35–36. Thickness of formation 9 ft (2.7 M), Cass County, Nebraska; about 7 ft (2 m), Winterset, Iowa; 10–12 ft (3–3.6 m), Kansas City, Missouri; 7–8 ft (2–2.4 m), northeastern Kansas; 10–30 ft (3–9 m), Iola, Kansas. Includes Paola Limestone, Muncie Creek Shale, and Raytown Limestone members.

T. L. Welp, L. A. Thomas, and H. R. Dixon, 1957, Iowa Academy of Sciences, Proceedings, v. 64, p. 418 (fig. 1), 420. Thickness of formation about 10 ft (3 m) in Madison and Adair counties, Iowa. Includes only Raytown Limestone Member. Underlies Lane Formation; overlies Chanute Shale. Kansas City Group.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 26, fig. 5. Includes Raytown Limestone Member, 9 ft (2.7 m); Muncie Creek Shale Member about 2.5 ft (0.76 m); Paola Limestone, about 1 ft (0.3 m). Overlies Chanute Shale; underlies Lane Shale. Kansas City Group.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 31. Includes: Raytown Limestone Member, Muncie Creek Shale Member, Paola Limestone Member. Thickness 0–30 ft (0–9 m), commonly about 7 ft (2 m).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 14. Reclassified from Linn Subgroup to Zarah Subgroup.

Type section: NE sec. 2, T. 25 S., R. 18 E. in cement plant quarry on south side of Iola, Allen County, Kansas.

Iola shale

Pennsylvanian: eastern Kansas.

E. Haworth, 1894, Kansas University Quarterly, v. 2, p. 124. Shale, 75 ft (22.7 m) thick, underlying Carlyle limestone and overlying Iola limestone in Cherryvale–Lawrence section.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,018. Conflicts with Iola limestone.

Probably named for Iola, Allen County, Kansas.

Iowa Point Shale Member (of Topeka Limestone)

Pennsylvanian (Virgilian Series): northeastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 40, 43, 51, 102. Iowa Point Shale, top bed of Calhoun Shale, consists of (at type section in Missouri River bluff just east of Iowa Point, Kansas), (descending): 1) Bluish, bedded to massive shale, with carbonaceous flakes and plant leaves; 2) blue to brownish shale with some sand, becoming loose sandstone at places; 3) bluish to brownish bedded shale. Thickness about 10 ft (3 m) at Iowa Point, Kansas, Forest City, Missouri, and southeast Nebraska. Underlies Curzen (Curzon) Limestone (basal bed of Topeka Limestone) and overlies Meadow Limestone.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 47. Meadow Limestone belongs in Stanton Limestone, and applied Sheldon Limestone to the limestone underlying Iowa Point Shale and overlying Jones Point Shale.

R. C. Moore and G. E. Condra, 1932, Revised classification chart of Pennsylvanian rocks of Kansas and Nebraska. Restricted Calhoun Shale to beds above Sheldon Limestone (redefined). Calhoun Shale (restricted) thus occupies interval of beds previously named Iowa Point Shale.

G. E. Condra, 1933, Nebraska Geological Survey, Paper No. 2, p. 5. Iowa Point Shale discarded for Calhoun restricted.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 11. Calhoun Shale divided into (descending): Iowa Point Shale, Sheldon Limestone, and Jones Point Shale.

G. E. Condra and E. C. Reed, 1937, Nebraska Geological Survey, Bulletin 11, 2nd series, p. 7, 12, 15, 20, 46, 51. Reallocated to member status in Topeka Limestone. Underlies Curzen [Curzon] Limestone Member; overlies Wolf River Limestone Member (new). Occurrences in Iowa noted.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig 5); 1949, Kansas Geological Survey, Bulletin 83, p. 126 (fig. 22), 162–163; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 18. Iowa Point Shale Member of Topeka Formation: underlies Curzon Limestone Member; overlies Hartford Limestone Member. Classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 21. Condra and Reed (1937) were uncertain regarding relation of the Hartford of southern Kansas to lower member of Topeka in northeastern Kansas, southeastern Nebraska, northwestern Missouri, and southwestern Iowa, so they proposed name Wolf River for basal member of Topeka in this area. Nebraska Survey will drop name Wolf River if it proves to be correlative with the Hartford, which was loosely defined by Kirk (1896) and may have priority, if it does not include beds of Du Bois, Iowa Point and Wolf River age.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 16, fig. 5. Commonly olive to dark brown in upper part grading to greenish gray below. Varies locally from calcareous shale to a complex of thin limestone beds. Thickness ranges from about 1/2 to 3 1/2 ft (0.15–1.1 m). Member of Topeka Limestone; underlies Curzon Limestone Member; overlies Hartford Limestone Member.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 38,

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,031 (fig. 4), 2,033. Island Creek Shale Member of Wyandotte Formation; underlies Farley Limestone Member; overlies Argentine Limestone Member. This is classification agreed upon by State Geological Surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma. Previously, Missouri had classed Island Creek as basal member of Lane Shale.

C. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 35. Thickness 2–3 ft (0.6–0.9 m) or more in Iowa and Nebraska, about 20 ft (6 m) in northwestern Missouri, maximum 40 ft (12 m) in Kansas. Additional data on type locality.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 79, 82, 88. Gray, yellow, and bluish clay shale of highly variable thickness; locally in Wyandotte County, several feet of sandstone, seemingly a channel filling, occupies this position; thickness ranges from a featheredge to about 40 ft (12 m).

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 25. As exposed in quarry in Madison County, Island Creek is a gray, platy, fossiliferous shale with limestone nodules near top. Thickness 4.5 ft (1.4 m). Underlies Farley Limestone Member; overlies Argentine Limestone Member.

J. M. Jewett, H. G. O'Conner, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 32. Contains gray, yellow, and bluish-gray clayey shale of highly variable thickness (0–40 ft [0–12 m]). Local lenticular sandstones.

D. J. Crowley, 1969, Kansas Geological Survey, Bulletin 198, p. 9, 15 (fig. 10). Thins down to few feet on thicker Argentine algal mound complexes. Thickens up to 40 ft (12 m) between algal mounds.

H. G. O'Conner, 1971, Kansas Geological Survey, Bulletin 203, p. 18. Identifies surface localities in Johnson County, Kansas.

W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 96, 98 (fig. 2–2), 102 (fig. 2–8), 110 (fig. 3–2, c). Demonstrate continuity of Island Creek in vicinity of algal mounds in Johnson County, Kansas, where shale undergoes considerable thinning.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 16. Redefine Island Creek Shale as lowermost member of Lane Shale. Overlies Argentine Limestone and underlies Farley Limestone. Define new type locality.

Type area: In quarry, NW corner sec. 11, T. 10 N., R. 23 E., near Wolcott, Wyandotte County, Kansas. Named for Island Creek. Consists of 43 ft (13 m) of bluish to greenish clay shale.

Neostratotype: Western Miami County (east line NE SE sec. 9, T. 19 S., R. 21 E.) where nearly 100 ft (30 m) thick.

J

"J bed"

Mississippian.

G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. Barren limestone or flint [in Tri-state mining district]; mineralized only in areas of intense shattering; sometimes occurs as soft, greenish, limy stratum; 4–8 ft (1.2–2.4 m) thick; overlain by "H bed," underlain by "K bed." Considered to be part of the Boone formation in the area.

Semi-formal mining terminology; not formally recognized by Kansas Geological Survey.

"J" sandstone (of Dakota Formation)

See Dakota Formation

Jackson Park Shale Member (of Kanwaka Shale)

Pennsylvanian (Virgilian Series): eastern Kansas and southeastern Nebraska.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 52, 94, 96. Jackson Park Shale is applied to basal member of Kanwaka Shale in eastern Kansas. Underlies Clay Creek Limestone Member. Jackson Park Shale is stated to be 52 ft (15.8 m) thick. R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p 170. Basal member of Kanwaka Shale. Chiefly bluish-gray and yellowish-brown sandy shale, 50+ ft (15+ m) thick along Kansas River; thins to less than 1 ft (0.3 m) in Nebraska. Underlies Clay Creek Limestone Member. Type locality designated.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 67. Basal member of Kanwaka Shale; underlies Clay Creek Limestone Member; overlies Kereford Limestone Member of Oread Limestone. Thickness 16–52 ft (4.8–15.8 m).

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 36, and pl. 1. Jackson Park Shale Member is a bluish-gray to yellowish-brown and red sandy shale and sandstone. Land plant fossils are more or less abundant. Locally in Douglas County, a thin coal bed and pelecypod-bearing sandy layers occur in the upper part. Thickness ranges from 16 to 52 ft (4.8–15.8 m).

Type locality: Jackson Park, southeastern part of Atchison, Atchison County, Kansas.

Janesville Shale (of Admire Group)

Pennsylvanian (Virgilian Series): southeastern Kansas.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273–2,274 (fig. 1). Defined to include strata between Foraker Limestone above and Falls City Limestone below. Average thickness 75 ft (22.7 m). Includes (ascending) West Branch Shale, Five Point Limestone, and Hamlin Shale Members.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 24–29. Thickness range 67–90 ft (20–27 m); Stine shale bed and Oaks shale bed of Hamlin Shale Member dropped; Houchen Creek limestone retained as "bed."

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed raising Virgilian–Wolfcampian boundary to base of Neva Limestone; reassigned Admire Group, including Janesville Shale, to Virgilian Series (Upper Pennsylvanian).

Type locality: In cut on east-west road in SW NE sec. 23, T. 23 S., R. 10 E., Greenwood County, Kansas. Name derived from Janesville Township.

23–25, 27. Chalky shale and chalky limestone, interbedded, "Shell-rock limestone" bed at top, gray, weathers to light-gray. Thickness ranges from 20 ft (6 m; Russell and Ellis counties) to 25 ft (7.6 m); average 22 ft (6.7 m). Overlies Hartland shale member of Greenhorn limestone; underlies Pfeifer shale member of Greenhorn limestone.

Named for prominent exposures south and east of Jetmore, along south side of Buckner Creek, Hodgeman County, Kansas.

Jim Creek Limestone Member (of Root Shale)
Jim Creek Shale Member (of Root Shale)
Jim Creek Limestone (of Wabaunsee Group)

Pennsylvanian (Virgilian Series): eastern Kansas, northeastern Oklahoma, northwestern Missouri, southeastern Nebraska, southwestern Iowa.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 94, 96. Name given to upper of two limestones previously referred to as Dover limestone (the lower being true Dover limestone); distinguished by the occurrence of coal a few inches to 2 or 3 ft (0.6–0.9 m) beneath the limestone; overlies Frenck shale.

R. C. Moore and G. E. Condra, October 1932, Revised classification chart of Pennsylvanian rocks of Nebraska and Kansas, replaced *Jim Creek limestone* with *Nebraska City limestone*.

R. C. Moore, 1935, Kansas Geological Survey, Bulletin 20, table opposite p. 14. *Jim Creek limestone* underlies French Creek shale and overlies Friedrich shale.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 9–10. Gave following downward sequence of members of his *Pony Creek shale formation*: Shale, 5 1/2 ft (1.7 m); Greyhorse limestone, 1 ft (0.3 m); Caneyville shale, 17 ft (5 m); Nebraska City limestone, 2± ft (0.6± m); French Creek shale, 16 ft (4.8 m); *Jim Creek limestone*, 6 inches to 1 ft (15 cm–0.3 m); and Friedrich-Dry shale, 17± ft (5± m). Later shown as overlying Dover limestone formation, which rested on Table Creek shale, top member of McKissick shale formation.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 49, 239–240. *Jim Creek limestone* is here applied to thin but persistent limestone that underlies French Creek shale, overlies Friedrich shale, and has been traced across Kansas and into Oklahoma and Nebraska, although it is nowhere more than 2 ft (0.6 m) thick. It is fine-grained, hard, and bluish gray or bluish; weathers brown and gray. The Jim Creek limestone of Moore and Condra (1932) is Nebraska City limestone.

F. C. Greene and W.V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 21. Jim Creek limestone is highest Pennsylvanian limestone identified in Missouri.

R.C. Moore and M.R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,275. Rank reduced to member status in Root shale (new). Underlies French Creek shale member; overlies Friedrich shale member.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 11, fig. 5. Geographically extended into southwestern Iowa where it is classified as formation in Wabaunsee group. Consists of dark-blue to black argillaceous limestone that weathers red or brown; upper part commonly thin bedded and lower part massive. Thickness about 1 ft (0.3 m). Fossils include *Chonetes* and *Myalina*. Overlies Friedrich shale; underlies French Creek shale.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 11, 12. Massive and hard to medium hard in fresh exposures; many unweathered surfaces have a purplish tint that was not observed in any of the other beds of limestone in the upper part of the Pennsylvanian System; average thickness about 1 ft (0.3 m).

Type locality: On Jim Creek, sec. 29, T. 7 S., R. 11 E., Pottawatomie County, Kansas.

Joe shale bed (in Pawnee Limestone)

Pennsylvanian (Desmoinesian Series): southeastern Kansas.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34. Proposed in manuscript by Price (1981). Distinctive and widespread thin dark shale below Laberdie Limestone Member in Kansas. Stratigraphically equivalent to upper Mine Creek Shale Member. Type section established from Price (1981). Ranges from 2 inches to 1 ft (5 cm–0.3 m) thick.

Type section: One mile (1.6 km) northwest of Joe triangulation station in northeastern Labette County, Kansas, along south side of section road in the NW NE sec. 7, T. 31 S., R. 21 E.

Johnson Shale (of Admire Group)
Johnson Shale (of Council Grove Group)

Pennsylvanian (Virgilian Series): southeastern Nebraska, northeastern Kansas, and northern Oklahoma.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 84, 86, 88. Bluish argillaceous shale modified by thin, grayish, sandy layers, calcareous plates, and some gypsiferous material and geodes; thickness 16–18 ft (4.8–5.5 m).

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 48. Gray shale that contains thin beds of argillaceous limestone in northern Kansas; carbonaceous material occurs in upper part; lower and middle parts commonly sandy. Thickness 16 ft (4.8 m) in north to 25 ft (7.6 m) in southern Kansas. Overlies Foraker Limestone; underlies Red Eagle Limestone. Wolfcampian Series.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 85–86. In Kansas and Nebraska, rocks of interval above Long Creek limestone and below Glenrock limestone member of Red Eagle limestone are known as Johnson shale. In Pawnee County, Red Eagle limestone has not been subdivided, and it is not certain that Glenrock member is present. Name Johnson shale has been retained and applied to beds between Eagle Rock and Long Creek limestone member of Foraker limestone. Unit extends southward into Lincoln County. Thickness 35–60 ft (10.6–18 m) in Pawnee County.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 36–37. Average thickness 25 ft (7.6 m) in Wabaunsee and Riley counties, thinning north and south to 20-ft (6-m) thick average; silty to clayey shale that is gray-green, olive-drab, and gray; thin bed of maroon/purple shale 6–8 ft (1.8–2.4 m) from base in southern Kansas; thin, argillaceous limestone and mudstone beds in middle part of unit in central outcrop belt; very calcareous in upper part from central outcrop belt southward; no fossils reported north of Lyon County.

Joplin Member (of Boone Formation)
Mississippian: southeast Kansas, southwest Missouri, and northeast Oklahoma.
E. T. McKnight and R. P. Fischer, 1970, U. S. Geological Survey, Professional Paper 588, p. 13, 20, 32–37. Gray crinoidal limestone and nodular or bedded chert with chert-free zone near base; 0–100 ft (0–30 m) thick; equivalent to lower part of "M bed" or entire "M bed" where Short Creek Oolite Member is absent.
Type section: Exposures at Joplin Marble Quarry Company on left bank of Shoal Creek, about 1/2 mi (0.8 km) below Grand Falls, 3 mi (4.8 km) southwest of Joplin, Newton County, Missouri.

Jordan coal (in Cherokee Group)
Pennsylvanian (Desmoinesian Series).
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 42 (fig. 6). A coal bed that is recognized only by Moore (1936). Probably equivalent to the Weir–Pittsburg coal bed.

"Junction City limestone"
Permian (Wolfcampian Series).
D. A. Grisafe, 1976, Kansas Geological Survey, Mineral Resources Series 4, 42 p. Colloquial name of limestone in Fort Riley Limestone Member, Barneston Limestone, Chase Group; named because of extensive quarrying of the stone in vicinity of Junction City. The first or east wing of the capitol building in Topeka was formed from this stone in 1867.

K

"K bed"
Mississippian.
G. M. Fowler, and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. An important ore bed [in the Tri-state mining district]; comprises rounded nodules 5–9 inches (12.5–25.2 cm) in diameter in upper part of bed with long, larger nodules in lower part; ore generally confined to upper two-thirds of bed; 8–12 ft (2.4–3.6 m) thick; overlain by "J bed," underlain by "L bed." Considered to be part of the Boone formation in the area.
Semi-formal mining terminology; not formally recognized by Kansas Geological Survey.

Kansan period
Pennsylvanian: Kansas.
L. C. Wooster, 1906, Kansas Academy of Science, Transactions, v. 20, pt. 1, p. 75–82. Divided Carboniferous of Kansas into (descending) Permian period, *Coal Measures or Kansan period*, and Mississippian period; and divided this *Kansan period* into Upper Coal Measure or *Upper Kansan epoch* (from top of Elmdale formation to top of Iola limestone) and Lower Coal Measure or *Lower Kansan epoch* (from top of Iola limestone to base of Cherokee shale).

Kansan Stage
Kansan Glaciation
Kansan Drift
Kansan stage of glaciation
Pleistocene Series: Mississippi Valley.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,069. Kansan drift is name applied to second drift of eastern, as well as western, part of area covered by Laurentide ice sheet; the name Kansan stage being applied to the time during which this drift was deposited. Originally applied by T. C. Chamberlin (1894, Geikie's Great Ice Age, 3rd edition, p. 724–775; 1895, Journal of Geology, v. 3, p. 270–277) to oldest drift of western or Keewatin part of Laurentide ice sheet, the name "East Iowan" being applied to the second drift; but Chamberlin (1896, Journal of Geology, v. 4, p. 872–876), as the result of further studies, shifted the name Kansas to the second drift (which is the drift that covers northeastern Kansas), and shifted the name Iowan to a younger drift. The Kansas drift overlies Aftonian soil and interglacial deposits and underlies Yarmouth interglacial deposits.
J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 38, 52, 70–104. Kansan age (stage) is interval between Aftonian and Yarmouthian. It is assumed that Kansas is type region for this stage. Kansan stage contains Atchison formation, Kansas till, and Meade formation, which includes Grand Island sand and gravel member at base and Sappa member with Pearlette volcanic ash bed.
C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 60–66. Sediments of the Kansan Stage are the most widespread of the Pleistocene deposits in Kansas. Fluvial deposits of Kansan age exceed in volume those of any other Pleistocene stage in Kansas. Eolian deposits of Kansan age are recognized only locally. The Pearlette ash bed, of widespread occurrence, is an important marker bed. Kansan Stage includes fluvial deposits in the southeastern area; Sappa Formation at top and Grand Island Formation at bottom in central and western area; and (bottom to top) Atchison Formation, Nickerson Till, fluvial deposits, Cedar Bluffs Till, and loess or fluvial deposits in the northeastern area.
Named for its development in Kansas.

Kansas City Group
Kansas City Formation
Kansas City limestone
Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.
H. Hinds, 1912, Missouri Bureau Geology and Mines, v. 11, p. 7. Basal formation of Missouri group; extends from top of Iola limestone member down to base of Hertha limestone member; underlies Lansing formation; overlies Pleasanton formation; thickness 225 ft (68 m) at Kansas City, 200 ft (61 m) in Harrison County, Missouri, and at Leavenworth, Kansas, and 165 ft (50 m) near St. Joseph, Missouri; very thick limestones interbedded with shale.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 91, 97. Kansas City group proposed to apply to the mainly shale unit that occurs between the top of the Winterset limestone and the base of the Wyandotte limestone; includes (top to bottom) Lane shale, Iola limestone, Chanute shale, Drum limestone, and Cherryvale shale.
R. C. Moore and G. E. Condra, 1932, Revised classification chart of Pennsylvanian rocks of Kansas and Nebraska. Underlies Lansing group; overlies Bronson group; top of Kansas City group drawn at base of Plattsburg limestone;

(Middle Pennsylvanian, with Atokan Stage below and Desmoinesian Stage above), and *Kawvian Stage* (Upper Pennsylvanian, with Missourian Stage below and Virgilian Stage above). Kawvian included Pleasanton through Wabaunsee groups in Kansas.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 15–17, 63. Referred to Northern Midcontinent Interstate Conference on Pennsylvanian Classification held at Lawrence, Kansas, on May 5–6, 1947, in which the Kansas, Nebraska, Oklahoma, and Missouri geological surveys adopted a unified Pennsylvanian stratigraphic nomenclature; Ardian, Oklan, and *Kawvian* apparently were not accepted at the meeting, although Moore continued to promote them in this bulletin.

Named for exposures along the Kansas River valley in northeastern Kansas. "Kaw River" is a locally used designation for Kansas River.

Kearny Formation

Lower Pennsylvanian (Morrowan Series): western Kansas subsurface.

M. L. Thompson, 1944, Kansas Geological Survey, Bulletin 52, part 7, p. 414–417. Greenish-, bluish-, and dark-gray glauconitic fossiliferous limestones interbedded with dark-gray and green fossiliferous shales; some sandstone in lower part.

J. C. Maher, 1947, Kansas Geological Survey, Oil and Gas Investigations no. 4, p. 7–8. Recognizes the Kearny as being 120–450 ft (36–136 m) thick in Kansas based on four wells in Hamilton, Kearny, and Scott counties.

D. A. McManus, 1959, Twenty-fourth Field Conference of Kansas Geological Society, Guidebook, p. 107–115. Shows distribution and lithofacies of the Kearny Formation, and discusses the division of the Kearny into two members: 1) a lower member of thick sandstone and limestone, and 2) an upper overlapping shale member containing limestone and sandstone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 102–103. Considers rocks in southwest Kansas below Atokan age and composed of shale, limestone, and sandstone to be of Morrowan age. Thickness about 350 ft (106 m).

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in,* D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 22. Unconformably overlies Mississippian beds; underlies a persistent coal in the Atokan Series. Morrowan. Two units are recognized that range up to 600 ft (182 m) in thickness. The lower unit is shale with many sandstone and limestone beds ranging from 0 to 250 ft (0–76 m) and thickens to the southwest. The lower unit is overlapped northward and eastward in western Kansas by the upper shale unit. This upper shale unit (0–350 ft [0–106 m] thick) contains fewer beds of limestone and sandstone than the lower unit [and thickens] southward in western Kansas.

D. C. Swanson, 1978, Tulsa Geological Society, Special Publication, no. 1, p. 118–119, 146, 159–167. Shows distribution of the Kearny and equivalent rocks in the Anadarko basin including southwest Kansas.

R. H. Franz, 1985, Kansas Geological Survey, Subsurface Geology Series 6, p. 48–55. Emphasis of discussion is on the Keyes sand which makes up the lower part of the lower member of the Kearny.

Type well: Stanolind Oil and Gas Co. No. 1 Patterson, SE corner of sec. 23, T. 22 S., R. 38 W., Kearny County, Kansas (interval between 4,752 and 4,879 ft).

Kenosha shale member (of Tecumseh shale)

Pennsylvanian (Virgilian): northeastern Kansas, southeastern Nebraska, and southwestern Iowa.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 47, 52. Shale, 6 or 7 ft (1.8–2.1 m) thick, at base of Tecumseh shale member, underlying Ost limestone.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 23. Underlies Ost limestone member of Tecumseh shale; overlies Avoca limestone member of Lecompton formation.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 156. Not distinct enough to be treated as subdivision of Tecumseh in Kansas.

Type locality: In Missouri River bluff near Kenosha landing at mouth of second small valley south of King Hill, Cass County, Nebraska.

Keokuk Limestone

Keokuk Limestone (of Cowley Formation)

Mississippian (Osagean Series): surface of southeastern Kansas, subsurface of most of the rest of Kansas.

D. D. Owen, 1852, Geological Survey of Wisconsin, Iowa, and Minnesota, p. 91, 92. *Keokuk cherty limestones*—Gray cherty limestones, forming wall of rock washed by the Mississippi below Keokuck Landing, Iowa. Overlain by Shell beds and underlain by Hannibal beds (brown encrinital limestones alternating with bands of chert), which rest on Burlington beds (the Encrinital group of Burlington). [named for Keokuck (sic) Landing]

J. Hall, 1857, American Association of Advanced Science, Proceedings, v. 10, pt. 2, p. 53–56. *Keokuk or lower Archimedes limestone*—Highly fossiliferous limestone, separated from overlying Warsaw or Second Archimedes limestone by "Geode bed" (a mass of shales or marls with impure limestones containing geodes), overlain, locally, near Warsaw, Illinois, Appanoose, Iowa, and other places, by 10 ft (3 m) of magnesian limestone. Separated from underlying Burlington limestone by 60–100 ft (18–30 m) of beds of passage, consisting of cherty layers with intercalated beds of light-gray limestone.

G. Wilmarth, 1938, U. S. Geological Survey, Bulletin 896, p. 1,084–1,085. The "cherty beds of passage" were treated as a distinct unit and excluded from both Keokuk and Burlington by Hall in 1858, 1959, 1864; by Worthen in 1858; by C. R. Keyes in 1894; by J. A. Udden in 1901; by H. Hinds in 1909; and by C. R. Keyes in 1914. They were included in the Burlington by C. A. White; by Wachsmith; by C. H. Gordon (1892 and 1895); by C. R. Keyes in 1895 (under the name "Montrose chert"); by W. H. Norton and H. E. Simpson in 1912; and by F. M. Van Tuyl in 1912. They were included in Keokuk by A. W. Vodges in 1888 and by F. M. Van Tuyl in 1925 (Iowa Geological Survey, v. 30, p. 47, 146) who stated that in them appear for first time several Keokuk types of brachiopods. The "geode bed" referred to by Hall has in subsequent reports been both included in and excluded from Keokuk limestone.

T. C. Hiestand, 1938, American Association of Petroleum Geologists, Bulletin, v. 22, p. 1,588–1,599. Stratigraphic studies using insoluble residues indicate that the "Mississippi lime" can be subdivided into zones that closely correspond with members of the Boone limestone of

or thick, fine-grained, gray to blue-gray limestone. In northeastern Kansas, upper slabby crossbedded layers, containing algal and locally land-plant remains, overlie more massive rock that contains fusulinids and other marine invertebrates. In southeastern Kansas, it is locally sandy and contains invertebrate fossils, also. The thickness ranges from 0 to more than 40 ft (0–12 m).

Type locality: Kereford quarry at south edge of Atchison, Atchison County, Kansas.

Keyes sand (in Kearny Formation)

A local term for glauconitic sandstones and sandy limestones in the lower part of the lower member of the Kearny Formation in southwest Kansas (D. A. McManus, 1959, Kansas Geological Society, 24th Field Conference, Guidebook, p. 108; R. H. Franz, 1985, Kansas Geological Survey, Subsurface Geology Series 6, p. 48). Named for the Keyes gas field in Cimarron County, Oklahoma (L. Jordan, 1957, Oklahoma Geological Survey, Guidebook 6, p. 113).

Kickapoo limestone

Pennsylvanian: eastern Kansas.

E. Haworth and J. Bennett, 1908, Kansas Academy of Science, Transactions, v. 21, pt. 1, p. 81. Thin limestone, extending entirely across Kansas, from State line in Chautauqua County to Doniphan County; underlies Lawrence shales and overlies LeRoy shales.

H. Hinds and F. C. Greene, 1915, Missouri Bureau of Geology and Mines, v. 13. Same as Iatan limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 139, 140, 152, 158. Included in Iatan, Haskell, and Amazonia limestones.

Named for Kickapoo, Leavenworth County, Kansas, 5 mi (8 km) south of Iatan, Platte County, Missouri.

Kiewitz shale (of Stanton limestone)

Pennsylvanian: eastern Kansas and southeastern Nebraska.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 42, 55. Howard limestone member of Shawnee formation in Nebraska consists of two limestones separated by a shale bed of variable thickness, here named Kiewitz shale. This shale is bluish to gray, argillaceous to quite calcareous, fossiliferous, and 2 or more feet (0.6 m) thick.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 11, 27, 31. The units called Louisville limestone, Kiewitz shale, Du Bois limestone, Severy shale, Topeka limestone, and Meadow limestone in Bulletin 1 are parts of Stanton limestone. The name Louisville limestone is preoccupied hence Stoner limestone is proposed for this unit, to include also Kiewitz shale and so-called Du Bois limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 134. Included within Olathe limestone member of Stanton limestone in Kansas.

Named for exposures in Kiewitz quarry located in Platte Valley bluffs west of Meadow Station, Sarpy County, Nebraska.

Kiger Shale Member (of Whitehorse Formation)

Kiger Group (of Cimarron Series)

Kiger division

Permian (Guadalupian Series): central-southern Kansas and northwestern Oklahoma.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 3, 39. All rocks of the so-called "red beds" that lie above the Medicine Lodge gypsum on the central plains north of the Ouachita Mountains; in southern Kansas divided into (top to bottom) Big Basin sandstone, Hackberry shales, Day Creek dolomite, Red Bluff sandstones, and Dog Creek shales; upper division of Cimarron series; overlies Salt Fork division, from which it is chiefly characterized by bright-red color of its major formations.

E. Haworth and J. Bennett, 1908, University Geological Survey of Kansas, v. 9, p. 77. Kiger stage includes (top to bottom) Taloga formation, Day Creek dolomite, and Red Bluff formation; overlies Dog Creek formation of Salt Fork stage.

G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,803–1,813. Cimarron series in Kansas includes all Permian red beds overlying salt- and gypsum-bearing gray shales of Wellington Formation. Divided by Cragin into Salt Fork and Kiger divisions. Kiger includes strata from base of Whitehorse Sandstone to base of Big Basin Formation.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 25–26. Referred to as group in Cimarron series in subsurface study.

H. G. O'Connor, 1963, American Association of Petroleum Geologists, Bulletin, v. 4, p. 1,874, 1,877. The name Kiger was originally used by Cragin (1896) for beds called Whitehorse Formation, Day Creek Dolomite, and Big Basin Formation of this report. The name Kiger Shale Member of Whitehorse Formation as used in this report is used in a restricted sense for only a part of Cragin's original Kiger division; top member of Whitehorse Formation, occurs about 100 ft (30 m) above top of Relay Creek Dolomite Member; overlies unnamed "even-bedded member" in Whitehorse Formation; underlies Day Creek Dolomite; about 38 ft (11.4 m) thick.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., 1968, Kansas Geological Survey, Bulletin 189, p. 53. Kiger Shale Member of Whitehorse Formation (O'Connor, 1963) comprises shale, siltstone, and some very fine grained sandstone, mostly brick red or maroon. Thickness about 38 ft (11.4 m). Uppermost member of Whitehorse Formation.

Name derived from Kiger Creek, Clark County, Kansas.

Kimball Member (of Ogallala Formation)

Kimball formation (of Ogallala group)

Miocene-?Pliocene Series: northwestern and north-central Kansas, southwestern Colorado, and northern Colorado.

A. L. Lugn, 1938, American Journal of Science, 5th series, v. 36, p. 224, 227; 1939, Geological Society of America, Bulletin, v. 50, p. 1,262–1,264, 1,266. Uppermost formation in group; silt, clay, and fine sand more or less cemented with caliche, with one or two algal limestone beds at top; pinkish to reddish; thickness 25–50 ft (7.5–15 m); overlies Sidney gravel; very late Pliocene.

C. B. Schultz and T. M. Stout, 1948, Geological Society of America, Bulletin, v. 59, 553–588. Formation includes Sidney gravel and silt member. Unconformity between Kimball and Broadwater formations is most significant stratigraphic break in upper Tertiary and Pleistocene deposits of western Nebraska and Great Plains in general. This break believed to be the Pliocene–Pleistocene boundary.

"Kinderhook" has been accepted by most petroleum geologists for Chattanooga Shale and the Boice Shale where present. The term "Kinderhook" also has been used for oolitic limestone in western Kansas equivalent to the Gilmore City.

G. Moore, 1983; *in*, J. M. Hills and F. E. Kottlowski, coord., AAPG–COSUNA Southwest/Southwest Midcontinent Correlation Chart. Subsurface term "Kinderhook shale" used in Kansas part of Hugoton embayment section 0–15 m (0–49.5 ft) thick, overlain by Gilmore City Limestone, rests unconformably on Viola Formation.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 22–24. "Kinderhook Shale" is a term long used in studies of the subsurface of western and northwestern Missouri for a sequence of black to gray and green shales between Devonian and Mississippian carbonates.

Kingfisher formation (of Cimarron group)

Permian: southern Kansas and central Oklahoma.

F. W. Cragin, 1897, American Geologist, v. 19, p. 352–355. Includes Salt Plain measures and saliferous Harper sandstones, which are in places difficult to separate; included in Salt Fort division.

C. C. Branson, 1957, Oklahoma Geology Notes, v. 17, no. 11, p. 101. Abandoned by Oklahoma Geological Survey.

Named for Kingfisher Creek and town in Kingfisher County, Oklahoma.

King Hill Shale Member (of Lecompton Limestone)

Pennsylvanian (Virgilian Series) : southeastern Nebraska, southwestern Iowa, northeastern Kansas, and northwestern Missouri.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 44, 45, 47. *King Hill shale*—Bluish-green and reddish argillaceous shale, about 7 ft (2.1 m) thick at type locality (in King Hill, southeast of Rock Bluff, Nebraska). Is 4 ft (1.2 m) thick in Missouri and 6–7 ft (1.8–2.1 m) thick in Kansas. Underlies Avoca limestone and overlies Cullom limestone [later named *Beil limestone* and still later, *Cullom* was abandoned]. All included in Lecompton limestone.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 23; R. C. Moore and others, 1951, Kansas Geological Survey, Bulletin 89, p. 66. Thickness 4–6 ft (1.2–1.8 m) in Nebraska, about 20 ft (6 m) in northwestern Missouri, and 5–20 ft (1.5–6 m) in Kansas. Underlies Avoca limestone member; overlies Beil limestone member.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 19, fig. 5. Dark- to greenish-gray massive shale with seams of nodular limestone. Thickness 6–7 1/2 ft (1.8–2.3 m). Underlies Avoca limestone member; overlies Beil limestone member.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37, and pl. 1. The King Hill Shale Member is greenish-gray to reddish-gray shale that is calcareous in northeastern Kansas. Brachiopods occur sparsely in the upper part of the member. The thickness ranges from about 4 to 20 ft (1.2–6 m).

Type locality: One and one-half miles (2.4 km) south and 1 mi (1.6 km) east of Rock Bluff, Cass County, Nebraska. Name derived from King Hill, a high point in Missouri River bluffs.

Kingman Sandstone Member (of Harper Sandstone)

Permian (Leonardian Series): southern Kansas and northern Oklahoma.

G. H. Norton, 1937, (abs.) American Association of Petroleum Geologists, Bulletin, v. 21, p. 1,557; 1939, v. 23, p. 1,785–1,786. An 80-ft (24-m) silty red sandstone containing a 3-ft (0.9-m) white sandstone at base. Overlies Chikaskia Sandstone Member (new). Top not distinct, but placed arbitrarily at maroon shale at base of Salt Plain measures of Cragin.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H.G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 36, 40. Upper member of Harper Sandstone; overlies Chikaskia Member; underlies Salt Plain Formation; red siltstone and sandstone and a few beds of red shale and white sandstone; prominent bed of white sandstone, 3 ft (0.9 m) thick, occurs at the base; thickness about 80 ft (24 m).

Named for exposures in and around Kingman, Kingman County, Kansas. US–54 cuts through ridge of the sandstone about 3/4 mi (1.2 km) east of Kingman; here basal bed and lower part of member are exposed.

Kingsdown formation (of Sanborn group)

Kingsdown silt

Kingsdown marl

Pleistocene (Illinoian and Sangamonian): southwestern Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 53, 54. Yellowish-brown lacustrine or slack-water marls, with concretions of carbonate and silicate of lime; 100–200 ft (30–60 m) thick. Overlies Pearlette ash; unconformably underlies Quaternary deposits. Thought to be late Pliocene formation in Tule division of Cummins (*Equus* beds of Cope).

H. T. U. Smith, 1940, Kansas Geological Survey, Bulletin 34, p. 111–116. Redefined as Kingsdown formation to include beds of Pleistocene age only. Light-colored sand and gravel grading upward into characteristically light-buff even-bedded silt and clay containing some small and scattered calcareous concretions; 64 ft (19 m) thick at section in Clark County; overlies Rexroad formation; overlain by loess and seems locally to grade upward into loess from which it differs little except in its bedding.

J. C. Frye and C. W. Hibbard, 1941, Kansas Geological Survey, Bulletin 38, pt. 13, p. 410, 411. Includes overlying loess; overlies Meade formation.

C. W. Hibbard, 1944, Geological Society of America, Bulletin, v. 55, p. 745–752. Kingsdown divisible into an upper and lower part separated by a disconformity. Lower Kingsdown consists of light-buff silt and some sand and caliche pebbles; unconformably overlies Meade formation; unconformably underlies upper Kingsdown silt; channelled into underlying Meade formation in Clark County. Upper Kingsdown silt consists of light-tan silt and fine sand, thin-bedded at base grading upward into massive silt and loess.

C. W. Hibbard, 1949, Michigan University Museum of Paleontology Contributions, v. 7, no. 4, p. 80–84. Redefined to include sands and gravels at base of silt; Kingsdown formation instead of Kingsdown marl. Redefined to exclude section described by Smith (1940), which is younger than Cragin's (1896) original definition and belongs to later cycle of erosion and deposition (Vanhem formation). In some areas overlies Meade formation, in other areas overlies Crooked Creek formation.

shales in the lower part of the Kiowa Formation form a locally mappable unit. The name proposed for these rocks is the "Longford Member of the Kiowa Formation." The Longford Member is recognized in parts of Marion, McPherson, Dickinson, Clay, Saline, and Rice counties. The Longford Member disconformably overlies the Permian and is conformable with the overlying marine shales of the Kiowa Formation. Thickness of the Longford Member ranges up to 100 ft (30 m) in the type area, located north of the town of Longford, southwestern Clay County.

V. Hamilton, 1994; *in*, G. W. Shurr, G. A. Ludvigson, and R. H. Hammond, eds., Geological Society of America, Special Paper 287, p. 79–96. The Lower and Upper Cretaceous strata that belong to the Cheyenne Sandstone, Kiowa Formation, and Dakota Formation in Kansas are divisible into three unconformity-bounded sequences. In ascending order these are the Cheyenne–Kiowa, the J, and the D. All three sequences can be traced into the center of the basin in Colorado and are equivalent to sequences defined by Weimer (1984). Each consists of landward-stepping progradational events of fluvial and nearshore to marine siliclastics belonging to: the Cheyenne Sandstone and Longford Member (Kiowa Formation) in the lower sequence, the lower part of the Dakota Formation ("J" sandstone) and Huntsman Shale in the middle sequence, and the upper part of the Dakota Formation ("D" sandstone) in the upper sequence. The Longford Member defined by Franks (1966) is recognized and extended into the subsurface westward of the central Kansas outcrop belt in which it was originally described. Also included within the Kiowa are shallow marine shale facies and shoreface deposits near the top.

Named for Kiowa County, Kansas.

Kirby clay

Cretaceous (Lower): south-central Kansas.

C. N. Gould, 1898, American Journal of Science, series 4, v. 5, p. 170–174. Yellowish clays, arenaceous below, reddish above, containing several beds of light-yellow sandstone; thickness 20–130 ft (6–39 m); underlies Reeder sandstone and overlies Greenleaf sandstone; included in Medicine beds.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,104. The U.S. Geological Survey discarded this name in 1921, the beds to which it was applied being regarded as Kiowa shale.

Named for Kirby, or C. W., or Fullington ranch, on upper Medicine River, 10 or 12 mi (16–20 km) west of Belvidere, Kiowa County, Kansas.

Knifeton coal bed (in Cherokee Group)

Knifeton formation (of Cherokee Group)

Knifeton cyclothem

Pennsylvanian (Desmoinesian): southeastern Kansas.

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 22; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 196. Cherokee group divided into 15-cyclic formational units. The Knifeton, fifth in sequence (ascending), occurs above the Bluejacket and below the Weir. Average thickness about 24 ft (7.3 m). Includes 8-inch (20-cm) coal bed here named Knifeton. A local name for an unnamed coal bed that is present above the Seville Limestone Member.

Knobtown sandstone (of Tacket Formation)

Knobtown sand

Pennsylvanian (Missourian Series), eastern Kansas.

F. C. Greene, 1933, Missouri Bureau of Geology and Mines, 57th Biennial Report, p. 13, 19, app. 2, pl. 2. A subsurface sand near the top of the Pleasanton formation of west-central Missouri; higher than Wayside sand.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 91. In Linn and Miami counties, Kansas, upper part of Pleasanton group partly occupied by massive sandstone (Knobtown), which is locally as much as 25 ft (7.5 m) thick.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 27. "In Miami and Linn counties the [basal Tacket Formation] interval is occupied by massive sandstone (Knobtown), which locally is as much as 25 feet [7.5 m] thick."

Named for outcrop north of Knobtown, Jackson County, Missouri, on U.S. Highway 50, sec. 22, T. 48 N., R. 32 W.

Knox Dolomite Megagroup

Cambrian and Ordovician: central North America.

D. H. Swann and H. B. Willman, 1961, American Association of Petroleum Geologists, Bulletin, v. 45, p. 471–483. Name "Knox" (from eastern Tennessee) has been used in places where individual late Cambrian and early Ordovician units could not be separated; proposed to extend usage of the name into those areas where individual units can be separated. Arbuckle in Oklahoma, Kansas, and Arkansas is synonymous with Knox; Knox Megagroup is truncated by St. Peter Sandstone or equivalent sandy strata in Simpson Group in most of the Midwest. Term "megagroup" is proposed as formal designation for rock-stratigraphic unit larger than group.

Krebs Formation (of Cherokee Group)

Krebs Group

Pennsylvanian (Desmoinesian Series): central and northeastern Oklahoma, southeastern Kansas, and western Missouri.

M. C. Oakes, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 1,523–1,524. Named for lower group of Desmoinesian Series in Oklahoma.

W. V. Searight , W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748 (fig. 1). Group shown on northern midcontinent composite stratigraphic column as including (ascending) Riverton, Warner, Rowe, Dry Wood, Bluejacket, and Seville Formations.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 26–28. The Cherokee Group is divided into the Cabaniss Subgroup and the Krebs Subgroup. The Krebs Subgroup includes the following formations, in ascending order: the Riverton, Warner, Rowe, Dry Wood, the Bluejacket, and the Seville limestone in the Seville. Average thickness between 200 and 250 ft (61–76 m). Comprises about half of pre-Marmaton Desmoinesian section in Kansas.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shown as formation in Cherokee Group. Underlies Cabaniss Formation.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 23–24. "Practical mapping considerations" led to changing the names of the Cabaniss and Krebs subgroups to formation

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 60–61. Formation consists of mainly clayey and sandy shale. In the middle upper part a rather persistent zone of platy to shaly sandstone. Near the base is the Lexington coal. Coal is overlain by thin limestone, the so-called Lexington caprock, in Missouri and Iowa. Another coal bed in upper part of Labette shale in parts of southeastern Kansas. Thickness ranges from about 20 to 60 ft (6–18 m).

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, part 11, p. 309–312. Comprises beds between Fort Scott and Pawnee Limestones. Thickness 40–80 ft (12–24 m). Includes Englevale Sandstone Member. Included in Marmaton Group; type section designated.

L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, p. 26–27 (fig. 2). Columnar section shows Labette Shale in Henrietta Group.

R. C. Moore, 1951, Kansas Geological Survey, Bulletin 89, p. 97. A rather persistent black shale and a bed of coal occur in basal part. Black shale occurs locally in upper part. Some sections show several thin limestones and coal beds. Persistent limestone, 1–2 ft (0.3–0.6 m) thick, occurs in the middle lower part. Thickness ranges from 30 to 100 ft (9–30 m).

M. C. Oakes, 1952, Oklahoma Geological Survey, Bulletin 69, p. 26–28. South of T. 23 N., Oklahoma, Pawnee, and Altamont Limestones merge to form Oologah Limestone. In Marmaton Group.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 25. Gray and yellow shale, sandstone, coal, and limestone beds; thickness 30–100 ft (9–30 m). Includes Englevale Sandstone Member ("Peru sand" in the subsurface) in middle to lower part.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 2. Englevale sandstone lowered to bed of Labette.

Type section: Exposure beginning near middle of north line and extending to point near NE corner sec. 22, T. 33 S., R. 20 E., near town of Labette, Labette County, Kansas.

La Cygne shale member

Pennsylvanian: eastern Kansas.

R. C. Moore, 1920, Kansas Geological Survey, Bulletin 6, pt. 2, p. 18, 21, 28. Top member of Marmaton formation; overlies Lenapah limestone member and underlies Hertha limestone member of Kansas City formation; 125–150 ft (38–45 m) of shales and intercalated sandstones with some thin discontinuous beds of limestone. Previously has been incorrectly called Pleasanton shale.

R. C. Moore, 1920, Kansas Geological Survey, Bulletin 6, pt. 2, errata. Name La Cygne shale is withdrawn because it is the same as Dudley shale.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 67, 73. Partly included in Memorial shale and partly included in Bourbon formation.

Named for town of La Cygne, Linn County, Kansas.

Ladore Shale (of Kansas City Group)

Ladore Shale (of Bronson Group)

Ladore Shale Member (of Kansas City Formation)

Pennsylvanian (Missourian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

G. I. Adams, 1904, U.S. Geological Survey, Bulletin 238, pl. 1 and 2. Shale shown on maps as overlying Hertha limestone and underlying Mound Valley limestone in Iola quadrangle, Kansas; included in Bronson formation.

E. Haworth and J. Bennett, 1908, University Geological Survey, v. 9, p. 91. Name applies to shale between Bethany Falls Limestone below and Mound Valley Limestone above.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 26. Use of Ladore as the shale between the Hertha and Mound Valley (Bethany Falls) as applied by Adams (1904) as shown near Ladore.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 193. Ladore Shale included in Bronson Group. Thickness 2–50 ft (0.6–15 m). Overlies Hertha Limestone; underlies Swope Limestone.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,031 (fig. 4); F. C. Greene and W. V. Searight, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 11. Ladore included in Bronson Subgroup of Kansas City Group; classification agreed upon by state geological surveys of Kansas, Iowa, Missouri, Nebraska, and Oklahoma.

R. C. Moore, J. C. Frye, J. M. Jewett, W. Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 90. Gray and brownish-yellow shale, sandstone, and some coal. Like the Galesburg Shale thickens southward. Thin marine shale in Kansas City area expanding to sandy deltaic deposit in southern Kansas.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 28. Ladore Shale contains brownish-yellow shale, sandstone, and some coal; changes from thin marine shale in Kansas City area to thick deltaic deposit in southeastern Kansas.

W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 8 (fig. 3c). Ladore Shale identified overlying Bethany Falls Limestone and underlying Mound Valley Limestone.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 9. Ladore Shale in type section correct, but pinches out to north. Ladore Shale missing north of northern Bourbon County. Correlation of Hertha and Swope limestones in type section miscorrelated in Neosho County (Adams, 1904). Ladore overlies Bethany Falls Limestone and underlies Mound Valley Limestone (new). Shale contains brownish-yellow to dark-gray shale, sandstone, and some coal.

Named for former town of Ladore, Neosho County, Kansas.

Lagonda Member (of Banzet Formation)

Lagonda formation (of Cherokee Group)

Lagonda sandstone

Lagonda sandstone member (of Cherokee shale)

Pennsylvanian (Desmoinesian): northwestern Missouri, eastern Kansas, southwestern Iowa, and northeastern Oklahoma.

C. H. Gordon, 1893, Missouri Geological Survey, Sheet Report 2, v. 9, p. 19. Sandy shales and sandstones, 18–50 ft (6–15 m) thick, overlying Bevier coal and forming top division of Lower Coal Measures in Bevier quadrangle.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,130. Is now treated as a member of the Cherokee shale.

A. G. Unklesbay, 1952, Missouri Geological Survey and Water Resources, 2nd series, v. 33, p. 86–90. Formation described

Arkansas. Rocks formerly named Lamotte and the lower part of the Bonneterre Dolomite are considered to be Reagan Sandstone.

Named for Mine La Motte Station, Madison County, Missouri.

Lane Shale (of Kansas City Group)

Lane Shale (of Lansing Group)

Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.

E. Haworth and M. Z. Kirk, 1895, Kansas University Quarterly, v. 3, p. 277, pl. facing p. 290; 1895, American Journal Science, 3rd, v. 50, p. 460, pl. facing p. 466. "Passing upwards from Iola Limestone and leaving unnoticed a shale bed 40 to 50 ft [12–15 m] thick and a limestone one-fourth as great, we come to the Lane shale, which in many places reaches 150 ft [45 m] in thickness."

G. I. Adams, 1904, U.S. Geological Survey, Bulletin 238, p. 20. Applies name of Concreto Shale to interval above Iola Limestone and below the Allen (Plattsburg) Limestone, near Iola. Thickness is 75 ft (23 m).

E. Hawthorn and J. Bennett, 1908, Kansas Geological Survey, v. 9, p. 100. Used for the shale between Iola and Allen limestones. "The term Lane Shale was applied by Haworth in 1895 to the bed of shales first above the Iola Limestone, and is here used with the same significance."

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 25, fig. 5. Recognized in Madison County as an olive to dark-gray fossiliferous shale containing limestone lenses; at some localities, has thin bed of maroon and green shale at base. In Union County, consists of greenish-gray to yellow calcareous shale with lenses of gray fossiliferous shale. Thickness 7 ft (2 m), Madison County; about 10 ft (3 m), Union County. Underlies Wyandotte Limestone; overlies Iola Limestone, Kansas City Group.

H. Hinds and F. C. Greene, 1915, Missouri Bureau of Geology and Mines, v. 13, p. 28. Adapted definition of Haworth and Kirk (1895) as interval overlying Wyandotte Limestone and underlying Plattsburg Limestone.

R. C. Moore and W. P. Haynes, 1917, Kansas Geological Survey, Bulletin 3, p. 99. Lane Shale classed as a member of the Lansing Formation. Includes beds between Iola (Argentine at Kansas City) and Plattsburg limestones.

R. C. Moore, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 92. Cited ms. by N. D. Newell. Notes that the limestone overlying Lane Shale at Lane, Franklin County, Kansas, is not the Plattsburg Formation, but an unnamed limestone for which the name Wyandotte is proposed. It is stated that the shale bed at Kansas City between the Raytown and "Iola" (Argentine) limestones, called upper Chanute by Missouri geologists, is really the Lane Shale.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 117. Defined type Lane shale.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 55. Stabilized use of name.

J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. Columnar section, Jackson and Cass counties, Missouri, shows Lane Shale in Lansing Group. Utilized definition of Lane Shale of Haworth (1895). Includes (ascending) Island Creek Shale, Farley Limestone, and Bonner Springs Shale Members. Underlies Plattsburg Limestone, Quindaro Shale, and Argentine Limestone members.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,031 (fig. 4), 2,032–2,033; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 13–14. Settlement of "Iola problem" led to several changes in Missouri Survey's classification of middle and upper Kansas City beds so as to bring interstate agreement in nomenclature. Liberty Memorial Shale (Clair, 1943), overlying Raytown Limestone, is no longer considered uppermost member of Chanute Shale but is suppressed as junior synonym of Lane Shale. Frisbie Limestone, Quindaro Shale, and Argentine Limestone, which were indicated as members of Iola Limestone are classified with overlying Island Creek Shale and Farley Limestone as members of Wyandotte Formation. Island Creek Shale and Farley Limestone, which were associated with overlying Bonner Springs Shale as members of Lane Shale, are included in Wyandotte Formation. Bonner Springs Shale is recognized as formational unit between Wyandotte and Plattsburg formations. Hence, Lane Shale in Missouri is removed from Lansing Group and placed in Kansas City Group where it occupies interval between Iola Limestone and Wyandotte Limestone.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 13–14. Revision of classification of Kansas City Group. Lane Shale is removed from Lansing Group and placed in Kansas City Group between Iola Limestone and Wyandotte Limestone.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 35. Thickness of formation 14 ft (4.2 m) in Sarpy County, Nebraska. Overlies Iola Formation; underlies Frisbie Limestone Member of Wyandotte Formation. Kansas City Group.

T. L. Welp, L. A. Thomas, and H. R. Dixon, 1957, Iowa Academy of Sciences, Proceedings, v. 64, p. 418 (fig. 1), 420. Thickness of Lane Formation about 10.5 ft (3.2 m) in Madison and Adair counties, Iowa. Overlies Iola Formation; underlies Frisbie Limestone Member of Wyandotte Formation. Kansas City Group.

S. M. Ball, M. M. Ball, and D. J. Laughlin, 1963, Kansas Geological Survey, Bulletin 163, p. 44. Section A12 described serves as new type section.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 31. Consists of dark-bluish-gray shale, sandy shale, and thin-bedded sandstone. Thickness 7–108 ft (2–33 m), average 50 ft (45 m; now Liberty Memorial Shale).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 16. Recorrelation has determined that type Lane Shale as defined by Moore (1948) is not shale between Iola and Wyandotte limestones, but what is here defined as Island Creek Shale. Overlies Wyandotte Limestone and underlies Plattsburg Liemstone. Type area of Moore (1936) is slumped and vegetated. New type defined. Lane Shale, utilizing usage of Haworth and Kirk (1895), includes: Bonner Springs Shale Member, Farley Limestone Member, Island Creek Shale Member. Type Lane Shale as defined by Moore (1948) is not shale between Iola and Wyandotte limestones, but above Wyandotte limestone. Revived type section for Liberty Memorial is as defined by Clair (1943). Principal reference section for Kansas is along I–435 southbound offramp to Holliday Road (NW NE NW sec. 6, T. 12 S., R. 24 E.) in

Lansing limestone
Lansing lime
Pennsylvanian (Missourian): eastern Kansas.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 83. In areas where rocks of the Lansing group are largely limestone, the term "Lansing limestone" or "Lansing lime" is used to designate the combined Plattsburg and Stanton limestones and the interlying Vilas shale (if present).

Larsh–Burroak Shale Member (of Deer Creek Limestone, Shawnee Group)
Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, northeastern Kansas, and northwestern Missouri.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 40, 43, 49, 50. Larsh Shale, near base of Deer Creek Limestone, is 1 2/3–2 ft (0.5–0.6 m) thick in southeast Nebraska and southwest Iowa, 6–8 ft (1.8–2.4 m) thick in northwest Missouri, and 8+ ft (2.4+ m) thick in northeast Kansas. Underlies Haynies Limestone and overlies Rock Bluff Limestone. Named for Larsh farm, on Ervine Creek, northeast of Union, Nebraska.
G. E. Condra and E. C. Reed, 1937, Nebraska Geological Survey, 2nd series, Bulletin 11, p. 8, 12, 16, 20, 54, fig. 2. Member of Deer Creek Limestone in Shawnee Group. Overlies Rock Bluff Limestone Member; underlies Haynies Limestone Member.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 179. Referred to as Larsh–Burroak Shale Member of Deer Creek Limestone. Average thickness 3 1/2 ft (1 m). Underlies Ervine Creek Limestone Member; overlies Rock Bluff Limestone Member.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5). Interstate agreement recognizes Larsh Shale Member of Deer Creek Formation. Overlies Rock Bluff Limestone Member; underlies Haynies Limestone Member.
F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. vi (fig. 3), 17–18. In Missouri, interval between Rock Bluff Limestone Member and uppermost limestone of Deer Creek is occupied by shale referred to as Rock Bluff–Ervine Creek shale with implication that intervening Haynies Limestone is absent in Missouri. Shale is here called Larsh–Burroak. Missouri Survey recognizes the possibility that Burroak Shale may be absent in Missouri and that uppermost limestone of Deer Creek may include both Haynies and Ervine Creek Members.
H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 18, fig. 5. Larsh Shale, in southwestern Iowa, is gray to olive-green blocky to thin-bedded in upper part; lower part black and fissile. Thickness about 2 ft (0.6 m) throughout entire area where Burroak and Larsh Shales are differentiated. Overlies Rock Bluff Limestone Member; underlies Haynies Limestone Member. In some areas referred to as Burroak–Larsh Shale.
J. M. Jewett, H. G. O'Connor, and D. E, Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 38, and pl. 1. Because the intervening Haynies Limestone Member, which is present in Nebraska, is missing in outcrops in Kansas, these two members, formerly called "Larsh–Burroak," are indistinguishable and are treated as one unit. It consists of gray or yellow clayey shale in the upper part and black, fissile shale in the lower part. Fossils are rare in the upper part, but conodonts occur in the black portion. Thickness ranges from about 2.5 to 7 ft (0.75–2 m).

Larsh Shale Member (of Deer Creek Limestone)
Larsh Shale
Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, northwestern Missouri, and ?northeastern Kansas.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, series 2, p. 40, 43, 49, 50. Underlies Haynies limestone; overlies Rock Bluff limestone; about 2 ft (0.6 m) thick in southeastern Nebraska and southwestern Iowa, 6–8 ft (1.8–2.4 m) thick in northwestern Missouri, and 8+ ft (2.4+ m) thick in northeastern Kansas.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 179. Referred to as Larsh–Burroak shale member of Deer Creek limestone in Kansas.
Type locality: Ervine Creek valley, 2 1/2 mi (4 km) east and 1 1/4 mi (2 km) north of Union, Cass County, Nebraska. Named for Larsh farm.

Laverne formation
Pliocene: southwestern Kansas and northwestern Oklahoma.
C. N. Gould, 1927, University of Oklahoma, Bulletin, Proceedings of the Oklahoma Academy of Science, v. 6, pt. 2, p. 235–238. Used by Waite to include some leaf-bearing beds of Tertiary age in Harper and Beaver counties, Oklahoma.
J. C. Frye and C. W. Hibbard, 1941, Kansas Geological Survey, Bulletin 38, p. 398–403. Geographically extended into southwestern Kansas where it is well exposed along both sides of Cimarron Valley in southeastern Seward County and southwestern Meade County. Consists of shale, sandstone, and limestone; locally contains a hard conglomerate; buff, blue gray, and gray; thickness about 60 ft (18 m); Laverne beds dip at angles as much as 15° and are overlain by horizontal beds of the Ogallala; Miocene and lower Pliocene.
C. W. Hibbard, 1949, Michigan University Museum of Paleontology, Contributions, v. 9, no. 5, p. 91–105. Unconformably underlies Rexroad formation in Seward and Meade counties, Kansas.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 20. Laverne formation in Meade and Seward counties, Kansas, equivalent in age (early Pliocene and possible late Miocene) to Valentine member of Ogallala formation.
A. J. Myers, 1959, Oklahoma Geological Survey, Bulletin 80, p. 47–50, pl. 2. At no place is Ogallala in contact with Laverne; lower Pliocene; type locality stated.
C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 59. It appears that "basin-fill" deposits in Kansas that have been called "Laverne" are probably equivalent in age to upper Ash Hollow deposits (C. W. Hibbard, personal communication with C. K. Bayne, 1964).
Type locality: In vicinity of Laverne, Harper County, Oklahoma.

(bottom to top): Spring Branch limestone, Doniphan shale, Big Springs limestone, Queen Hill shale, Beil limestone, King Hill shale, and Avoca limestone.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 179–180. Includes: Avoca Limestone Member, King Hill Shale Member, Beil Limestone Member, Queen Hill Shale Member, Big Springs Limestone Member, Doniphan Shale Member, Spring Branch Limestone Member. Thickness 30–50 ft (9–15 m). Underlies Tecumseh Shale; overlies Kanwaka Shale. Shawnee Group.

Named for exposures at Lecompton, Douglas County, Kansas.

Lecompton shale

Pennsylvanian: eastern Kansas and northwestern Missouri.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 64, 94. Name suggested by G. I. Adams for persistent and heavy shales, 90 ft (27 m) thick, in places containing much sandstone, in other places almost no sandstone; basal member of Shawnee formation; underlies Lecompton limestone; overlies Oread limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 169. Synonymized with Kanwaka shale because Lecompton is already in use for overlying limestone unit.

Named for exposures at Lecompton, Douglas County, Kansas.

Legion Shale Member (of Grenola Limestone)

Pennsylvanian (Virgilian Series): eastern Kansas, southeastern Nebraska, north-central Oklahoma.

G. E. Condra and C. E. Busby, 1933, Nebraska Geological Survey, Paper No. 1, p. 9–10, 18. *Legion shale member of Grenola formation*—The newly established Grenola formation is divided into following members (descending): Neva limestone, Salem Point shale, Burr limestone, Legion shale, and Sallyards limestone. The Legion shale is largely gray argillaceous shale with few fossils in north, becoming nearly black at top north of Manhattan and at Elmdale, Kansas. In central and southern Kansas, it is indurated and more calcareous locally, with numerous pelecypods, some brachiopods, crinoids, Bryozoa, etc. In Oklahoma it grades into red sandy shale. Thickness 4–8 ft (1.2–2.4 m).

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 48. Consists of shale, mostly gray but locally zones of black; in central Kansas upper part commonly fossiliferous. Thickness 4–12 ft (1.2–3.6 m). Underlies Burr limestone member; overlies Sallyards limestone member.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 42–43. Stratigraphic section 236 (p. 161–163) of this report was measured at the type section; generally gray in Kansas; thin pelecypod-bearing limestones present in middle part in southern Kansas; 1.4–12.9 ft (0.4–4 m) thick, average thickness of 5.8 ft (1.75 m).

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva Limestone to conform, including Legion Shale Member.

Type locality: Cuts on US–40, just southwest of American Legion Golf Club grounds, about 1 3/4 mi (2.8 km) southwest of Manhattan, Riley County, Kansas.

Lenapah Limestone (in Marmaton Group)

Pennsylvanian (Desmoinesian Series): northeast Oklahoma, southwest Iowa, southern Kansas, and western Missouri.

C. N. Gould, D. W. Ohern, and L. L. Hutchinson, 1910, Oklahoma State University, Research Bulletin 3, p. 6–12. A limestone lying at the approximate horizon of the Upper Parsons or Coffeyville limestone of Kansas; basal member of Sapulpa group; overlies Tulsa group.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 66. Light bluish-gray, fairly pure, hard and massive limestone; main body of the formation near Lenapah, Oklahoma, is very fine-grained, but becomes nodular and shaly in southern Kansas; top part of formation is a fairly persistent, single massive ledge 2–7 ft (0.6–2.1 m) thick that appears strongly mottled or brecciated and contains rather common algal remains; about 20 ft (6 m) thick at the type locality, thins to 7 ft (2.1 m) or less near Coffeyville, Kansas; conformably overlies Nowata shale; underlies Memorial shale.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, part 11, p. 300, 336–340. Subdivided into: Idenbro Limestone Member, Perry Farm Shale Member, Norfleet Limestone Member. Thickness at type exposure about 22 ft (6.6 m). Marmaton Group, Desmoinesian Series.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. v (fig. 1), 9. In western Missouri, formation comprises (ascending) Norfleet Limestone, Perry Farm Shale, and Sni Mills Limestone members. Overlies Nowata Formation; underlies Memorial Shale.

M. C. Oakes, 1952, Oklahoma Geological Survey, Bulletin 69, p. 36–41, pl. 1. Described in Tulsa County. Thickness a few feet to as much as 20 ft (6 m).

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 30 (fig. 5). Formation represented in Iowa by Cooper Limestone (Sni Mills of Missouri). Characteristically white to light gray; has brecciated appearance with dense limestone fragments in light grayish-green argillaceous matrix. Overlies Nowata Formation; underlies Pleasanton Group.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D.E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 26. Formation locally thin or absent as a result of pre-Missourian erosion; lower two members locally absent. Thickness 1–18 ft (0.3–5.4 m). Overlies Nowata Shale; underlies Holdenville Shale.

P. H. Heckel, 1991, Kansas Geological Survey, Geology Series 4, P. . Lenapah Limestone, comprising Norfleet Limestone Member, Perry Farm Shale Member, and Idenbro Limestone Member, all named from southeastern Kansas, is not equivalent to Sni Mills Limestone of Missouri or Cooper Creek Limestone of Iowa. Overlain by Memorial Shale and middle Perry Farm Shale Member grades laterally into lower part of Memorial Shale where upper Idenbro Limestone Member is absent.

Type section: In quarry in NW NE sec. 30, T. 28 N., R. 16 E., Nowata County, Oklahoma, at Bell Spur north of Lenapah.

Leon Gravel

Late Miocene–Early Pleistocene Series: Butler and Cowley counties, Kansas.

J. S. Aber, 1992, Kansas Academy of Science, Transactions, p. 109–115, 117–120. Name given to chert gravel deposits that are abundant on high terraces and hill tops in southern

Leonardville kimberlite
Leonardville intrusion
Cretaceous: Riley County, Kansas.
K. L. Cook, 1955, Mining Engineering, v. 7, p. 481–486. Northwest-trending vertical or steeply dipping dike that is more than 1,700 ft (515 m) long and locally 500 ft (151 m) wide; shallow saddle separates the narrow southeastern part from the wide, shallow, bifurcating northwestern part (based on magnetic survey).
F. E. Byrne, K. L. Parish, and C. F. Crumpton, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, p. 377–387. Cite Milton (1953, written communication) that rock is similar to Stockdale intrusion.
R. L. Cullers and J. Mullenax, 1981, Geological Society of America, Abstracts with Programs, v. 13, no. 6, p. 275. Leonardville kimberlite petrogenesis described; intrusion is a kimberlite pipe.
Name derived from Leonardville, Riley County, Kansas. Informal usage in Kansas to describe this particular exposure in SE NW sec. 22, T. 8 S., R. 5 E., about 1 mi (1.6 km) south of Leonardville.

Le Roy shale
Pennsylvanian: eastern Kansas.
E. Haworth and M. Z. Kirk, 1894, Kansas University Quarterly, v. 2, p. 110. Shale and sandstone, 150 ft (45 m) thick, underlying Burlington or Garnett limestone and overlying Carlyle limestone in section along Neosho River from Indian Territory to White City, Kansas.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 139, 140, 146, 152. Synonymized with Weston shale, Iatan limestone, Stranger formation, and Haskell limestone.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,172. In broad sense in which name was used, it represents all of Douglas group as originally defined except Oread limestone; in restricted sense it is same as Weston shale.
Named for exposures in vicinity of LeRoy, Coffey County, Kansas.

Lexington coal bed (in Labette Shale, Marmaton Group)
Pennsylvanian (Desmoinesian Series): southeastern Kansas, western and northern Missouri. The coal bed is near the top of the Labette Shale.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 61. Lexington coal is equivalent to Mystic Coal of Iowa.
R. E. Whitla, 1940, Kansas Geological Survey, Bulletin 32, p. 16–17. Describes the Lexington coal in Kansas as being near the top of the Labette Shale, and being 1 to 2 inches (2.5–5 cm) thick.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 2. Described in the Labette Shale description as the Lexington coal present near the top of the Labette in places.
Named from a coal outcrop near Lexington, Missouri.

Liberty Memorial Shale (of Kansas City Group)
Liberty Memorial Shale (of Lansing Group)
Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.
J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1, p. 24. Shows Lane shale in Lansing Group. Originally suggested shale above Raytown Limestone Member of the Iola limestone to base of Frisbie limestone member of Wyandotte Limestone be named Liberty Memorial Shale from locality in Kansas City, Missouri, presumably after monument of the name in Penn Valley Park (SW sec. 8, T. 49 N., R. 33 W.). Ranges from 7 to 61 ft (2–18.3 m) of shale in Missouri with channel sandstone in southwestern Jackson County.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,031 (fig. 4), 2,032–2,033; 1949, Kansas Geological Survey, Bulletin 83, p. 103. Settlement of "Iola problem" has led to number of changes in Missouri Survey's classification of middle and upper Kansas City beds so as to bring interstate agreement in nomenclature. Liberty Memorial shale, overlying Raytown Limestone, no longer considered as uppermost member of Chanute Shale. Name suppressed as junior synonym of Lane Shale.
F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 13–14. Revision of classification of Kansas City Group. Liberty Memorial Shale is changed to Lane Shale. Lane Shale is removed from Lansing Group and placed in Kansas City Group between Iola Limestone and Wyandotte Limestone.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 15. Revive name of Liberty Memorial Shale originally proposed by Clair (1943). Overlies Iola Limestone and underlies Wyandotte Limestone. Type Lane Shale as defined by Moore (1948) is not shale between Iola and Wyandotte Limestones, but above Wyandotte Limestone. Lane Shale of Kansas City area is below Wyandotte Limestone. Principal reference section for Liberty Memorial Shale in Kansas is along I–435 southbound offramp to Holliday Road (NW NE NW, sec. 6, T. 12 S., R. 24 E.) in northern Johnson County where it contains of 40 ft (12 m) of gray shale with thin bed of fossiliferous limestone in middle.
Named for exposures near the Liberty Memorial, Kansas City, Missouri.

Lightning Creek coal bed (in Cherokee Group)
Pennsylvanian (Desmoinsian Series).
A local name for either the Mineral or Bevier coal beds (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 62, 80). W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 70, lists the Lightning Creek coal bed as being equivalent to the Mineral coal. This is probably the most common coal called Lightning Creek.

Limestone coal (in Cherokee Group)
Pennsylvanian (Desmoinesian Series).
A local name for the Bevier coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 76; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 80).

Limestone of Batesville age
"Limestone facies of Batesville Sandstone"
Mississippian: southeastern Kansas.
W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 89, pl. 2. Non-cherty limestone; occurs only in extreme southeastern Kansas; unconformable above Warsaw limestone; 0–50 ft (0–15 m) thick.

published with Kansas Geological Survey, Bulletin 24 (1937). This coal name changed to Riverton coal bed in W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 62.

Little Cabin sandstone (of Cherokee Group)
A sandstone in the lower part of the Cherokee Group recognized by W. G. Pierce and W. H. Courtier (1937, Kansas Geological Survey, Bulletin 24, p. 22–25). This is now considered as the Warner Sandstone Member.
Named for exposures along Little Cabin Creek near Vinita, in Craig County, Oklahoma.

Little Kaw Limestone Member (of South Bend Limestone)
Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, southeast Nebraska.
R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Stratigraphic sections of Pennsylvanian and "Permian" rocks of Kansas River valley: Kansas Geological Survey; R. C. Moore, 1935, Rock formations of Kansas in Kansas Geological Society: Wichita, Kansas; N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, pt. 1, p. 76–79. Bluish-gray blocky limestone, 2± ft (0.6± m) thick (maximum thickness 8 ft [2.4 m]), forming top member of Stanton limestone in Johnson and Miami counties. Underlies Weston shale and overlies Victory Junction shale member of the Stanton limestone.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 45, 136, 137. Topmost member of Stanton limestone; overlies Victory Junction shale member of Stanton limestone; underlies conformably the Weston shale. One or two beds of dark-gray, fine-grained limestone; lower part is sandy and in places there is a thin bed of buff sandstone and some sandy shale between the limestone beds; fossils are most abundant where the member is least sandy; thickness in northeastern Kansas is rather constantly about 4–5 ft (1.2–1.5 m). Typical road-cut exposures just west of Victory Junction, and at Camp Naish, east of Bonner Springs, Kansas; quarry 1/4-mi (0.4 km) west of the southeastern corner sec. 26, T. 10 S., R. 23 E.; section west of road, south edge of sec. 8, T. 11 S., R. 23 E. A limestone that is possibly equivalent to the Little Kaw member of the Stanton as here described occurs in the Platte Valley section of southeastern Nebraska. This has been called the South Bend limestone and is now classed by Condra as the uppermost member of the Stanton. If the Stanton is correctly identified in Nebraska and if the South Bend corresponds to the Little Kaw, the name South Bend has priority but this is not satisfactorily established.
Named for Little Kaw Creek, north of Loring, Leavenworth County, Kansas.

Little Osage Shale Member (of Fort Scott Limestone)
Little Osage Member (of Fort Scott Formation)
Pennsylvanian (Desmoinesian Series): eastern Kansas, western Missouri, southwestern Iowa, and northeastern Oklahoma.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, pt. 11, p. 306–309, pl. 1. Name applied to shale, coal bed, and limestone bed that lie between Blackjack Creek Limestone Member below and Higginsville Limestone Member above. Thickness in Kansas about 5–11 ft (1.5–3.3 m). Includes Houx Limestone bed near top.
F. C. Greene and W. B. Howe, 1952, Missouri Geological Survey and Water Resources, Information Circular 8, p. 19. Columnar section shows the Little Osage.
M. C. Oakes, 1952, Oklahoma Geological Survey, Bulletin 69, p. 22, 24 (fig. 2). Geographically extended into northeastern Oklahoma.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 1–2. Includes phosphatic black shale bed at top and Summit Coal bed (named from Missouri) above and Morgan School shale bed (named from Iowa) at base.
Type section: In northeast part of SE sec. 2, T. 24 S., R. 25 E., Bourbon County, Kansas, on south valley wall of Little Osage River, now destroyed by strip mining.
Reference sections: US-59 roadcut SE SW NE sec. 21, T. 33 S., R. 21 E., just south of Oswego; US-156 roadcut SE SW SW sec. 30, T. 39 S., R. 21 E., 3 mi (4.8 km) east of Bartlett, Labette County.

Long Creek Limestone Member (of Foraker Limestone)
Long Creek Limestone
Pennsylvanian (Virgilian Series): south-central and northeastern Kansas, southeastern Nebraska, and northern Oklahoma.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 84, 85, 88. *Long Creek limestone*—Named for exposures on Longs Creek, at foot of bluff west of cemetery at Auburn, Nemaha County, Nebraska. Usually weathers buff to yellowish, somewhat cavernous and irregular. Thickness 3 1/4–5 ft (1–1.5 m) in Nebraska and 3–6 ft (0.9–1.8 m) in northeast Kansas. Underlies Johnson shale and overlies Hughes Creek shale, all in Elmdale shale member.
G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 8, extended Foraker limestone into Nebraska and divided it into (descending): Long Creek limestone, 3–6 ft (0.9–1.8 m); Hughes Creek shale, 36–38 ft (11–1.5 m); and Americus limestone, 2–3 ft (0.6–0.8 m).
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 50. Transferred this unit to Permian.
R. C. Moore, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 103. Limestone member of Foraker limestone. Identifiable in southern Kansas and northern Oklahoma.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 168. Alternating beds of limestone and shale, or thin-bedded limestone, locally containing abundant fusulinids in northern outcrop belt; thickness is 5–8 ft (1.5–2.4 m); average 7 ft (2.1 m).
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 48. Alternating beds of yellow limestone and shale, or thin-bedded limestone, locally containing abundance of fusulines in northern part of outcrop area; in southern Kansas, light-gray limestone, more or less massive in upper and lower parts and sparsely fossiliferous. Thickness 5–8 ft (1.5–2.4 m). Overlies Hughes Creek shale member; underlies Johnson shale.
P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 83–85, pls. 1, 2, 3, 4. Persists as far south as T. 16 N., in southern Lincoln County. In northern Osage County, consists of shaly limestone and shale and minor amounts of chert. Ranges in thickness from 9.8 to 12 ft (3–3.6 m). In Pawnee County, consists of interbedded dense gray limestone and gray marly shale; no chert. Thickness as

Louisville limestone

Pennsylvanian: southeastern Nebraska and eastern Kansas.

G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science, Publication, v. 9, no. 2, p. 7, 23. Member of Braddyville formation; main ledge in upper Atwood quarry in Cedar Creek valley and in north side of Platte Valley from State fish hatcheries to Meadow; is main quarry ledge in abandoned Murphy and Green quarries west of Meadow; thickness 10–12 ft(3–3.6 m); upper part thin bedded, but mostly massive, hard, and compact; blue-gray, weathers light; 6–10 ft (1.8–3 m) below South Bend limestone and higher than Meadow limestone.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 11, 27. Louisville limestone is preoccupied, hence Stoner limestone is proposed for this unit, to include also Kiewitz shale and so-called Du Bois limestone; parts of the Stanton limestone member.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 134. Olathe limestone member of Stanton limestone includes Louisville limestone, Kiewitz shale, and "Du Bois limestone" of Nebraska.

Exposed at base of slope west of South Bend, Nebraska, and in the upper slopes eastward to Louisville, Nebraska.

Loup Fork beds

Loup Fork formation

Loup Fork group

Loupfork formation

Miocene, Pliocene, and Pleistocene (?): eastern Colorado, Nebraska, South Dakota, western Kansas, and other western states.

F. B. Meek and F. V. Hayden, 1862, Philadelphia Academy of Natural Sciences, Proceedings, v. 13, p. 415–435. Loup River beds are fine loose sand, with some layers of limestone; thickness 300–400 ft (90–121 m); all freshwater fossils; Pliocene; extends from Loup Fork of Platte River north to Niobrara River and south to unknown distance beyond the Platte; overlies White River group (Miocene).

E. D. Cope, 1888, American Geologist, v. 2, p. 290–292. Loupfork formation (upper Miocene) overlies Whiteriver beds in Nebraska, Wyoming, and Colorado, and extends into Kansas, where it rests on Cretacic; present in Wyoming, Texas, New Mexico, and Mexico; is same as Niobrara of Marsh.

N. H. Darton, 1899, Loup Fork beds of Nebraska divided into Ogallala formation (above) and Arikaree formation (below).

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,223. Loup River beds applied by some geologists to deposits called "Loup Fork beds" by other geologists.

A. L. Lugn, 1939, Geological Society of America, Bulletin, v. 50, p. 1,269–1,270. Loup River is original name and Loup Fork was its synonym for many years; both names abandoned.

Named for occurrences along Loup River, Nebraska.

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Named for occurrences along Loup River, Nebraska.

Loveland Formation

Loveland clay

Loveland loess

Loveland silt member (of Sanborn Formation)

Pleistocene Series (Illinoian Stage): Kansas, Nebraska, South Dakota, Iowa, Illinois, Kentucky, Tennessee, and Mississippi.

B. Shimek, 1909, Geological Society of America, Bulletin, v. 20, p. 405; 1910, Science, new series, v. 31, p. 75. Loveland joint clay is a bed of reddish clay, which frequently shows stratification and often contains sand and pebbles in lower part; thickness 0–30+ ft (0–9+ m); rests on Aftonian sands and underlies fossiliferous post-Kansan bluish-gray loess; evidently bears same relation to Kansan drift as Buchanan gravels, and probably belong to period of melting of Kansan ice.

A. L. Lugn, 1934, Nebraska State Museum, v. 1, Bulletin 41, p. 326, 347–349. Lower or "valley phase" consists of sand, gravel, and clay filling pre-Loveland valleys, and may be of Illinoian age. This "valley phase" seems to everywhere grade upward into the loess or "upland phase," which grows less and less sandy until it is quite typical loess clay and silt; volcanic ash or pumicite occurs at base of loess phase quite generally in Nebraska. Generally 5–8 ft (1.5–2.4 m) thick; ranges up to 150 ft (45 m) thick; thickens and coarsens westward, covering about 42,000 mi^2 (70,000 km^2) in Nebraska. Sangamonian; rests unconformably on Upland formation; underlies Sand Hills formation in part of area. Peorian loess in part of area.

J. C. Frye and O. S. Fent, 1947, Kansas Geological Survey, Bulletin 70, pt. 3, p. 42–45. Traced southward from Nebraska into central Kansas; referred to as Loveland silt member of Sanborn formation; includes eolian silts of the uplands and stratigraphically continuous colluvial silts on some slopes and fluvial-eolian silts of lower levels; thickness 5–80 ft (1.5–24 m); underlies Peoria silt member.

G. E. Condra, E. C. Reed, and E. D. Gordon, 1947, Nebraska Geological Survey, Bulletin 15, p. 25, 26. Overlies Crete formation; thickness 8.5 ft (2.6 m) at type section of Crete; underlies Peorian formation.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 12, 14, 16. Massive silt and sandy silt, reddish-tan; in part eolian. Thick, prominent, buried Sangamon soil, formed in pre-Peoria (Sangamonian) time, occurs at the top of the Loveland silt; Illinoian and early Sangamonian in age; thickness commonly 20 ft (6 m), as much as 50 ft (15 m); overlies Crete sand and gravel member of Sanborn formation; Sangamon soil occurs at top of Loveland and beneath Peoria silt member of Sanborn formation.

C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55. Included in Sanborn group; overlies Crete formation; underlies Peoria formation.

M

"M bed"
Mississippian.
G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. One of the most important ore beds of the Picher–Miami [Tri-state mining district] area; where metamorphosed, definite nodules 4–12 inches (10–30 cm) in diameter occur throughout entire thickness of bed; often large nodules (6–12 inches [15–30 cm] thick; 2–5 ft [0.6–1.5 m] diameter) are found at bottom of bed; the bottom 12 ft (3.6 m) is the most productive horizon; 19–22 ft (5.8–6.6 m) thick; overlain by "L bed," underlain by "N bed." Considered to be part of the Boone formation in the area.
C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 12, 15. The Burlington–Keokuk succession can be subdivided into four distinct lithologic units below the Short Creek oolite in the Joplin district; from youngest to oldest these units are designated: the calcarenite bed, the marble bed, the cherty bed, and the N-bed. M bed of Fowler and Lyden (1932) composed of Short Creek oolite member, calcarenite bed, marble bed, and cherty bed.
Semi-formal mining terminology; not formally recognized by Kansas Geological Survey.

Manhattan beds
Permian: northern Kansas.
R. Kay, 1893, Kansas State Board of Agriculture, 8th Bicentennial Report, p. 101. *Manhattan beds*—Series of beds, not worked out in detail, but containing limestone and buffy, limy shales, also the gypsum beds of Marshall County and Pottawatomie. Overlain by Fort Riley beds and underlain by upper coal measures. Assigned to Permo–Carboniferous.
Named for Manhattan, Riley County.

Manhattan limestone
Permian: northern Kansas.
C. S. Prosser, 1894, Geological Society of America, Bulletin, v. 6, p. 37, 40–41. *Manhattan limestone*—Light yellowish-gray massive limestone, 5 ft (1.5 m) thick, containing much chert and in upper part great numbers of *Fusulina cylindrica*. Basal member of Cottonwood formation at Manhattan and vicinity. Overlain by Cottonwood shales and underlain by 31–36 ft (9–11 m) of shales and marls with thin limestone layer. Equivalent to Cottonwood limestone and Alma limestone.
Named for Manhattan, Riley County.

Maple Hill Limestone Member (of Zeandale Limestone)
Maple Hill Limestone (of Wabaunsee Group)
Pennsylvanian (Virgilian Series): eastern Kansas, western Missouri, and southeastern Nebraska.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 80. *Maple Hill limestone*—Bluish-gray, somewhat arenaceous irregular limestone, 2–4 ft (0.6–1.4 m) thick. Forms a small fall in Maple Creek about 2 mi (3.2 km) southwest of Maple Hill, Kansas. Is well shown under Pony Creek bridge south of Falls City and at other places in Nebraska, thinning to northeast. Overlies Pierson Point shale and underlies Table Creek shale, all included in McKissick Grove shale member of Wabaunsee formation.
G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 10. *Maple Hill limestone* underlies Table Creek shale and overlies Pierson Point shale.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 233–234. Discarded McKissick Grove shale and treated its subdivisions as formations in Wabaunsee group.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,290. The shale overlying Maple Hill limestone was, in August to September 3, 1932, chart of R. C. Moore, named *Frenck shale*, and *Table Creek shale* was restricted to upper part of the original Table Creek. In October 1932 chart, however, Moore and Condra transposed these names, and described the shale resting on Maple Hill limestone as *Table Creek shale* [restricted].
G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 42, 43, 44. Underlies Langdon formation and overlies Wamego shale (both new).
R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 189–190. The Maple Hill limestone consists in most places of a single bed of bluish-gray, somewhat sandy limestone, 1–4 ft (0.3–1.2 m) thick; extends from Emporia northward into Nebraska.
F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. vii, 21. Generalized section shows Maple Hill limestone present in Missouri. Overlies Wamego shale and underlies Langdon shale. This is classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, and Nebraska, May 1947.
R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,276. Rank reduced to member status in Zeandale formation (new). Overlies Wamego shale member; underlies Pillsbury shale (new), which name replaces Langdon shale.
M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 6. Notes that the middle limestone bed of Moore's three-limestone-bed Dover limestone in southern Kansas correlates with the Maple Hill limestone in northern Kansas [see additional discussion under Dover Limestone Member].
Type locality: Maple Creek, about 2 mi (3.2 km) southwest of Maple Hill, Wabaunsee County, Kansas.

Maquoketa Shale
Maquoketa Formation
Maquoketa Group
Upper Ordovician: eastern Iowa, western Illinois, eastern Kansas, southern Minnesota, eastern Missouri, and southwestern Wisconsin.
C. A. White, 1870, Iowa Geological Survey, v. 1, p. 180–182. Bluish and brownish shales, 80 ft (24 m) thick, forming top formation of Lower Ordovician in Iowa; equivalent to Hudson River shales of Hall; overlain by Niagara limestone; underlain by Galena limestone.
S. Calvin, 1906, Iowa Geological Survey, v. 16, p. 60. Overlies Galena Limestone; underlies beds belonging to Wapsipinicon Stage of Devonian.
E. O. Ulrich, 1915, Missouri Bureau of Geology and Mines, v. 15, p. 234–239. Sylvan and Maquoketa Shales are correlative according to similar lithologic character and stratigraphic position.
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of

"Marble bed"
Mississippian.
C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 12, 15. The Burlington–Keokuk succession can be subdivided into four distinct lithologic units below the Short Creek oolite in the Joplin district; from youngest to oldest these units are designated: the calcarenite bed, the marble bed, the cherty bed, and the N-bed. Marble bed is 20–30 ft (6–9 m) thick, composed of limestone, coarse-grained, thick, massive beds, relatively chert free; middle part of "M bed" of Fowler and Lyden (1932).

Marion concretionary limestone (in Chase formation)
Permian: central Kansas.
C. S. Prosser, 1895, Journal of Geology, v. 3, p. 772, 773, 780, 783, 797. Massive limestone, 10 ft (3 m) thick, containing large flint concretions that weather brown and contain *Productus* and a few other fossils; composed of two beds of limestone separated by thin shale; top member of Chase formation.
C. S. Prosser, 1897, Kansas University Geological Survey, v. 2. Top member of Chase formation has been called "Marion concretionary limestone," but is here replaced by Winfield concretionary limestone.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,301. Is upper bed of Winfield limestone of Prosser (1902, Journal of Geology, v. 10, p. 715) and other geologists; appears to be Cresswell limestone of Condra and Upp (1931, Nebraska Geological Survey Bulletin 6, 2nd series, p. 51).
Named for Marion, Marion County, Kansas.

Marion flint (in Chase formation)
Permian: central Kansas
C. S. Prosser, 1895, Journal of Geology, v. 3, p. 773, 779–786, 797. Light-gray limestone, generally containing flint, 4 ft (1.2 m) thick; near top of Chase formation; separated from overlying Marion concretionary limestone by 13 ft (3.6 m) of yellowish shales.
M G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,301. This bed was later included in the Winfield formation. It appears to be Stovall limestone of Condra and Upp (1931), which they treated as the basal bed of the Winfield limestone.
Named for Marion, Marion County, Kansas.

Marion formation (of Sumner group)
Marion stage
Permian: eastern Kansas, north-central Oklahoma, and southeastern Nebraska.
C. S. Prosser, 1895, Journal of Geology, v. 3, p. 786–789. Vari-colored shales and marls with limestones and gypsum, 400 ft (121 m) thick, overlying Chase formation and underlying Dakota sandstone (Cretaceous).
F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 1–48. Sumner division of Big Blue series divided into Wellington shales (above) and Geuda salt measures (below); Prosser's (1895) term Marion formation is equivalent to Geuda salt measures plus lower part of Wellington; rests on Chase limestones.
C. S. Prosser, 1897, Kansas University Geological Survey, v. 2. In general agreement with Cragin (1896); Marion formation restricted to lower part of Marion formation as originally defined, and upper part is here called Wellington formation; the Marion as here defined consists of thin buff limestones, shales, and marls,with beds of gypsum and salt, and is Geuda salt measures of Cragin.
L. C. Wooster, 1905, The Carboniferous rock system of eastern Kansas. Top of Marion formation is Abilene conglomerate (excludes Geuda salt measures of Cragin).
J. W. Beede, 1909, Kansas Academy of Science, Transactions, v. 22, p. 248–256. Marion stage limited to following formations (top to bottom): Abilene conglomerate (?), correlation not positive; Pearl shales, 70 ft (21 m); Herington limestone; Enterprise shale, 44 ft (13.3 m); Luta limestone, 0–30 ft (0–9 m). Overlies Winfield limestone.
R. C. Moore and W. P. Haynes, 1917, Kansas Geological Survey, Bulletin 3. Marion formation, 150± ft (45± m) thick, divided into (top to bottom): Abilene conglomerate member, Pearl shale member, Herington limestone member, Enterprise shale member, and Luta limestone member.
R. C. Moore, 1920, Kansas Geological Survey, Bulletin 6, pt. 2, p. 63. It appears that the so-called Abilene conglomerate, which has previously been referred to uppermost part of Marion formation, is in reality a Tertiary deposit. It contains fragments of rock with apparently belong to Dakota sandstone, and at no point has it been observed in a stratigraphic position beneath Wellington shale.
N. W. Bass, 1929, Kansas Geological Survey, Bulletin 12. Marion formation abandoned; Wellington formation redefined to include all beds below "Red Beds" and above Herington limestone.
R. C. Moore, 1936, Journal of Geology, v. 44, no. 1; Kansas Geological Society, 10th Annual Field Conference Guidebook, p. 12. Marion limestone not used; beds extending from top of Herington limestone to top of Luta limestone divided into two formations, Nolans limestone above and Odell shale below.
Named for exposures in Marion County, Kansas.

Marlow Sandstone Member (of Whitehorse Formation)
Marlow Formation (of Whitehorse Group)
Permian (Guadalupian Series): southwestern and central Oklahoma, and southern Kansas.
R. W. Sawyer, 1924, American Association of Petroleum Geologists, Bulletin, v. 8, p. 312–320, map. Brick-red shales and even-bedded sandstones with bands of fine white sand and sandy gypsums; at top is a thin layer of almost pure gypsum 1± ft (0.3± m) thick; thickness 120± ft (36± m); underlies Whitehorse sandstone as here defined, but thought to have been part of Whitehorse sandstone as originally defined; overlies Dog Creek shale to west and Duncan sandstone to east.
C. N. Gould, 1924, American Association of Petroleum Geologists, Bulletin, v. 8, p. 324–341. Marlow formation includes Dog Creek shale and Blaine gypsum.
G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,815. In Kansas, Whitehorse Sandstone is divided into four members: Marlow, Relay Creek Dolomite, an even-bedded sandstone member, and an upper shale member, the latter two representing the Rush Springs–Cloud Chief Member of Oklahoma. Thickness 110 ft (33 m). Overlies Dog Creek Shale.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 36, 38. Red beds of sandstone, fine-grained, locally shaly or silty, crossbedded; "sand balls" locally prominent; thickness

Shale (including Summit Coal), Stephen Forest Formation (including Little Osage Shale, Houx Limestone, unnamed shale, and Higginsville Limestone), Labette Formation including Mystic Coal, Pawnee Formation, Bandera Shale, Altamont Formation, Nowata Shale, Lenapah Formation, unnamed shale formation, "Lost Branch" Formation (Sni Mills Limestone, unnamed shale, and Cooper Creek Limestone members).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34 , p. 1. Revisions include: Holdenville Shale raised to Subgroup (including Altamont Limestone, Nowata Shale, Lenapah Limestone, Memorial Shale, and Lost Branch Formation), Lost Branch Formation added as uppermost formation in Marmaton, Memorial Shale (formation) is reinstated (overlying Lenapah Limestone and underlying Lost Branch Formation), and base of Fort Scott Limestone and Marmaton Group extended downward to include Excello Shale. Revised Marmaton Group includes: Lost Branch Formation, Memorial Shale, Lenapah Limestone, Nowata Shale, Altamont Limestone, Bandera Shale, Pawnee Limestone, Labette Shale, Fort Scott Limestone.

Named for exposures on Marmaton River, Bourbon County, Kansas, and Vernon County, Missouri.

Marquette member (of Belvidere Formation)

Marquette sandstone member (of Belvidere Formation)

Cretaceous (Lower): central Kansas.

W. H. Twenhofel, 1924, Kansas Geological Survey, Bulletin 9, p. 31, 32. Zones 5–10 of Natural Corral section, consisting of (from top to bottom): cross-laminated medium-grained friable yellow sandstone, 2 ft (0.6 m); friable fine-grained yellowish sandstone with a somewhat compact 6-inch (15–cm) band near middle and a similar 2-inch (5-cm) band about 7 ft (2.1 m) below top, 17 ft (5 m); compact yellowish-white sandstone, 7–8 ft (2.1–2.4 m); blue paper shale, 10 ft (3 m); pale-yellow sandstone, 2 ft (0.6 m); blue gypsiferous shale, 14 ft (4.2 m). Overlies Windom member; underlies Mentor member.

R. C. Moore, 1935, Rock formations of Kansas; *in,* Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Marquette sandstone member is middle member of Belvidere formation; overlies Kiowa shale member; underlies Mentor sandstone member.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 153. Dakota formation defined to include stratigraphic units formerly called Rocktown channel sandstone, Ellsworth formation, Solomon formation, Reeder sandstone, Marquette sandstone, Spring Creek clay, and others.

Apparently named for Marquette, McPherson County, Kansas.

Marslandian Age

Miocene (Lower): western North America.

R. W. Wilson, 1960, University of Kansas, Paleontological Contributions, Vertebrata, Article 7, p. 5–19. Age proposed for correlation of some North American and European fossil faunas; overlies Harrisonian; underlies Sheepcreekian; name credited to Schultz and Stout, Stout, from various sources.

C. B. Schultz and T. M. Stout, 1961, Nebraska University State Museum, Special Publication 2, p. 8. Shown on correlation chart for Miocene and Pliocene of central Great Plains; placed in lower half of Heringfordian between Sheepcreekian above and Arikareean below.

M. C. McKenna, 1965, American Museum Novitates, no. 2228, 21 p. Rejected terms of Wilson (1960).

Named for the Marsland Formation, southwest of Marsland, along the Niobrara River, Box Butte County, Nebraska.

"Maryville rock"

Pennsylvanian: eastern Kansas

G. C. Broadhead, 1886, St. Louis Academy of Science, Transactions, v. 4, p. 489. Magnesian limestone quarried at Maryville, Kansas.

Mascallian Age

Miocene: western North America.

R. W. Wilson, 1960, University of Kansas, Paleontological Contributions, Vertebrata, Article 7, p. 16. Shown on chart in upper part of the Heringfordian above Sheepcreekian and below Barstovian.

M. C. McKenna, 1965, American Museum Novitates, no. 2228, 21 p. Rejected terms of Wilson (1960).

Matfield Shale (of Chase Group)

Permian (Wolfcampian Series): eastern Kansas, southeastern Nebraska, and northern Oklahoma.

C. S. Prosser, 1902, Journal of Geology, v. 10, p. 714. Variously colored shales, with some shaly, buff, occasionally cherty limestones and a light-gray limestone, 2 ft (0.6 m) or more thick, about 30 ft (9 m) below the top; thickness 60–70 ft (18–27 m); underlies Florence flint; overlies Wreford limestone; included in Chase stage.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 36. Includes: Blue Springs Shale Member, Kinney Limestone Member, Wymore Shale Member.

R. C. Moore, 1935, Rock formations of Kansas; *in,* Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Matfield shale abandoned; members of Condra and Upp (1931) used at formation level.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, part 4, p. 164–165. Thickness 60–90 ft (18–27 m). Underlies Barneston Limestone; overlies Wreford Limestone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 42, 45, 50. Two units of varicolored shale separated by a limestone member; thickness about 50–80 ft (15–24 m).

Named for development in Matfield Township, Chase County, Kansas.

McKissick shale

W. A. VerWiebe and W. R. Vickery, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 110. Used McKissick shale formation for beds below Brownville limestone and above Tarkio limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 232–243. Same as McKissick Grove shale; used by Condra, Moore, and Dunbar (1932), but never accepted by Moore, who discarded the name and divided the strata into 11 separate formations.

(1940). Generally, formation consists of early Pleistocene stream deposits, later and coarser Pleistocene stream channel deposits, and still later Pleistocene silt, clay, and fine sand. Locally, conglomeratic bed 1–6 ft (0.3–1.8 m) thick occurs at base of formation; conglomerate similar to so-called Abilene conglomerate; volcanic ash present locally; overlies Delmore formation.

J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 94, 110. Included at least in part as Sanborn formation; Meade formation in [McPherson] Valley was formerly included within broadly inclusive McPherson formation.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 66. The "McPherson Formation" in McPherson, Harvey, and Sedgwick counties and the "Belleville Formation" in Republic County are in part equivalent to the Grand Island [Formation], and the "Abilene conglomerate" in Dickinson and Clay counties may be of this age.

Named for exposures in McPherson County, Kansas.

Meade group

Meade formation

Meade gravel

Pleistocene: southwestern Kansas and northern Oklahoma.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 52. Highly fossiliferous gravels and sands, mostly unconsolidated, 10–40 ft (3–12 m) thick, laid down in deep and broad valleys; overlain by Pearlette ash, into which they frequently grade; supposed to be late Pliocene and belong to Tule division of Cummins (1893, Texas Geological Survey, 4th Annual Report, pt. 1, p. 199, 200, 203). Named for Meade Center, Meade County, Kansas.

H. T. U. Smith, 1940, Kansas Geological Survey, Bulletin 34, p. 108. Meade gravels of Cragin (1896) should be abandoned unless future work leads to an adequate understanding of nature of beds.

J. C. Frye and C. W. Hibbard, 1941, Kansas Geological Survey, Bulletin 38, p. 399, 411–419. Formation redefined to include Meade gravels of Cragin (1896) at base; Pearlette ash of Cragin (1896); Smith's (1940) Odee formation, *Equus niobrarensis* beds, Jones Ranch beds, and all other beds of Pleistocene age above Rexroad member of Ogallala formation and below Kingsdown silt; thickness 50–150 ft (15–45 m). Type locality designated.

T. G. McLaughlin, 1946, Kansas Geological Survey, Bulletin 61, p. 123–130. Jones Ranch beds removed from Meade formation and included in overlying Kingsdown silt.

J. C. Frye, A. Swineford, and A. B. Leonard, 1948, Journal of Geology, v. 56, p. 520–523. Proposed to restrict Meade formation to sediments at the type section of Frye and Hibbard (1941) and equivalent beds elsewhere, which means that this term should be used throughout Kansas to include the sediments of the Kansan cycle of fluvial sedimentation. Includes Grand Island member below and Sappa member (with Pearlette volcanic ash lentil) above.

C. W. Hibbard, 1949, Michigan University Museum of Paleontology, Contributions, v. 7, no. 4, p. 63–70. Redefined to include original deposits designated by Cragin (1896) as Meade gravels in vicinity of old Vanhem post office; formation also includes overlying silts and caliche exposed in section on tributary of Spring Creek, west of Crooked Creek. These upper beds (named Missler member of Meade formation) are not present near Vanhem post office, but occur below another gravel that is included with Pearlette ash in Crooked Creek formation. Type locality of Meade redesignated to conform with new definition of formation because type locality of Frye and Hibbard (1941) does not include Meade gravels as defined by Cragin (1896). Thickness 29 ft (9 m) at type locality.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 12, 14, 16. Gravel, sand, silt, clay, and volcanic ash; derived from continental and mountain glacial outwash and locally; occurs in terrace position along some valleys (particularly Smoky Hill), as filling in abandoned valleys (McPherson, Wilson, and others), as basin fillings, and above Kansas till; thickness commonly 50 ft (15 m).

J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 84–106. Discussion of usage of Meade formation in Kansas; type locality of Frye and Hibbard (1941) restudied; Meade is 62 ft 4 inches (19 m 10 cm) thick at type locality and includes Grand Island member below and Sappa member above; Sappa member includes Pearlette ash bed; overlies Ogallala formation; underlies Sanborn formation; Kansan stage of Pleistocene.

C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55, 56. Group in northern Kansas, includes all Pleistocene deposits above base of David City formation and below Crete formation; in Meade County, group includes all deposits above Rexroad formation and below Kingsdown formation; in southwestern Kansas, group comprises Ballard formation below and Crooked Creek formation above; elsewhere divided into two unnamed formations and underlies Crete formation of Sanborn group.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189. No mention of Meade formation [apparently dropped from usage by Kansas Geological Survey].

Type locality (Frye and Hibbard, 1941): SE NE NE sec. 21, T. 33 S., R. 28 W., Meade County, Kansas (as given in Frye and Leonard, 1952).

Type locality (Hibbard, 1949): Exposures along tributary of Spring Creek in SW sec. 6, and in sec. 7, T. 32 S., R. 28 W., Meade County, Kansas.

Meadow limestone

Pennsylvanian: eastern Kansas, southeastern Nebraska, and northwest Missouri.

G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science Publication, v. 9, no. 2, p. 7, 13, 22, 37. First distinct limestone member of Braddyville formation above Forbes limestone; has wide distribution in Nebraska and apparently in Kansas and Missouri; usually in one bed, but two beds in places; light-bluish-gray, massive, hard, semicrystalline; upper part weathers light-colored and basal part buff; occurs 6–10 ft (1.8–3 m) above Forbes limestone and 5–6 ft (1.5–1.8 m) below Union limestone; thickness 2 ft 7 inches to 4 ft (0.8–1.2 m). Crops out west of Meadow, Nebraska, and elsewhere.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 43, 51. Named the shale overlying the Meadow limestone the Iowa Point shale and the shale underlying it the Jones Point shale and assigned all three to Calhoun shale member.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 11, 12, 26, 28, 31, 47. Meadow limestone as originally defined should be extended to include a shale and

Medicine Lodge Gypsum Member (of Blaine Formation)
Medicine Lodge Gypsum (of Cimarron Group)
Permian (Leonardian Series): southern Kansas and western Oklahoma.
F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 3, 27–39. Persistent bed of massive gypsum, 12–30 ft (3.6–9 m) thick; usually of grayish white color, forming basal member of Cave Creek formation; separated from overlying Shimer gypsum member of Cave Creek formation by 7–10 ft (2–3 m) of Jenkins clay; overlies Flower-pot shales.
N. Evans, 1931, American Association of Petroleum Geologists, Bulletin, v. 15, p. 405. Nearly all geologists who have traced the Blaine think that the Medicine Lodge member of Blaine of Kansas is equivalent to the Ferguson member of the Oklahoma section; base of Medicine Lodge gypsum of Kansas can be correlated with base of Ferguson gypsum of Oklahoma.
D. A. Green, 1936, American Association of Petroleum Geologists, Bulletin, v. 20, p. 1,468. In Canadian County, Oklahoma, Medicine Lodge gypsum bed, 4–7 ft (1.2–2 m) thick, is separated from overlying Shimer gypsum bed by Alabaster gypsum bed (new). All in Blaine Formation.
G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,784, 1,795, 1,796. Underlies Nescatunga Gypsum Member.
A. J. Myers, 1959, Oklahoma Geological Survey, Bulletin 80, p. 24 (fig. 6), 28–29. Overlies Flowerpot Shale. Guadalupe Series.
H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 52. Thickest bed of gypsum in Kansas; forms conspicuous rim rock at top of Flower-pot Shale. Maximum thickness 30 ft (9 m) or more, average 20 ft (6 m). Cimarronian Stage (Leonardian).
Named for Medicine Lodge River and town of Medicine Lodge, Barber County, Kansas.

Megalonyx beds
Tertiary: western states.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,340. A paleontologic name applied by E. D. Cope to strata containing fossil remains of *Megalonyx*. According to H. F. Osborn (1909, U.S. Geological Survey, Bulletin 361, p. 82, 83, 87, 88), this genus occurs in strata ranging in age from middle Pliocene to middle Pleistocene.

Memorial Shale (of Marmaton Group)
Pennsylvanian (Desmoinesian Series): central Oklahoma, southeastern Kansas, and southwestern Missouri.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 67. Undetermined thickness of shale that overlies the Lenapah limestone and unconformably underlies the Missouri series; name credited to R. H. Dott, manuscript, 1936.
R. H. Dott, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, p. 1,591-1,597. Term Memorial Shale applied to strata above top of Lenapah (Eleventh Street) limestone and below base of Seminole Formation. Consists principally of silty shale and contains zones of sandstone and thin fossiliferous limestone. Named from Memorial Park Cemetery on southeast side of Tulsa. Type section along Eleventh Street east of Sheridan Road on east side of Tulsa.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 94, 95, 100. Gray and yellowish clay shale, generally unfossiliferous; in Labette County, Kansas, it comprises dark-gray shale that bears marine fossils and contains two or more coal beds; locally absent owing to pre-Missourian erosion; overlies Idenbro limestone member of Lenapah limestone; unconformably underlies Hepler sandstone; maximum known thickness is 30 ft (9 m).
M. C. Oakes, 1952, Oklahoma Geological Survey, Bulletin 69, p. 42–47, pl. 11. Memorial and Holdenville shales lie between same stratigraphic limits and are equivalent. Holdenville has priority and is commonly used term. In northern Oklahoma and in Kansas, unit occurs in thin ragged patches.
W. B. Howe, 1953, Missouri Geological Survey and Water Resources, Report of Investigations 9, p. 14–16. Term Memorial has been dropped. Uppermost formation of Marmaton Group. Lies between Lenapah Formation and base of Hepler Sandstone, basal Pleasanton, of Missouri Series. Term Memorial, formerly applied to post-Lenapah, pre-Pleasanton beds in Missouri, has been dropped. Use of name Holdenville follows recent work of Oklahoma Geological Survey. Formation in western Missouri is predominately gray shale. Thickness 0 to at least 15 ft (0–4.5 m).
J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shown on chart at top of Marmaton Group. Overlies Lenapah Limestone; underlies Hepler Sandstone.
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 27. Holdenville Shale (formerly Memorial Shale) is gray and yellowish-gray clay shale, generally unfossiliferous. In Labette County, it comprises dark-gray, fossiliferous shale and two coal beds. Overlies Lenapah Limestone; underlies Seminole Formation of Pleasanton Group. Locally absent due to pre-Missourian erosion; maximum thickness 30 ft (9 m).
P. H. Heckel, 1991, Kansas Geological Survey, Geology Series 4, 67 p. Underlies Lost Branch Formation.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 4. The unit overlies either the Idenbro Limestone Member or the Norfleet Limestone Member of the Lenapah Limestone, if the former is absent. The Memorial Shale underlies the Lost Branch Formation.
Type locality: Near Memorial Park Cemetery, along west line of SW sec. 36, T. 19 N., R. 13 E., and in SE sec. 35, T. 19 N., R. 13 E., in vicinity of Tulsa, Oklahoma.

Mentor beds
Mentor formation
Mentor marine sandstone
Mentor sandstone member (of Belvidere formation)
Cretaceous (Lower): central Kansas.
F. W. Cragin, 1895, American Geologist, v. 16, p. 162. Fossiliferous, variegated, earthy mixture, marine shales, with thin beds of brown sandstone; thickness 50–60 ft (15–18 m); formerly thought to belong to Dakota group, but now known to belong to upper part of Comanche series. Whether they overlie all of Kiowa shale, or only lower part of it, or whether they merge southward into upper part of Kiowa remains undetermined.

Limestone; glauconite in Meramecian rocks seemingly decreases upward.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations No. 70, p. 97–123. Presents synonymy and nomenclatural history for term "Meramecian." The best exposures today of the Meramecian Series are the roadcuts along I–270 immediately north of the junction of this highway with I–44.

C. G. Maples and J. A. Waters, 1987, Geology, v. 15, p. 647–650. Removed Ste. Genevieve Limestone from top of Meramecian Series and placed it in overlying Chesterian Series. [See Ste. Genevievian Limestone and St. Louis Limestone for further discussion of Meramecian–Chesterian boundary.]

T. W. Kammer, P. L. Brenckle, J. L. Carter, and W. I. Ausich, 1990, Palaios, v. 5, p. 414–431. Placed Meramec–Osage boundary between Baxter Springs Member of Boone Formation and Moccasin Bend Member of Boone Formation [=within Warsaw Formation] in Tri-state mining district (Missouri, Arkansas, Oklahoma, and Kansas).

Named for Meramec Highlands and Meramec River, west of St. Louis, Missouri.

Merriam Limestone Member (of Plattsburg Limestone)

Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, and southeastern Nebraska.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 46, 93, 97. Members of Plattsburg Limestone readily identified in many Kansas sections are, in upward order: Merriam Limestone, Hickory Creek Shale ("middle"), and Spring Hill Limestone ("upper"). Consists of 2–5 ft (0.6–1.5 m) of gray to buff massive limestone.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 18, 71–73. Basal member of Plattsburg Limestone, and perhaps most characteristic part of Plattsburg, is here termed Merriam Limestone Member. In many places consists of two divisions, the lower a blocky even layer, less commonly crossbedded limestone, drab to light-gray, generally weathering white, often highly fossiliferous, up to 5 ft (1.5 m) thick, locally absent. Upper division, generally 1 ft (0.3 m) thick, is fine-grained dense gray massive blocky limestone in one layer, seldom fossiliferous, but contains in upper part numerous irregularly disposed hollow tubes. Underlies Hickory Creek Shale Member. Named for Merriam, Johnson County.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22. Stated that Newell is author of this name.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 33–34. This is "Meadow" limestone named by Condra and Bengston (1915). Its type locality is in Kiewitz quarry west of Meadow Station, Sarpy County, Nebraska. Although member was properly defined with relation to its position and sequence in the section, its age correlation has proved to be in error; although name has been in use for more than 30 years, it is now dropped, and name Merriam accepted by Nebraska Survey.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 81. Basal member of Plattsburg. Underlies Hickory Creek Shale Member; overlies Bonner Springs Shale.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 32, and pl. 1. In central and northern outcrops in eastern Kansas, the Merriam consists of a light-gray to yellowish-gray limestone bed characterized by mollusks, *Composita*, and abundant Osagia and oolites in the upper part. This bed is overlain by a fine-grained gray limestone containing fusulinids, brachiopods, and crinoids. Merriam commonly is 1–3 ft thick except locally where the oolitic or Osagia-bearing limestone expands the thickness to as much as 11 ft (3.3 m). In southern outcrops the Merriam is a single thin fossiliferous limestone generally having a thickness of 1 ft (0.3 m) or less.

Named for exposures in town of Merriam, Johnson County, Kansas.

Middleburg Limestone Member (of Bader Limestone)

Middleburg Limestone (of Council Grove Group)

Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 20, 25. *Middleburg limestone*—Name for middle part of Easly Creek shale of Condra, 1927. Thickness between 4 and 9 ft (1.2–2.7 m), increasing southward to vicinity of Hooser and Dexter, Kansas. Type locality consists of (descending): 1) Gray limestone, massive, granular, dense, weathers buff-gray, 1 ft 4 inches (40 cm); 2) limestone, variegated light- to dark-gray, massive, tough, with many small dark-colored high-spired gastropods, 1 ft 6 inches (45 cm); 3) olive shale, 6 ft to 1 ft (1.8–0.3 m); 4) limestone, dark-gray, blocky, dense, 2 inches to 3 inches (5–7.5 cm). Underlies Easly Creek shale and overlies Hooser shale.

R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Pennsylvanian and "Permian" rocks of Kansas, composite section along Kansas River and in west-central Missouri: Kansas Geological Survey, Open-file Report 34-3, 1 sheet

R. C. Moore, 1935, Rock formations of Kansas; *in,* Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23].

G. E. Condra, 1935, Nebraska Geological Survey, Paper 8, p. 4, 7. Reallocated to member status in Bader limestone.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 46. Uppermost member of Bader limestone. Overlies Hooser shale member; underlies Easly Creek shale. Wolfcampian series.

Type locality: Easly Creek, 1.5 mi (2.4 km) south of Middleburg School (E sec. 36, T. 1 N., R. 13 E.), Richardson County, Nebraska.

Middle coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Fleming coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 68).

Middle Creek Limestone Member (of Swope Limestone)

Pennsylvanian (Missourian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

J. M. Jewett, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 101. Proposed name as cited in a manuscript of N. D. Newell. Dense blue limestone evenly bedded, 1–2 ft (0.3–0.6 m) thick between Ladore [Elm Branch] Shale below and Hushpuckney Shale above. Classed as member of the Swope Formation.

Mineral coal bed (in Cabaniss Formation)
Mineral formation
Mineral cyclothems
Pennsylvanian (Desmoinesian Series): southeastern Kansas, southwestern Missouri, and northeastern Oklahoma.
G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 22; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 196. Cherokee Group is divided into 15-cyclic formational units. Mineral formation (cyclothem), ninth in sequence (ascending), occurs below the Fleming and above the Scammon cyclothems. Average thickness 12 ft (3.6 m). Includes the Mineral coal (1.8 ft [0.5 m]) thick.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 98, 101. The Mineral cyclothem consists of underclay, coal (Mineral) black shale, and gray shale. Thickness of cyclothem is about 12 ft (3.6 m).
W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as Mineral formation. Underlies Robinson Branch formation; overlies Scammon formation. Included in Cabaniss group.
W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 60–62. A formation in Cabaniss subgroup of Cherokee Group. In southeastern Kansas the following divisions are differentiated (ascending): lower limestone bed, dark shale, underlimestone and sandstone, underclay, Mineral coal. Thickness in Crawford and Cherokee counties averages about 23 ft (7 m); in northeastern Crawford County commonly less than 15 ft (4.5 m).
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. The Mineral coal bed is about 1.5–2.0 ft (0.5–0.6 m) in thickness. There is approximately 15–20 ft (4.5–6 m) of shale and underclay between the Mineral coal bed and the overlying Fleming coal bed, except in those areas in Cherokee County where the Robinson Branch coal bed is present.
L. L. Brady, 1990, Geological Society of America, Coal Geology Division guidebook, p. 107–127. General distribution and resources of the Mineral coal in Kansas (p. 118, fig. 8B).
Named for a strip-pit highwall in SE NW sec. 24, T. 28 S., R. 25 E., Crawford County, Kansas.

Mineral rider coal (in Cherokee Group)
Pennsylvanian (Desmoinesian Series).
A local name for the Fleming coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 73; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 68).

Minersville shale member (of Friedrich Formation)
Pennsylvanian (Virgilian Series): southeastern Nebraska and northeastern Kansas.
G. E. Condra and E. C. Reed, 1938, Nebraska Geological Survey, Paper 12, p. 9. Defined as basal member of formation. Underlies Palmyra formation (new).
G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 42. Overlies Morton limestone (new).
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 14. Composed of red and grayish shales; locally sandy. Thickness 30 ft (9 m) at Nebraska City and less southward in Nebraska and northeastern Kansas. [This name was never used in Kansas and not mentioned by Moore et al. (1951, Kansas Geological Survey, Bulletin 89); it no longer is used in Nebraska.]
Named from exposures in Missouri River bluffs near railroad station at Minersville, Otoe County, Nebraska.

Misener Sandstone Member (of Chattanooga Shale)
Misener sand
Devonian (Kinderhookian Series): northern Oklahoma and southern Kansas.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,384–1,385. A name that has been applied by drillers and oil geologists to a sand, or sands, encountered in oil and gas wells of many counties of eastern and northern Oklahoma, and Cowley and adjoining counties of southern Kansas; has been correlated with Sylamore sandstone. The sand, as now commonly interpreted, is a transgressing unit that is treated as basal member of Chattanooga shale, and it overlies a widespread unconformity of pre-Chattanooga time.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 111. Occurs at base of Chattanooga shale; in most of eastern Kansas is represented only by disseminated rounded sand grains.
J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Abandoned as member of Chattanooga Shale in Kansas.
E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 17. Basal member of Chattanooga Shale in Kansas.
C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–69, 72, 73. Noted that the Misener Sandstone Member currently is used for the coarse, Devonian siliciclastic unit at the base of the Chattanooga Shale, therefore it cannot be Mississippian in age. However, "Misener sandstone" has been used in the past for a coarse siliciclastic unit between Mississippian carbonates and either the Chattanooga Shale or older Paleozoic rocks where the Chattanooga Shale is absent. Briefly discussed history of the nomenclatural problem and suggested that Misener Sandstone be restricted to the coarse, Devonian siliciclastic unit at the base of the Chattanooga Shale, and that "Misner sandstone" is the probable equivalent of Bachelor or Bushberg sandstones.
Said (N. W. Bass, letter to M. G. Wilmarth) to have been named for Fred D. Misener, an oil operator of Tulsa, and to have been found at depths of 3,009–3,054 ft (912–925 m) in No. 1 well on McWilliams lease in sec. 23, T. 15 N., R. 10 E. (now included in Wilcox oil pool, Creek County, Oklahoma), where it rests on Viola limestone.

Mission Creek shale (of Deer Creek limestone)
Pennsylvanian (Virgilian): southeastern Nebraska, southwestern Iowa, northwestern Missouri, and northeastern Kansas.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 40, 43, 49, 50. Overlies Haynies limestone and underlies Ervine Creek limestone, all included in Deer Creek limestone; 0.5–1.5 ft (0.15–0.4 m) thick in Nebraska and southwestern Iowa, 3–4 ft (0.9–1.2 m) thick in north-

Mississippian "C"
T. C. Hiestand, 1938, American Association of Petroleum Geologists, Bulletin, v. 22, p. 1,588–1,599. Stratigraphic studies using insoluble residues indicate that the "Mississippi lime" can be subdivided into zones that closely correspond with members of the Boone limestone of Missouri. Zone "C" is <10–160 ft (<3–49 m) and is correlated conclusively with the Fern Glen formation.

"Mississippian chat"
J. M. Jewett, 1954 [reprinted 1979], Kansas Geological Survey, Bulletin 104, p. 80. Residual or transported chert from chert-bearing Mississippian limestones; occurs at the base of the Pennsylvanian and probably is Pennsylvanian in age, therefore more correctly referred to as "chat."
D. F. Merriam, 1955, Kansas Geological Survey, Bulletin 114, p. 176. Term for weathered and eroded, unconsolidated or cemented by quartz and chalcedony, chert fragments of the Mississippian limestones.
K. D. Newell, W. L. Watney, S. W. L. Cheng, and R. L. Brownrigg, 1987, Kansas Geological Survey, Subsurface Geology Series 9, p. 32. Solution weathering of the Mississippian limestones commonly produces a residual cherty, porous weathered zone just beneath the unconformity that is called the Mississippian "chat" by drillers. According to Ver Wiebe (1950), "chat" is a modification of the word "chert" and was originally identified as such in wells drilled in the Welch (i.e., Welch–Bornholdt) field in Rice County. The chat is thickest in the vicinity of the Central Kansas uplift and Pratt anticline.

"Mississippian lime"
G. Moore, 1983; *in*, J. M. Hills and F. E. Kottlowski (coord.), AAPG–COSUNA Southwest/Southwest Midcontinent Correlation Chart. "Mississippian lime" noted as being 260 m (858 ft) thick in Kansas part of Hugoton embayment, and 30–90 m (99–297 ft) thick in Kansas part of Las Animas Arch; does not include Chester Group in Hugoton embayment; Chester Group not present in Las Animas Arch.

"Mississippian limestone"
A. S. Bunte, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 643–662.
E. D. Goebel and D. F. Merriam, 1959, Sixth Biennial Geological Symposium, Proceedings, p. 99–121.
J. A. Worden, 1960, Shale Shaker, v. 10, no. 9, p. 2–28.

Missler member (of Ballard formation)
Missler member (of Meade formation)
Pleistocene: southwestern Kansas.
C. W. Hibbard, 1949, Michigan University Museum of Paleontology, Contributions, v. 7, no. 4, p. 67, 68. Beds overlying Meade gravels member of Meade formation and underlying Stump Arroyo member of Crooked Creek formation; consists of reddish sandy silt; thickness 17 ft (5.1 m).
C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55, 56. Reallocated to member status in Ballard formation; overlies Angell member.
C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 66. Abandoned Hibbard's (1949) stratigraphy; deposits of Nebraskan age assigned to Fullerton Formation (above) and Holdrege Formation (below).
Type locality: Along tributary of Spring Creek in secs. 6 and 7, T. 32 S., R. 28 W., Meade County, Kansas. Named for town of Missler on Rock Island Railroad, sec. 26 T. 31 S., R. 29 W.

Missourian Series
Missourian Stage
Missouri group
Missouri formation
Missourian division
Upper Pennsylvanian: Iowa, Arkansas, Kansas, Missouri, and Oklahoma.
C. R. Keyes, 1893, Iowa Geological Survey, v. 1, p. 114–116. Missouri formation or Upper Coal Measures are shales, limestones, sandstones, and clays overlying Des Moines beds, or Lower Coal Measures, and underlying Cretaceous rocks in Iowa; thickness 1,200 ft (364 m).
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Includes (bottom to top): Bourbon formation, Hertha limestone, Ladore shale, Swope limestone, Galesburg shale, Dennis limestone, Fontana shale, Block limestone, Wea shale, Westerville limestone, Quivira shale, Drum limestone, Chanute shale, Iola limestone, Land shale, Wyandotte limestone, Bonner Springs shale, Plattsburg limestone, Vilas shale, Stanton limestone,Weston shale, and Iatan limestone.
H. S. McQueen, 1938, Missouri Geological Survey and Water Resources, 2nd series, v. 25, p. 25–29, pl. 5. Missourian Series comprises (ascending) Pleasanton, Kansas City, Lansing, Pedee, Douglas, Shawnee, and Virgil Series.
R. C. Moore, H. R. Wanless, J. M. Weller, J. S. Williams, C. B. Read, G. H. Bell, G. H. Ashley, M. G. Cheney, L. M. Cline, G. E. Condra, R. H. Dott, C. O. Dunbar, M. K. Elias, L. C. Glenn, F. C. Greene, T. A. Hendricks, J. M. Jewett, J. H. Johnson, P. B. King, J. B. Knight, A. I. Levorsen, H. D. Miser, N. D. Newell, F. B. Plummer, M. L. Thompson, C. W. Tomlinson, and J. Westheimer, 1944, Geological Society of America, Bulletin, v. 55, p. 657–706, chart 6. In upward order, midcontinent time-rock divisions of Pennsylvanian are Morrowan, Lampasan, Desmoinesian, Missourian, and Virgilian.
M. G. Cheney, R. H. Dott, B. F. Hake, R. C. Moore, N. D. Newell, H. D. Thomas, and C. W. Tomlinson, 1945, American Association of Petroleum Geologists, Bulletin, v. 29, p. 140 (chart 2), 166–169. Chart shows classification and correlation of type Pennsylvanian section of Pennsylvania with co-standard sections of Appalachian and midcontinent regions. Midcontinent section comprises (ascending) Springer, Morrow, Des Moines, Missouri, and Virgil Series. Missourian Series is equivalent to Conemaughan Series of Appalachian region and to most of Conemaugh of type section in western Pennsylvania. Ardmore basin designated as reference section.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,020, 2,021 (fig. 1), 2,031 (fig. 4). Prior to 1932, a widespread disconformity was recognized within the Missourian and this seemed to rank in importance with other main time-rock boundaries in Pennsylvanian System. Deposits between post-Desmoinesian disconformity and that in mid-part of Upper Pennsylvanian are classed as Missourian Series. Series comprises lower part of zone of *Triticites*. Missourian Series recognized by state geological surveys of

Morgan School shale bed (in Fort Scott Limestone)
Morgan School Shale (ofMarmaton Group)
Pennsylvanian (Desmoinesian Series): southeastern Kansas.
R. L. Ravn, J. W. Swade, M. R. Howes, J. L. Gregory, R. R. Anderson, and P. E. Van Dorpe, 1984, Iowa Geological Survey, Technical Information Series 12, p. 49. Nonmarine and marginal marine siliciclastic olive to brownish-green, calcareous shale and siltstone; contains Summit Coal Member or a weathered carbonaceous streak that marks the position of the Summit Coal Member; overlies Mouse Creek Formation; underlies Stephens Forest Formation; thickness 1–19 ft, 5.6 ft at the type section.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 1–2. Morgan School shale bed is a thin (less than 1 m [3.3 ft] thick), but distinctive, gray shale and mudstone in the lower part of the Little Osage Shale Member. It contains nodular limestone, underclay, and the Summit coal bed at the top.
Type section: Center of the east line, NW sec. 18, T. 72 N., R. 22 W., Lucas County, Iowa. Named for the former site of Morgan School, approximately 1 mi (1.6 km) to the southeast.

Morrill Limestone Member (of Beattie Limestone)
Morrill Limestone (of Council Grove Group)
Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 234, 235, 237. *Morrill limestone* (in Garrison shale member of Council Grove formation) consists of 1–3 ft (0.3–0.9 m) of hard gray massive limestone, irregular above, weathering grayish, basal portion weathering brownish and cavernous. Overlies Florena shale (which rests on Cottonwood limestone) and underlies Stearns shale.
G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 17. *Morrill limestone* consists of two dark-gray granular limestones separated by thin gray calcareous shale. Thickness usually about 4 ft (1.2 m) in northern occurrence but becomes 7 to 13 ft (2.1–4 m) at places in central and southern Kansas. When named was exposed at type locality, in gutter below the roadcut in which Eiss limestone is shown, but is now covered here by a new road grade. However, it is shown in a small bench, first above the Cottonwood, about 1/2 mi (0.8 km) north of type locality and east of north-south road in northwestern corner of sec. 27 and southwest corner of sec. 22.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 166. Uppermost member of Beattie limestone. Overlies Florena shale member; underlies Stearns shale. Consists of brown to gray impure cellular limestone that, in northern part of outcrop area, contains a thin shale parting; in southern Kansas, thickens mainly as a result of algal accumulations in upper part. Thickness 2–8 ft (0.6–2.4 m). Wolfcampian series.
M. R. Mudge and H. R. Burton, 1959, U.S. Geological Survey, Bulletin 1068, p. 13 (table 2), 76, pls. Thickness 3 1/4 to 7 1/2 ft (1.1–2.3 m) in Wabaunsee County, Kansas. Overlies Florena shale member; underlies Stearns shale.
H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 47. Morrill is a brown to grayish-brown, clayey limestone that often weathers with a box-work pattern. It generally contains one or more thin mudrock beds and is characterized by osagid oncolites in southern Kansas. Thickness is 2–9 ft (0.6–3 m).
Type locality: Two miles (3.2 km) west and 0.5 mi (0.8 km) north of Morrill, Brown County, Kansas.

Morrison Formation
Upper Jurassic: Colorado, Arizona, Kansas, Montana, New Mexico, Oklahoma, South Dakota, Utah, and Wyoming.
G. H. Eldridge, 1896, U.S. Geological Survey, Monograph 27. Freshwater marls, of average thickness of 200± ft (60± m); upper limit sharply defined by Dakota sandstone, while the brown and pink sandstone closing the Triassic clearly marks its lower limit; marls are green, drab, or gray, and carry in lower two-thirds numerous lenticular bodies of limestone of characteristic drab color and a texture compact and even throughout; persistent band of alternating limestones and sandstones, or all sandstones, about 20 ft (6 m) above the base, 10–15 ft (3–4.5 m) thick.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,423–1,424. In western South Dakota, Wyoming, and as far south in eastern Colorado as Loveland, the Morrison formation is underlain by marine Sundance formation, of Upper Jurassic age. The age of the Morrison was long questioned, some geologists considering it Upper Jurassic, others considering it Lower Cretaceous. The U.S. Geological Survey now classifies it as Upper Jurassic, although for many years it classified it as Lower Cretaceous(?).
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 162, p. 29. "Shales correlated with the Morrison Formation of the Jurassic System have been penetrated by drilling in northwestern Kansas. The shales are predominantly green in color and are characterized by pink jasperlike chert and pink gypsum. Where noted in wells, these shales range in thickness from 100 to 275 feet [30–83 m]."
D. F. Merriam, 1955, American Association of Petroleum Geologists, Bulletin, v. 39, p. 31–46. "Jurassic sedimentary beds of the Morrison Formation, which occur in about the western one-fifth of Kansas, range in thickness from a feather edge to 350 feet [106 m]." The rocks consist primarily of shale, sandstone, and limestone with minor amounts of chert and anhydrite. Two lithologic units that are recognizable in the formation are persistent and traceable over large areas. The upper unit consists of sandy shale with limestone stringers; the lower unit consists of shale with chert and anhydrite. Present correlations suggest that the upper unit is equivalent to the Morrison as originally defined, and the lower unit is equivalent to the upper Sundance. The Morrison Formation unconformably overlies Permian and Triassic(?) rocks and is unconformably overlain by Cretaceous rocks. "Evidence suggests that the sediments are of fluvial and lacustrine origin, with the source of the sediments in Kansas probably from the southeast."
D. F. Merriam, 1963, Kansas Geological Survey, Bulletin 162, p. 69–75. "The lower unit of the Morrison Formation in Kansas, then, is believed to be equivalent to the upper Sundance of Wyoming and possibly to the Ralston Formation of Colorado. . . (which is) equivalent to the Wanakah Formation of Colorado and New Mexico, Summerville Formation of Arizona, and Swift Formation of North Dakota and Montana. The upper unit of the Morrison Formation in Kansas is equivalent to the type Morrison. . . ." Also, "A

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 11, fig. 5. Noted that Morton limestone of Condra and Reed (1943) may occupy horizon of Grandhaven limestone.

Named from outcrops at Morton stockyards in south Table Creek valley, southwest of Nebraska City, Otoe County, Nebraska. Extends from near Thurman, Iowa, to northeastern Kansas but not as far as Kansas River valley.

Mound City Shale Member (of Hertha Limestone)

Mound City Shale (of Swope Limestone)

Pennsylvanian (Missourian Series): eastern Kansas and northwestern Missouri.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 90, 97. Swope formation divided into (top to bottom): Bethany Falls limestone, Hushpuckney shale, Middle Creek limestone, Elm Branch shale, Sniabar limestone, Mound City shale, Critizer limestone, Tennison Creek shale, and Schubert Creek limestone.

J. M. Jewett, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 99, 100, 103. Yellow fossiliferous shale containing local beds of limestone a few inches thick; thickness generally less than 5 ft (1.5 m); underlies Sniabar limestone; overlies Critizer limestone.

J. M. Jewett, 1933, Kansas Academy of Science, Transactions, v. 36, p. 136. Type locality established.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,429. R. C. Moore (1936 [1935], Kansas Geological Survey, Bulletin 22) dropped this name from his classification, without explanation of its fate. But, as he restricted his Swope limestone to beds above the base of the Middle Creek limestone, this shale appears to have been included in his underlying Ladore shale.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 193. Middle member of Hertha Limestone. Underlies Sniabar Limestone Member; overlies Critzer Limestone Member. Thickness as much as 14 ft (4.2 m); average about 6 ft (1.8 m).

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 11. The Hertha differs from previous usage of Missouri Survey by inclusion of Critzer Limestone and Mound City Shale Member.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 8. Mound City Shale overlies the lower Guthrie Mountain shale member of the Shale Hill Formation and underlies the Sniabar Limestone Member. Consists of black to green-gray shale overlying gray blocky mudstone occasionally capped by a thin coal.

Type locality: Near Mound City, Linn County, Kansas.

Reference sections: The second US–69 roadcut north of LaCyne Junction, and also a roadcut northwest of Xenia in northwestern Bourbon County, Kansas (center south line SE, sec. 20, T. 23 S., R. 22 E.).

Mound Valley Limestone (of Kansas City Group)

Pennsylvanian (Missourian Series): southeastern Kansas.

G. I. Adams, 1896, Kansas University Geological Survey, v. 1, p. 23. Limestone, 10–15 ft (3–4.5 m) thick capping hills northwest of Mound Valley, Labette County, Kansas.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 47, 102. Regards Mound Valley as equivalent to the middle limestone of the Erie or "triple system."

G. I. Adams, 1904, U.S. Geological Survey, Bulletin 238, p. 18. Reports that the Mound Valley Limestone occurs between Ladore Shale and Galesburg Shale. Classes it as the middle member of the Bronson formation.

F. C. Schrader and E. Haworth, 1906, U.S. Geological Survey, Bulletin 296, p. 14. Describe the Mound Valley Limestone Lentil as a division of the Coffeyville Formation in the Independence quadrangle. Overlies Ladore–Dudley Shale and occurs below Galesburg Shale.

E. Haworth and J. Bennett, 1908, Kansas University Geological Survey, v. 9, p. 89, 92. Supports classification and nomenclature of Adams. Applies the name to limestone immediately northwest of Mound Valley, between Ladore and Galesburg shales.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 86–88. Discarded name. "A good deal of confusion was introduced in the classification and nomenclature of beds that are now referred to the Bronson Group by reason of mistakes and carelessness on the part of Adams."

W. L. Watney, J. A. French, and E. K. Franseen, 1989, Kansas Geological Society, Guidebook, 41st Annual Field Conference, p. 8–9. Mound Valley Limestone overlies Ladore Shale and overlain by Galesburg Shale.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 9–10. Restore name of Mound Valley Limestone and define as overlying Ladore Shale and underlying Galesburg Shale in southern Kansas as originally proposed by Adams.

Type locality: Top of Dixon Mound along road near center south line SE sec. 27, T. 32 S., R. 28 E., about 1 mi (1.6 km) northwest of Mound Valley. Here it consists of 6–8 ft (1.8–2.4 m) of skeletal wackestone. Named for Mound Valley, Labette County, Kansas.

Mound Valley shale

Pennsylvanian: eastern Kansas and northwestern Missouri.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 47, 102. Heavy bed of light ashy-gray to jet-black shale carrying some sandstone and constituting escarpment to northwest of Mound Valley.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,430. Same as Ladore shale, later but well-established name adopted by Kansas Geological Survey. Mound Valley shale was dropped years ago.

Named for Mound Valley, Labette County, Kansas.

Moundville coal (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Croweburg coal (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 72).

Mud seam coal (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Croweburg coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 74; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 71).

Mulberry coal bed (in Bandera Shale, Marmaton Group)

Pennsylvanian (Desmoinesian Series): southeastern Kansas.

H. Hinds, 1912, Missouri Bureau of Geology and Mines, v. 5, 2nd series, p. 75.

Myrick Station Limestone Member (of Pawnee Limestone)
Pennsylvanian (Desmoinesian Series): eastern Kansas, western Missouri, southwestern Iowa, northeastern Oklahoma.
L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, no. 1, p. 26 (fig. 2), 37. Pawnee Limestone splits into two limestones separated by shale as it is traced from Kansas into Missouri. Name Myrick Station is proposed for lower limestone member. Thickness in type area is 5 1/2 ft (1.4 m).
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, p. 316, 317–318, 319. In Kansas, Myrick Station is second member from base of Pawnee. Characteristically brownish gray, massive, and somewhat earthy in low part. Average thickness about 4 ft (1.2 m). Overlies Anna Shale Member and underlies Mine Creek Shale Member.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 25. Pawnee limestone in Kansas divided into (bottom to top): Anna shale member, Myrick Station limestone member, Mine Creek shale member, Laberdie limestone member. Myrick Station limestone member is a dark-gray, brown, and light-gray limestone; lower part, comprising about 2 ft (0.6 m) of massive dark-gray, brown-weathering limestone, is most persistent, and this is overlain locally by a lighter-colored *Chaetetes*-bearing limestone; thickness 2 to about 8.5 ft (0.6–2.6 m).
R. D. Alexander, 1954, Oklahoma Geological Survey, Circular 31, p. 15, 16 (fig. 2). In Nowata County, Oologah Formation consists of Pawnee Limestone at base, the Pawnee consisting of (ascending) cap rock of Lexington coal, Anna Shale, Myrick Station Limestone, and Coal City Limestone.
R. C. Price, 1984; *in*, N. J. Hyne, ed., Limestones of the midcontinent: Tulsa Geological Society, Special Publication 2, p. 377, 383 (fig. 6), 387. Overlies Anna Shale and underlies Mine Creek Shale and Frog limestone bed.
Type section: Crops out in ravines in south bluff of Missouri River near Myrick Station on Missouri Pacific Railroad, just west of Lexington, Lafayette County, Missouri.

N

"N bed"
G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. Massive limestone, dolomite, or flint with very few large (1-ft [0.3 m] thick; 5–15-ft [1.5–4.5-m] diameter) nodules; sporadically contains ore; in some mines [in the Tri-state mining district] a "porcelain" stratum 1-ft (0.3-m) thick is found 6–8 ft (1.8–2.4 m) from top of bed; 20–25 ft (6–7.5 m) thick; overlain by "M bed," underlain by "O bed." Considered to be part of the Boone formation in the area.
C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 12, 15. The Burlington–Keokuk succession can be subdivided into four distinct lithologic units below the Short Creek oolite in the Joplin district; from youngest to oldest these units are designated: the calcarenite bed, the marble bed, the cherty bed, and the N-bed.
Semi-formal mining terminology; not formally recognized by Kansas Geological Survey.

Naish limestone
Pennsylvanian: eastern Kansas.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 87, 97. Basal member of Stanton limestone along Kansas River; absent in southeastern Nebraska; underlies Linwood shale member.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,458. R. C. Moore and G. E. Condra also used this name in their October 1932 revised classification of Pennsylvanian rocks of Kansas and Nebraska, but there is no other record of the name. The bed appears to be included in the Captain Creek limestone member.
Derivation of name not stated, but probably named for exposures near Camp Naish, west of Bonner Springs, Kansas.

Naish sandstone
Pennsylvanian: eastern Kansas.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference Guidebook, p. 46. At base of Stanton limestone; 1.8 ft (0.5 m) of hard gray calcareous sandstone.
No other record of Naish sandstone is known. Moore (1936 [1935], KGS Bulletin 22, p. 130, 131) noted under Vilas shale that, "Near Kansas river a persistent zone of gray hard ripple-marked sandstone occurs near the top or at the middle." This may be the "Naish sandstone" of Moore, 1932.
Derivation of name not stated, but probably named for exposures near Camp Naish, west of Bonner Springs, Kansas.

Natural Corral member (of Belvidere formation)
Cretaceous (Lower): central Kansas.
W. H. Twenhofel, 1924, Kansas Geological Survey, Bulletin 9, p. 31, 32. The basal strata of Belvidere formation; underlies Windom member. Belvidere in McPherson County, Kansas, divided into (top to bottom): Mentor member, Marquette member (53 ft [16 m]), Windom member (3 ft [0.9 m]), Natural Corral member (30 ± ft [9± m]). These member names are used only for convenience to designate occurrence of fossils and stratigraphic position. The Windom and Natural Corral members apparently were dropped in favor of the name Kiowa shale.
Exposed at Natural Corral, a box canyon about 5 mi (8 km) southwest of Marquette, McPherson County, Kansas, in NW sec. 5, T. 18 S., R. 5 W.

Nebraska beds
Miocene: Nebraska and other western states.
W. B. Scott, 1894, Geological Society of America, Bulletin, v. 5, p. 594, 595. Nebraska or Loup Fork proper is the second or middle horizon of Loup Fork; covers a vast area from Nebraska to Mexico; characterized by *Cosoryx*; underlies Palo Duro horizon and is younger than Deep River horizon of Loup Fork of Montana.
H. F. Osborn, 1909, U.S. Geological Survey, Bulletin 361, p. 65, 79. Assigned these beds to upper Miocene and to lower part of Ogallala formation.
Named for state of Nebraska.

Winterset Limestone Member and below the Cement City Limestone.

E. R. Ries, 1954, Oklahoma Geological Survey, Bulletin 71, p. 64–68. In Okfuskee County, consists of six mappable sandstones and seven mappable shales. Thickness 440–460 ft (133–139 m). Conformably overlies Hogshooter; conformably underlies Dewey Formation.

W. F. Turner, 1956, Oklahoma Geological Survey, Bulletin 74, p. 70–78, pls. 1, 2. In Seminole County, consists of shale, sandstone, siltstone, chert conglomerate, limestone and limestone conglomerate; only a single ledge, the basal (No. 1) sandstone, is continuous across county. Thickness 300–400 ft (91–121 m). Conformable above Coffeyville Formation and below the Belle City; in northern part of county, apparently conformable below Hilltop Formation; in Pontotoc County, truncated by Ada Formation.

A. P. Bennison, 1985, Proceedings of Third Annual Meeting and Field Conference, Midcontinent Section Society of Economic Paleontologists and Mineralogists, p. 228, 238–240. Nellie Bly Formation is equivalent to shale interval overlying Quivira Shale and underlying Drum Limestone at Independence, Kansas.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 13. The Nellie Bly Shale overlies the Cherryvale Formation and underlies the Dewey Limestone. The principal reference section for the Nellie Bly Formation is north of center, south line, NE sec. 19, T. 32 S., R. 16 E. on north side of Independence, Kansas (Heckel, in prep.). Section consists of about 20 ft (6 m) of shale-parted sandstone grading upwards to sandy shale. Nellie Bly thins to the north where it is less than 1 ft (0.3 m) thick and is locally absent in the Kansas City area. There it is a blocky, locally reddish mudstone, typically with calcareous nodules, and locally containing a thin coal (reference section: center W/2 SE SE sec. 12, T. 11 S., R. 24 E., Wyandotte County, Kansas). The Nellie Bly overlies the Westerville Limestone and underlies the Quivira Shale Member of the Dewey Limestone in eastern Kansas.

Type locality: On Nellie Bly Creek, in secs. 31, 32, 29, 28, T. 24 N., R. 13 E., Washington County, Oklahoma. Ranges from 115 to 180 ft (34–55 m) of sandy shale to sandstone in type area.

Nemaha Subgroup (of Wabaunsee Group)
Nemaha Formation
Nemaha Member

Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, eastern Kansas, northwestern Missouri, and northern Oklahoma.

G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science, Publication, v. 9, no. 2, p. 8, 14, 26. *Nemaha formation*—A formation of limestones and shales, 110–130 ft (33–39 m) thick, underlying McKissick Grove shales and overlying City Bluffs (Scranton) shales. Includes (descending) Tarkio limestone, Preston limestone, Fargo limestone, Burlingame limestone, and Rulo limestone members and the separating shales. Best developed in Big Nemaha Valley, with exposures between Tecumseh and Humboldt and between Union and Nebraska City, north of Rulo, and at mouth of the Big Nemaha.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 62, 71. The so-called Nemaha member or formation is reduced by excluding at base the Rulo limestone and overlying Silver Lake shale, which some geologists would assign to Scranton shale. The "Preston" limestone is the Emporia; the "Fargo" limestone is the Wakarusa, both of which have priority. Nemaha formation is dropped provisionally, to be revived if it is decided by State and Federal geological surveys that Wabaunsee beds represent two formations, and body of lower one is placed at Rulo limestone or at Silver Lake coal.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 4, 10. *Nemaha subgroup* is adopted to include Tarkio limestone at top, down to base of Burlingame limestone formation.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 215. In Nebraska Geological Survey, Bulletin 5, 1932, table C, p. 18, by G. E. Condra, R. C. Moore, and C. O. Dunbar, strata from base of Burlingame limestone to top of Tarkio are called *"Nemaha limestone."* Moore was not consulted on this usage and has never adopted it. [Nemaha is discarded by Kansas Survey.]

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,036, 2,037, (fig. 6); 1949, Kansas Geological Survey, Bulletin 83, p. 177–179; G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 15–16; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 20. Subgroups named (ascending) Sacfox, Nemaha, and Richardson by Condra (1935) have been included in interstate classification agreed upon by the state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma. As thus defined, Nemaha subgroup in standard section includes (ascending) Burlingame limestone, Soldier Creek shale, Wakarusa limestone, Auburn shale, Reading limestone, Harveyville shale, Elmont limestone, Willard shale, and Tarkio limestone. Nomenclature in the several states may deviate from this by combination or omission of terms where certain named rock units are not recognizable.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 177–179. Average thickness in Kansas is about 160 ft (48 m).

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 20. Subgroups named (ascending): Sacfox, Nemaha, and Richardson by Condra (1935) included in interstate classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma. Nemaha Subgroup includes (ascending): Burlingame Limestone, Soldier Creek Shale, Wakarusa Limestone, Auburn Shale, Reading Limestone, Harveyville Shale, Elmont Limestone, Willard Shale, and Tarkio Limestone.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,277. Nemaha–Richardson boundary lowered to base of Tarkio Limestone, herein reduced to member status in Zeandale Formation. Change agreed to by Nebraska and Kansas Geological Surveys which are chiefly concerned. Nemaha Subgroup comprises: Willard Shale, Emporia Limestone, Auburn Shale, Bern Limestone.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D.E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 40–41. Subgroup not recognized in southeastern Kansas. Thickness about 150 ft (45 m).

Type locality: Big Nemaha Valley between south of Falls City and southeast of Rulo, Richardson County, Nebraska.

from main ledge by calcareous gray shale. To south this upper thin limestone thickens, becomes massively bedded, crops out with a slightly pitted, sharply rough surface, and closely resembles the main limestone of type locality. Early Kansas reports restricted Neva limestone to main ledge-forming limestone of type locality, but report on Cowley County, by writer, placed in Neva limestone both these limestones and the intervening shale. In southern Kansas and northern Oklahoma these two limestones merge into one thick limestone. The Neva, as expanded by Moore and Condra, included all beds between Roca shale below and Eskridge shale redefined above. Subsequent to preparation of this report the expanded Neva was named *Grenola formation* by Condra and Busby [1933 report cited above], and they restricted Neva to the limestone originally named by Prosser.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 47. Neva limestone member consists of four or five limestones separated by shales. Thickness 16–24 ft (5–7 m). Overlies Salem Point shale member; underlies Eskridge shale. Wolfcampian series.

H. D. Miser, 1954, Geologic map of Oklahoma (1:500,000): U.S. Geological Survey. Mapped as Neva limestone in Council Grove group.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 94–100. In Kansas and Nebraska, the Neva is defined as top member of the Grenola and is underlain in turn by Salem Point shale, Burr limestone, Legion shale, and Sallyards limestone members. Only Neva member of Grenola can be identified with assurance in Pawnee County. Consists of upper and lower limestone members separated by 13–22 ft (4–6 m) of blue-gray shale. Overall thickness 17–40 ft (5.1–12 m). Overlies Roca shale; underlies Eskridge shale.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 46–48. Consists of six beds of limestone and four beds of shale at the type locality, total thickness about 17 ft (5.1 m). Not uniform in thickness (9–27 ft [2.7–8 m]).

D. L. Baars, C. A. Ross, S. M. Ritter, and C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 5–10. Elevated Neva Limestone to formation status as basal unit in the Council Grove Group (revised) and Permian System (revised).

Type locality: Near Neva Station, Cottonwood River valley, Chase County, Kansas. Neva Station has been moved since limestone was named. Limestone was named from exposures near junction of Diamond Creek and Cottonwood River valleys in Chase County.

New Albany sand

Pennsylvanian (Desmoinesian): eastern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 84. Used for sandstone in the Nowata shale in some parts of eastern Kansas; first applied in the New Albany oil field in northeastern Elk County; "Wayside" is the more common term for sandstones in the Nowata shale that collectively are known as Walter Johnson sandstone.

Newbern shale (of Sumner group)

Newbern shale member (of Donegal limestone)

Permian: northeastern Kansas.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Middle member of Donegal limestone; averages 11 ft (3.3 m) thick; gray calcareous shale.

R. C. Moore, 1936, Kansas Geological Society, 10th Annual Field Conference, Guidebook, p. 12. Middle member of Donegal limestone; 5± ft (1.5± m) thick; underlies Strickler limestone member; overlies Hollenberg limestone member.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 30. Term Wellington used for section between top of Herington limestone and base of Ninnescah shale; of the 10 subdivisions in this interval, Strickler limestone member and Newbern shale member of Donegal limestone are not very persistent; name Donegal limestone is not well founded.

Type locality and derivation of name not stated.

Nine Hundred-Foot sand

Pennsylvanian (Desmoinesian): eastern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 84. Applied to sandstone deposits in the Cherokee group in Anderson County about 300 ft (90 m) below the top of the Cherokee section.

Ninnescah Shale (of Sumner Group)

Ninnescah Shale Member (of Harper Sandstone)

Permian (Leonardian Series): southern Kansas and northern Oklahoma.

G. H. Norton, 1937, (abs.) American Association of Petroleum Geologists, Bulletin, v. 21, p. 1,557. Basal member of Harper Sandstone; underlies Stone Corral Member; overlies Wellington Shale.

G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,667–1,773. Rank raised to formation. Basal formation of Cimarron red beds. Composed largely of red shale; minor amounts gray shale, impure limestone, and calcareous sandstone. Thickness about 425 ft (129 m) near Oklahoma line; 280 ft (85 m), 50 mi (80 km) north. Topmost bed is Runnymede Sandstone Member.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 159–160. Ninnescah Shale assigned to Sumner Group; Leonardian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 50–51. Contains much salt in subsurface of southwestern Kansas. Maximum outcrop thickness 450 ft (136 m); average about 300 ft (91 m).

Bailey Rascoe, Jr., 1988, Midcontinent SEPM Special Publication No. 1, p. 3–12. Runnymede Sandstone (previously member of Ninnescah Shale) raised to formation rank and included in the overlying Nippewalla Group on the basis of a regional unconformity at the base of the Runnymede.

Named for exposures on both forks of Ninnescah River in south-central Reno and north-central Kingman counties, Kansas.

1.7 ft (0.5 m) thick; typically ash gray, but also gray, blue gray, olive green, and yellowish green.

Nolans Limestone (of Chase Group)
Nolans Limestone (of Sumner Group)
Permian (Wolfcampian Series): Kansas.
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Divided Sumner group ("Permian") into (top to bottom): Wellington shale, Donegal limestone, Pearl shale, Nolans limestone, and Odell shale. Nolans limestone overlies Odell shale and underlies Pearl shale; composed of (top to bottom): Herington limestone member (white to buff, massive and flaggy impure dolomitic limestone with dominantly molluscan fauna; 8 ft [2.4 m]), Paddock shale member (gray to olive-drab clay shale; 14 ft [4.2 m]), and Krider limestone member (white to gray limestone and calcareous shale, fossiliferous; 6 ft [1.8 m]); 28 ft (8.5 m) thick.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 89–91. Reallocated to Chase group based on redefinition of Wolfcamp–Leonard boundary; base of Leonard in Kansas arbitrarily placed at top of Nolans formation (top of Herington limestone member). Derivation of name given.
H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 49–50. Three members in northern and central Kansas; member boundaries not clearly defined in southern Kansas; thickness ranges from about 22 to 40 ft (7–12 m).
Name derived from Nolans, a railway siding near Emmons, Washington County, Kansas.

Norfleet Limestone Member (of Lenapah Limestone)
Pennsylvanian (Desmoinesian Series): southeastern Kansas, western Missouri, southwestern Iowa.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, pt. 11, p. 337, 338–339, pl. 1. Defined to include all limestone and shale beds of the Lenapah below Perry Farm Shale member. Where best developed, member comprises a few inches of dark-bluish dense limestone overlain by shale which is mostly black and has maximum thickness of about 5 ft (1.5 m); locally upper part is very calcareous but also black and platy; at top of member is a limestone which is few inches to about 3 ft (0.9 m) thick. Overlies Nowata shale. Defined type section.
J. M. Jewett, 1945, Kansas Geological Survey, Bulletin 58, p. 69. Discussed as cyclothem in Lenapah megacyclothem.
F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. v (fig. 1), 9. Geographically extended into northwestern Missouri, where it underlies Perry Farm Shale Member and overlies Warrenburg Sandstone Member of Nowata Formation.
C. M. Cade, 3rd, 1953, Tulsa Geological Society, Digest, v. 21, p. 134, 135. Geographically extended into northeastern Oklahoma.
J. M. Jewett, H. G. O'Conner, and D. E. Zeller, 1968; *in*, Doris E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 26. Dark brownish-gray, massive to bluish-gray, slabby limestone. Thickness ranges from few inches to 3 ft (0.9 m).
Type locality: Located on Norfleet Farm along Pumpkin Creek, north of low water bridge at the edge of Mound Valley, Labette County, Kansas (SE sec. 35, T. 32 S., R. 18 E.).

Northview Formation
Northview Formation (of Chouteau Group)
Northview Member (of Chouteau Formation)
Northview Shale
Mississippian (Kinderhookian Series); subsurface of southeastern Kansas.
S. Weller, 1901, Journal of Geology, v. 9, p. 140. *Northview sandstone and shale*—Fossiliferous yellowish sandstone, grading imperceptibly downward into bluish shale, latter most persistent and very fossiliferous in places but usually barren of fossils. Thickness 10–90 ft (3–27 m). Known as Vermicular sandstone and shale in early reports. Overlain by Pierson limestone and underlain by so-called (not typical) Louisiana limestone. Not equivalent to typical Hannibal shale of central Missouri. Included in Kinderhook group. Faunas of upper yellow sandstone at Burlington and Northview sandstone are analogous.
W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 28–32, pl. 2, 8. Gray to greenish-gray, slightly calcareous or dolomitic shale; more dolomitic in area where Northview is transitional with upper part of Chouteau Limestone; subsurface Northview in Kansas generally resembles the lower part of surface exposures of the Northview in Missouri, with the upper, more silty part generally absent in Kansas, but present in Allen and Bourbon counties; 0–61 ft (0–19 m) thick; grades northward into upper part of Chouteau Limestone. Erroneously listed as Northview Limestone in pl. 8.
E. B. Branson, 1944, Missouri University Studies, v. 19, no. 3, p. 184 (fig. 28), 193–196. Rank reduced to member status in Chouteau formation. Overlies Compton member; underlies Pierson member. Seems to be about middle of Lower Mississippian.
J. R. Clair, 1948 [1949], Kansas Geological Society, p. 12–13, pl. 1 [World Oil, v. 129, no. 8, p. 62, 66]. The use of the term Chouteau by the writer [for the lowest Mississippian limestone in western Kansas] is in part an arbitrary device to get away from the use of the term "Gilmore City" to denote the basal Mississippian, and in part to indicate the writer's belief that this basal section is correlative in age and time of deposition to the Northview Shale and Compton Limestone.
C. P. Kaiser, 1950, American Association of Petroleum Geologists, Bulletin, v. 34, no. 11, p. 2,154–2,157. Formation ranges in thickness from a trace to 77 ft (23 m), which was observed in vicinity of Northview, Webster County, Missouri. Present throughout central part of area of southeastern Missouri. In most of area of occurrence, conformably overlies Chouteau limestone. The Chouteau pinches out southward before the Northview. Thus, in southern part of area of its occurrences, the Northview unconformably overlies Sylamore sandstone or rocks of Ordovician age. Conformably overlain by Sedalia dolomite.
E. L. Clark and T. R. Beveridge, 1952, Kansas Geological Society, Guidebook, 16th Field Conference, p. 71, 72 (fig. 1), 74, 77 (reprinted as Missouri Geological Survey and Water Resources, Report of Investigations 13). Top formation of the Chouteau, herein redefined as group. Where formation is thick, consists of two members: upper

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 26. Gray to yellow clay shale and sandstone; marine and nonmarine. Locally absent due to pre-Missourian erosion; thickness 3–30 ft (0.9–9 m). Includes Walter Johnson sandstone member ("Wayside sand" in subsurface) locally in southeastern Kansas.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 4. Walter Johnson Sandstone Member lowered to bed status.

Type locality: T. 26 N., R. 16 E., latitude of Nowata.

Type section: SW sec. 10, T. 27 N., R. 16 E., Nowata County. Section measured on south bank of Verdigris River. Named for Nowata, Nowata County, Oklahoma.

Noxie Sandstone Member (of Chanute Shale)
Noxie Sandstone Lentil (in Chanute Formation)
Noxie sandstone bed (in Chanute Formation)

Pennsylvanian (Missourian Series): northern Oklahoma and southern Kansas.

R. C. Moore, N. D. Newell, R. h. Dott, and J. L. Borden, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 40, 43, 104. Sandstone lentil forming base of Chanute Shale in Chautauqua arch area. Underlies Thayer Coal.

M. C. Oakes, 1940, Oklahoma Geological Survey, Bulletin 62, p. 61, pl. 1. Has maximum thickness of 60 ft (18 m) in vicinity of Noxie. Consists of massive coarse-grained crossbedded buff to reddish-brown sandstone. Upper part overlaps Nellie Bly beds along south side of pre-Chanute erosion channel.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 190. Commonly fills channels that extend as low as Stark shale or lower; locally contains limestone conglomerate at base. Average thickness 40 ft (12 m); in southern Kansas, may be as much as 100 ft (30 m), locally. Underlies unnamed clay shale; disconformable above Drum Limestone.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 14. Drop Noxie Sandstone as formal member, but retain as informal bed.

Named for outcrops in vicinity of Noxie, NW corner sec. 30, T. 29 N., R. 15 E., Nowata County, Oklahoma.

Nuyaka Creek shale bed (in Lost Branch Formation)

Pennsylvanian (Desmoinesian Series): northeast Oklahoma, southeast Kansas, western Missouri, southwestern Iowa.

A. P. Bennison, G. W. Krumme, and R. I. Wilson, 1981, Oklahoma City Geological Society, Guidebook Field Trip 2. Proposed name.

A. P. Bennison, 1984; *in*, N. J. Hyne, ed.) Tulsa Geological Society, Special Publication 2, p. 101 (fig. 3), 114, 115. Describes Nuyaka Creek Shale.

P. H. Heckel, 1991, Kansas Geological Survey, Geology Series 4, 67 p. Included in Lost Branch Formation.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 5. A distinctive phosphatic black shale member named the Nuyaka Creek shale bed was named by Bennison (1981). Shale overlies an unnamed shale or the Sni Mills Limestone Member (Heckel, 1991); underlies an unnamed shale or the Glenpool Limestone (Bennison, 1984).

Type locality: An exposure along a cutbank on the west side of Lost Branch, near center NE NE NE sec. 10, T. 33 S., R. 18 E., just south of Mound Valley, Labette County, Kansas, as named by Heckel (in edit). The stratotype of the Lost Branch includes 1.3 ft (0.4 m) of fissile black Nuyaka Creek Shale containing phosphatic laminae and nodules.

Nyman coal bed (in Pilsbury Shale, Wabaunse Group)

Pennsylvanian (Virgilian Series).

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 234. Nyman coal was recognized in Kansas near the top of the Table Creek Shale. This coal is recognized in Missouri and Iowa, and across southeast Nebraska, northern Kansas, and locally in southern Kansas.

R. E. Whitla, 1940, Kansas Geological Survey, Bulletin 32, p. 25, 52. In Wabaunsee County, this coal is 7 to 8 inches (17.5–20 cm) thick and about 11 ft (3.3 m) below the Dover Limestone. The coal was worked locally in Wabaunsee County, and might have been worked in Nemaha and Lyon counties.

Nymar coal bed

D. L. Baars, 1994, Kansas Geological Survey, 1 sheet. Erroneous reference to Nyman coal bed on stratigraphic chart.

O

"O bed"

G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. Important ore bed in a few mines [in the Tri-state mining district]; contains round, flat nodules (2–4 inches [5–10 cm] by 3–6 ft [0.9–1.8 m]) embedded with cherty bands 1–4 inches (2.5–10 cm) thick; in some mines contains interbedded layers of nearly pure galena or sphalerite, or both, varying in thickness from a fraction of an inch to several inches; these sheets of ore are often very persistent over large areas; such mineralization comprised the "sheet ground" formation and mines in the area; sometimes mineralized with beds O, P, and Q, making an ore horizon 30–38 ft (9–11.5 m) thick; O bed is 8–9 ft (2.4–2.8 m) thick; underlain by "P bed," overlain by "N bed"; the Grand Falls horizon falls within the range of beds O, P, and Q. Considered to be part of the Boone formation in the area.

Semi-formal mining terminology; not formally recognized by Kansas Geological Survey

Oakley Shale Member (of Cabaniss Formation)
Oakley Shale Member (of Swede Hollow Formation)

Pennsylvanian (Desmoinesian Series): ?southern Iowa, eastern Kansas, and western Missouri.

R. L. Ravn, J. W. Swade, M. R. Howes, J. L. Gregory, R. R. Anderson, and P. E. Van Dorpe, 1984, Iowa Geological Survey, Technical Information Series 12, p. 35–37. Fissile, black shale containing phosphate nodules at the base, overlain by bioturbated gray shale (eastern area) or gray shale containing plant fossils (western area); overlies Whitebreast Coal Member of Swede Hollow Formation with a sharp, irregular contact; underlies Ardmore Limestone Member of Swede Hollow Formation; the black shale bed may be equivalent to the Mecca Quarry Shale in northeastern Illinois; thickness 1.5 ft (0.5 m) at type section, ranges from 1.5 ft to 25 ft (0.5–7.5 m; in western area).

R. L. Brenner, 1989, Kansas Geological Survey, Geology Series 3, p. 8. Proposed use of Oakley shale as a member in

Kansas and Colorado far into Nebraska; is part of, or entirely, deposits that in Kansas and southward have been called "Mortar beds," "Tertiary grit," and other names; is upper part of Loup Fork beds.

N. H. Darton, 1920, U.S. Geological Survey, Syracuse–Lakin folio, No. 212. Thick sheet of sand and gravel (chiefly sand) of late Tertiary age, which constitutes the surface of the Great Plains in western Kansas and occupies most of the highlands of the Syracuse and Lakin quadrangles; extends across Haskell, Grant, and Stanton counties; thickness 180 to 300 or more feet (54–90 m). It is possible that the 300 ft (90 m) or more of beds that constitute the Ogalalla [sic] formation comprise deposits elsewhere separable, even including locally in their upper part a representative of McPherson formation ("*Equus* beds"). Apparently no separation is practicable in this region. Originally the entire formation was known as "Loup Fork beds," but this term also included Arikaree formation, which is older than the Ogalalla [sic] and apparently does not extend into Kansas. In the valleys and in places on the uplands the Ogalalla [sic] grades up into fine sands and silts, which appear to have been carried and deposited by the wind at various times from Tertiary to very recent. In part these are Plains marl.

M. K. Elias, 1931, Kansas Geological Survey, Bulletin 18, p. 131–180. Restricted to beds beneath "Plains marl." In Wallace County, Kansas, usually buff-colored to pinkish, mostly unsorted sand and gravel, usually mixed in various proportions with fine dust, which makes the rocks of the formation rough to the touch; unconformably overlies Pierre shale; unconformably underlies Sanborn formation. In some areas fine unctuous clays of light-green and reddish-brown colors constitute important beds in lower part of formation, and in middle and, especially uppermost parts, lenses of white and pinkish limestone occur. Beds of gravel and light-gray or greenish sorted sand, some crossbedded, occur in places. Miocene or lower Pliocene.

H. T. U. Smith, 1940, Kansas Geological Survey, Bulletin 34, p. 39–94. Unit herein named Rexroad has been mapped as Ogallala, and some beds are indistinguishable from Ogallala.

J. C. Frye and C. W. Hibbard, 1941, Kansas Geological Survey, Bulletin 38, pt. 13, p. 404–410. Formation is 60–375 ft (18–113 m) thick in Meade basin. Overlies Laverne Formation; underlies Meade Formation. Middle Pliocene. Beds called Rexroad by Smith (1940) are herein designated Rexroad Member of Ogallala.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 20. Formation, in Kansas, comprises (ascending) Valentine, Ash Hollow, and Kimball Members. Maximum thickness 350 ft (106 m). Overlies Pierre Shale; underlies Meade Formation in some areas and in others Sanborn Formation.

C. K. Bayne and H. G. O'Connor, 1968; *in,* D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 59. Only Tertiary formation is Ogallala Formation of Pliocene Series.

J. Boellstorff, 1976, Kansas Geological Survey, Guidebook Series 1, p. 64.

E. D. Gutentag, 1988, Geological Society of America, Centennial Field Guide–South Central Section, p. 63–66. Ogallala Formation is Miocene on the basis of fission-track dates.

Named for exposures around Ogallala, Keith County, Nebraska.

Ogden flint

Permian: central Kansas.

C. S. Prosser, 1894, Geological Society of America, Bulletin, v. 6, p. 48. If for any reason the local name Wreford limestone should not prove desirable, on account of prominence of this ledge near Ogden, Kansas, it might appropriately be called Ogden flint.

Oketo Shale Member (of Barneston Limestone)

Oketo Shale (of Chase Group)

Permian (Wolfcampian Series): central Kansas.

R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Kansas Geological Survey, Open-file Report 34–3, chart. Shown as middle member of Barneston limestone; underlies Fort Riley Limestone Member; overlies Florence limestone member.

R. C. Moore, 1935, Rock formations of Kansas; *in,* Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Light-gray calcareous shale; 5 ft (1.5 m) thick.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 76–77. Member of Barneston. Blue and gray, calcareous shale, and locally contains one or more beds of limestone. Thickness as much as 17 ft (5 m). Underlies Fort Riley Limestone Member; overlies Florence Limestone Member. Wolfcampian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in,* D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 48, and pl. 1. Oketo is a calcareous, gray shale. It is generally absent in southeastern Kansas and locally absent elsewhere. Thickness ranges from 0 to 8 ft (0–2.4 m), but generally less than 5 ft (1.5 m).

Name derived from Oketo, Marshall County, Kansas.

Oklahoma series

G. H. Ashley, 1923, Engineering and Mineral Journal–Press, v. 115, p. 1,106–1,108, proposed that *Permian system,* as he called it, be divided into two series, and that lower one be designated *Oklahoma series.*

Oklan Series

Oklan Epoch

Pennsylvanian: North America.

R. C. Moore and M. L. Thompson, 1949, American Association of Petroleum Geologists, Bulletin, v. 33, no. 3, p. 284, 286, 288, 289, 292–297. Middle of three Pennsylvanian series; overlies Ardian (Lower Pennsylvanian) and underlies Kawvian (Upper Pennsylvanian). Oklan series includes all Pennsylvanian deposits between Morrowan and Missourian; boundaries marked by disconformities that are clearly distinguished at many places but obscure in others. Divisible into two stages: Atokan (or Derryan) and Desmoinesian. Rocks of Oklan series are more widespread than those of either older or younger divisions of Pennsylvanian.

Name Oklan is based on abbreviation of state of Oklahoma and refers to the thick fossiliferous succession of Middle Pennsylvanian deposits in east-central and northwestern Oklahoma.

Okmulgee group

Pennsylvanian: Kansas and Oklahoma.

R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference Guidebook, correlation chart. Des Moines

stone by 11 1/2 ft (3.5 m) of dark-blue shale, overlain by two layers of limestone, each 9 inches (22.5 cm) thick, and by 45 ft 8 inches (14 m 20 cm) of yellowish ferruginous shales.

D. A. Grisafe, 1976, Kansas Geological Survey, Mineral Resources Series 4, p. 11. Main limestone bed of the Funston Limestone commonly is called the Onaga limestone because it is quarried extensively near Onaga, Kansas, where it is 4–5 ft (1.2–1.5 m) thick. Where found elsewhere in state is approximately 2 ft (0.6 m) thick.

Occurs in vicinity of Onaga, Pottawatomie County, Kansas.

Onaga Shale (of Admire Group)

Pennsylvanian (Virgilian Series): northeastern Kansas.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, n. 9, p. 2,273–2,274. Defined to include strata between Falls City Limestone above and Wood Siding Formation below. Thickness ranges from 12 to 140 ft (3.6–42 m). Comprises (ascending) Towle Shale, Aspinwall Limestone, and Hawxby Shale Members.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 44. Includes: Hawxby Shale Member, Aspinwall Limestone Member, Towle Shale Member. Thickness about 30 ft (9 m).

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary upward to base of Neva Limestone to conform with global usage; Admire Group reassigned to Virgilian Series.

Type section: In east-west roadcut and ditch in SW SW sec. 2, T. 8 S., R. 10 E., Pottawatomie County, Kansas. Name derived from town of Onaga in northern part of county.

One-foot coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Croweburg coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 71).

Onion Creek Sandstone Lentil (in Rock Lake Member of Stanton Formation)

Pennsylvanian (Missourian): southeast Kansas.

P. H. Heckel, 1975, Kansas Geological Survey, Bulletin 210, p. 27–28. Buff to reddish-brown quartz sandstone with shale; massive to bedded, friable; about 100 ft (30 m) thick.

Type locality: Exposures along Onion Creek, secs. 14, 15, 22, and 23, T. 33 S., R. 14 E., Montgomery County, Kansas.

Oread Limestone (of Shawnee Group)

Oread Limestone Member (of Vamoosa Formation)

Oread Limestone (of Douglas Group)

Oread Limestone Member (of Douglas Formation)

Pennsylvanian (Virgilian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, southeastern Nebraska, and northern Oklahoma.

E. Haworth, 1894, Kansas University Quarterly, v. 2, p. 123–124. Very fossiliferous limestone, light-blue, weathering buff; 10 ft (3 m) thick; capping all hills in vicinity of Lawrence, Kansas; overlies Lawrence shales and underlies 8 ft (2.4 m) of shale and a 1-ft (0.3-m) limestone.

E. Haworth, 1895, American Journal of Science, v. 50, p. 461. Name applied to two limestones, each about 15 ft (4.5 m) thick, separated by about 20 ft (6 m) of shale.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. As here developed, the Oread limestone contains (bottom to top): Toronto limestone member, Snyderville shale member, Leavenworth limestone member, Heebner shale member, Plattsmouth limestone member, Heumader shale member, and Kereford limestone member; 50 ft (15 m) thick; overlies Lawrence shale; underlies Kanwaka shale. Basal formation in Shawnee group.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 15, 27, 32, 44, 48, 160–169. Haworth (1894) first applied this name to the lowermost limestone of the formation [Toronto limestone member] as here developed, but later (1895) he extended the name to include the overlying thick light-gray limestone now commonly known as upper Oread or Plattsmouth. An intermediate thin blue limestone (Leavenworth member) was not recognized in the early reports. Total thickness in neighborhood of type locality is 45 ft (13.6 m).

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,034–2,036; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey, Report of Investigations 11, p. vii (fig. 3), 16–17. Shawnee Group, from base Oread Limestone to top Topeka Limestone, now recognized by interstate agreement. Oread Formation comprises: Kereford Limestone Member, Heumader Shale Member, Plattsmouth Limestone Member, Heebner Shale Member, Leavenworth Limestone Member, Snyderville Shale Member, Toronto Limestone Member. Overlies Lawrence Formation; underlies Kanwaka Formation.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 35–36. Basal formation of Shawnee Group. Average thickness in north and central Kansas 52 ft (16 m); about 100 ft (30 m) in southern outcrops.

Named for Mount Oread at Lawrence, Douglas County, Kansas.

Osage chert

G. R. Curtis, 1968, American Association of Petroleum Geologists, Memoir 9, v. 2, p. 1,582–1,587.

Osage City limestone

Pennsylvanian: eastern Kansas.

J. G. Hall, 1896, Kansas University Geological Survey, v. 1, p. 104. *Osage City limestone* (no. 4) crops out 6 mi (9.6 km) southeast of Burlingame, but can be traced only short distance. It is 60 ft (18 m) above No. 3 and of grayish-white color, very soft. Overlies Osage City shale and underlies Burlingame shale.

R. C. Moore and W. P. Haynes, 1917, Kansas Geological Survey, Bulletin 3, chart between p. 24 and p. 25. Equivalent to Howard limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 204. Osage City limestone of Hall is Howard limestone and is abandoned.

Probably named for Osage City, Osage County, Kansas.

Osage City shale

Pennsylvanian: eastern Kansas.

E. Haworth, 1895, Kansas University Quarterly, v. 3, p. 278 and pl. 20; American Journal of Science, 3rd, v. 50, p. 461–

Burlington Limestone, Fern Glen Limestone (Reeds Spring Limestone Member, St. Joe Limestone Member).

V. B. Cole, 1975, Kansas Geological Survey, Open-file Report 75–8, sheet 6, scale 1:1,200,000. Compiled thickness map for Osage rocks in southwestern Kansas; ranges from 0 to 480 ft (0–145 m) thick.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations No. 70, p. 65–96. Presents discussion of nomenclatural history and synonymy of "Osagean" in type area.

T. W. Kammer, P. L. Brenckle, J. L. Carter, and W. I. Ausich, 1990, Palaios, v. 5, p. 414–431. Placed Meramec–Osage boundary between Baxter Springs Member of Boone Formation and Moccasin Bend Member of Boone Formation [=within Warsaw Formation] in Tri-state mining district (Missouri, Oklahoma, and Kansas).

Named for Osage River, Missouri, along which both Keokuk and Burlington are exposed.

Osborne limestone

Cretaceous (Upper): north-central Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 51. Limestone in rather thick courses, overlying Victoria shale and constituting lower formation of Niobrara. Overlain by Smoky Hill chalk, upper formation of Niobrara.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,566. Same as Fort Hays limestone member of Niobrara formation, the better established name.

Named for exposures at Osborne and in Osborne County, Kansas.

Oskaloosa Shale Member (of Deer Creek Limestone)

Pennsylvanian (Virgilian Series): eastern Kansas, southwestern Iowa, and northwestern Missouri.

R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Kansas Geological Survey, Open-file Report 34–3, chart. Shown as shale member of Deer Creek limestone; overlies Ozawkie limestone member; underlies Rock Bluff limestone member.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Gray shale; average thickness 6 ft (1.8 m); maximum thickness 10 ft (3 m).

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 12. Gray shale, 4–7 ft (1.2–2.1 m) thick. Underlies Rock Bluff Limestone and overlies Ozawkie Limestone, all included in Deer Creek Limestone. [Derivation of name not stated.]

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 182–184). Shale member of Deer Creek Limestone that lies next below Rock Bluff Limestone and above Ozawkie Limestone is here named Oskaloosa Shale. It is bluish-gray or yellowish blocky clay with one or two calcareous, somewhat ferruginous, siltstones in outcrops in northern Kansas, but south of Coffey County parts of the member are distinctly sandy and micaceous, a prominent red zone appears, and there are one or two thin beds of nodular light bluish-gray impure limestone. Thickness 5–10 ft (1.5–3 m) in northern Kansas, but to south it increases to 25 ft (7.5 m). Has been miscalled Larsh shale, but is older than true Larsh Shale of Nebraska. Type locality, vicinity of Oskaloosa, Jefferson County. The Oskaloosa and Ozawkie members are absent in Nebraska, where Rock Bluff Limestone is basal member of Deer Creek Limestone.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations, p. vii, 17. Columnar section shows Oskaloosa shale member above Ozawkie limestone member and below Rock Bluff limestone member. [Text does not discuss member in Missouri.]

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 65. Consists of bluish- or yellowish-gray shale in northern Kansas and sandy micaceous shale containing red zone and some nodular limestone in southern part of state. Thickness ranges from minimum of 3 ft (0.9 m) to maximum of about 50 ft (15 m) locally in Osage County. Overlies Ozawkie limestone member; underlies Rock Bluff limestone member.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 18, fig. 5. Greenish-gray blocky 6-ft interval in quarry south of Pacific Junction, E/2 NW NW sec. 15, T. 71 N., R. 43 W., Mills County, has been identified as Oskaloosa shale. Not recognized over greater part of area of this report [southwestern Iowa]. Underlies Rock Bluff limestone member; overlies Ozawkie limestone member.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37, pl. 1. This member is a bluish-gray or yellowish-gray shale in northeastern Kansas and a sandy, micaceous shale containing some red shale and nodular limestone in the southeastern part of the state. The thickness ranges from a minimum of 3 ft (0.9 m) to a maximum of 50 ft (15 m) locally in Osage County.

Type locality: Vicinity of Oskaloosa, Jefferson County, Kansas.

Ost Limestone Member (of Tecumseh Shale)

Pennsylvanian: southeastern Nebraska, southwestern Iowa, and northeastern Kansas.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 47, 52. The limestone next above the Kenosha shale and below the Rakes Creek shale.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Locally occurs as sandy, impure limestone in Tecumseh shale in Kansas.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 23. Thickness 2–4 ft (0.6–1.2 m); does not persist very far into Kansas.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 66. A more or less discontinuous limestone in the upper part of the Tecumseh shale that is not persistent enough to call for subdivision of the [Tecumseh shale] as in Nebraska.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37. The Ost Limestone Member may be present locally in northeastern Kansas [not recognized in Kansas stratigraphy, however].

Type locality: On Ost Farm on South Fork of Weeping Water Creek, about 3.5 mi (5.8 km) east of Avoca, Cass County, Nebraska.

vii, 17. Columnar section shows Ozawkie Limestone Member at base of Deer Creek Limestone. [Text does not discuss unit in Missouri.]

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 66. Consists of brownish-gray brown-weathering massive limestone. Fusulines and other marine fossils locally abundant. Commonly thickness is about 5 ft (1.5 m) but ranges from about 1 to 20 ft (0.3–6 m). Underlies Oskaloosa Shale Member; overlies Tecumseh Formation.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 18, fig. 5. Identified only in quarry south of Pacific Junction, E/2 NW NW sec. 15, T. 71 N., R. 43 W., Mills County. Here it is 0.4 ft (0.12 m) of light-gray, fine-grained limestone overlying 1 1/2 ft (0.5 m) of dark-gray arenaceous shale which in turn overlies buff sandy limestone bed about 1 ft (0.3 m) thick. Where not recognized, the Ozwakie and overlying Oskaloosa Shale Member may be included in upper part of Tecumseh Shale.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37, and pl. 1. Ozawkie Limestone Member is brownish-gray, brown-weathering, massive limestone. Fossils are somewhat sparse, but fusulinids and other marine fossils are abundant in some outcrops. Commonly the thickness is about 5 ft (1.5 m) but ranges from 1 to 20 ft (0.3–0.6 m).

Type locality: In roadcut in NE sec. 31, T. 9 S., R. 18 E., near Ozawkie, Jefferson County, Kansas.

P

"P bed"

G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. Large flat chert nodules interbedded in chert [in Tri-state mining district]; barren in most instances; sometimes mineralized with beds O, P, and Q, making an ore horizon 30–38 ft (9–11.5 m) thick; 8–11 ft (2.4–3.3 m) thick; underlies "O bed," overlies "Q bed"; the Grand Falls horizon falls within the range of beds O, P, and Q. Considered to be part of the Boone formation in the area.

Semi-formal mining terminology; not formally recognized by Kansas Geological Survey.

Paddock Shale Member (of Nolans Limestone)

Paddock Shale (of Sumner Group)

Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 61. Top member of Enterprise Formation, overlying Krider Limestone and underlying Herington Limestone. Typically olive-drab to bluish-gray massive shale, usually containing some platy argillaceous-calcareous stringers which locally become quite prominent. Weathers buff to yellowish. Thickness 9–10 ft (2.7–3 m) in southern Kansas; 14+ ft (4.2+ m) in northern Kansas and Nebraska. Type locality designated.

R. C. Moore, 1936, Kansas Geological Society, 10th Annual Field Conference, Guidebook, p. 12. Discarded Enterprise and treated Paddock Shale as middle member of Nolans Formation (new).

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 9, p. 41. Member of Nolans Limestone. Underlies Herington Limestone Member; overlies Krider Limestone Member. Thickness 7–10 ft (2.1–3 m) in northern part of Kansas and about 30 ft (9 m) in southern part. Leonardian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 49, and pl. 1. Paddock is a gray shale, which in northern Kansas contains stringers and vein fillings of calcite. In southern Kansas it is buff colored and contains dolomite in the lower part. Pelecypods are locally abundant in northern and central Kansas outcrops. Thickness ranges from about 7 to 13 ft (2–4 m).

Type locality: Roadcut 1/4 mi (0.4 km) south of Krider, Gage County, Nebraska. Named for Paddock Township, southern Gage County, Nebraska.

Painterhood limestone

Pennsylvanian: eastern Kansas.

F. C. Schrader and E. Haworth, 1905, U.S. Geological Survey, Bulletin 260, p. 447. Fine-grained fossiliferous limestone, 12 ft (3.6 m) thick, underlying 10 ft (3 m) of sandstone; regarded as probably Elgin sandstone and overlying Buxton formation in Independence quadrangle.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 139, 161. Same as Oread limestone in Kansas.

Named from Painterhood Creek, T. 30 S., R. 12 E., Elk County, Kansas.

Palmyra limestone member (of Friedrich Formation)

Pennsylvanian (Virgilian Series): northeastern Kansas and southeastern Nebraska.

G. E. Condra and E. C. Reed, 1938, Nebraska Geological Survey, Paper 12, p. 9. Defined as middle member of formation. Underlies Otoe shale member (new); overlies Minersville shale member (new).

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 14. Consists of one or two light-gray limestones containing *Triticites*. Thickness 1–3 ft (0.3–0.9 m). [This name was never used in Kansas and not mentioned by Moore and others (1951, Kansas Geological Survey, Bulletin 89); it no longer is used in Nebraska.]

Type locality: In cut-bank of Little Nemaha River, southeast of railroad station at Palmyra, Otoe County, Nebraska.

Paola Limestone Member (of Iola Limestone)

Pennsylvanian (Missourian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 92, 97. Cited manuscript by N. D. Newell. Named for blocky, dense, blue limestone, 1–2 ft (0.3–0.6 m) thick, classed as the basal member of the Iola formation.

M. C. Oakes, 1940, Oklahoma Geological Survey, Bulletin 62, p. 68–69. Member, in Oklahoma, is 3–5 ft (0.9–1.5 m) of massive calcareous sandstone and comprises three lenticular phases, which grade into each other, both laterally and vertically. Basal member of Iola; underlies Muncie Creek Shale Member; overlies Chanute Formation.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p.

Pawnee limestone series
Pennsylvanian: eastern Kansas.
G. C. Swallow, 1866, Kansas Geological Survey, Preliminary Report, p. 24, 25. Series of fossiliferous limestones, slate, and shales, 112.5 ft (34 m) thick, including beds 203–211, inclusive, of geological section of eastern Kansas; underlies Marais des Cygnes coal series, overlies Fort Scott limestone; includes Pawnee limestone as its top member.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 60, 62. Synonymized with Labette shale and Pawnee limestone.
Probably named for Pawnee Creek, near village of Pawnee, Bourbon County, Kansas.

"Paxico Stone"
Lower Permian.
Trade name. Quarried for a brief period in the vicinity of Paxico. It was used primarily for rubble and not as cut stone. A question remains as to the geological name of the quarried stone because the exact location is unknown and there are several locations from which stone has been quarried in this area.

Peace Treaty Bed (in Cedar Hills Sandstone Member of Hennessey Shale)
Peace Treaty Bed (in Cedar Hills Sandstone)
Permian: south-central Kansas and north-central Oklahoma.
G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,762, 1,789–1,790. A sandstone bed about 100 ft (30 m) below top of Cedar Hills sandstone.
R. O. Fay, 1965, Oklahoma Geological Survey, Bulletin 106, p. 19, 20, 21, pl. 1. Ten- to 15-ft (3–4.5-m) resistant sandstone with greenish-gray band in the middle; occurs about 105 ft (31.5 m) below the top of the Cedar Hills Sandstone Member; overlies and underlies unnamed units of the Hennessey Shale.
Type area: State park 2 mi (3.2 km) east of Medicine Lodge, Barber County, Kansas, where bed forms a natural amphitheater in which a peace treaty was signed in 1867 with the Plains Indians.

Peacock sand
Pennsylvanian (Virgilian): southern Kansas.
N. W. Bass, 1929, Kansas Geological Survey, Bulletin 12, p. 135. A zone in the lower part of the Shawnee group about 150 ft (45 m) above the Oread limestone.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 84–85. Used to designate the principal producing formation in the Peacock oil field, Cowley County, Kansas.

Pearl shale (of Sumner group)
Pearl shale member (of Marion formation)
Pearl shale member (of Wellington formation)
Permian: eastern Kansas and southeastern Nebraska.
J. W. Beede, 1909, Kansas Academy of Science, Transactions, v. 21, pt. 2, p. 255. Succession of red, blue, and green shales, 70 ft (21 m) thick, overlying Herington limestone and underlying Abilene conglomerate; included in Marion stage.
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Gray, green and red clay shale, 27 ft (8 m) thick; underlies Hollenberg limestone member of Donegal limestone; overlies Herington limestone member of Nolans limestone.
W. A. VerWiebe, 1937, Wichita Municipal University, Bulletin, v. 12, no. 5, p. 3–5, 15, 17. Bluish-gray shales and clays with thin calcareous claystones and limestones; prominent varicolored shale near middle especially in south part of state; lowest member of Wellington formation; 43 ft (13 m) thick; underlies Hollenberg limestone member of Wellington formation; overlies Herington limestone.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,620, 1,621. In 1927, the beds previously called "Pearl shale member of Marion formation" were transferred to overlying Wellington formation because of difficulty separating them from the Wellington, and Pearl shale member was abandoned by both Kansas Geological Survey and U.S. Geological Survey. However, the 1932 revised classification of Permian rocks of Kansas and Nebraska by R. C. Moore and G. E. Condra excluded the Pearl shale from the Wellington and treated it as a distinct formation, as did R. C. Moore (Kansas Geological Society, 10th Annual Field Conference, Guidebook, p. 12). Moore also restricted Wellington shale to upper part of the Wellington of prior usage and applied new name Donegal limestone to beds overlying Pearl shale and underlying his restricted Wellington formation.
Named for exposures at Pearl, Dickinson County, Kansas.

Pearlette Ash Bed
Pearlette ash
Pearlette volcanic ash bed (in Sappa member of Meade formation)
Pearlette ash member (of Sappa formation)
Pearlette ash member (of Crooked Creek formation and Meade formation)
Pearlette ash lentil (in Atwater member of Crooked Creek formation
Pleistocene Series (Kansan Stage): Kansas, Nebraska, Iowa, Oklahoma, southeastern South Dakota, northwestern Texas.
F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 53, 54. Widespread horizon of white to brownish, rarely greenish, volcanic ash, 13 ft (4 m) thick, underlying Kingsdown marls and overlying Meade gravels. Supposed to be late Pliocene and to belong to Tule division of Cummins (*Equus* beds of Cope).
J. C. Frye and C. W. Hibbard, 1941, Kansas Geological Survey, Bulletin 38, pt. 13, p. 411. Included in Meade formation (redefined).
G. E. Condra, E. C. Reed, and E. D. Gordon, 1947, Nebraska Geological Survey, Bulletin 15, p. 22, 23. Pearlette ash has wide occurrence in Nebraska, Kansas, South Dakota, Iowa, and is perhaps best horizon marker in the Pleistocene. In Kansas, occurs between Upland and Crete formations.
J. C. Frye, A. Swineford, and A. B. Leonard, 1948, Journal of Geology, v. 56, p. 501–523. Ash lentils, collectively called Pearlette, can be differentiated petrographically from other late Cenozoic ash deposits of Plains region and have been studied at localities extending from southeastern South Dakota to northwestern Texas. Associated molluscan fauna possesses a great degree of uniformity and stratigraphic significance. Pearlette ash and faunal zone occurs above Kansas till and below Loveland loess and Iowa till in Missouri Valley region and is judged to be early Yarmouthian in age.

Formation. In southeastern area consists of eolian silt (loess) with a maximum thickness of about 10 ft (3 m); mantles much of the upland area where locally all of it may be included in the modern soil. In central and western area comprises pale yellowish-buff to light-gray eolian silt (loess) that mantles most of the upland areas; as much as 90 ft (27 m) thick in northwestern Kansas, but commonly 20–30 ft (6–9 m) thick; in central Kansas is 10 ft (3 m) or less thick.

Named for exposures in the vicinity of Peoria, Tazewell County, Illinois.

Peoria Loess

R. F. Madole, C. R. Ferring, M. J. Guccione, S. A. Hall, W. C. Johnson, and C. J. Sorenson, 1991, Geological Society of America, The Geology of North America, v. K–2, p. 512. Peoria Loess probably is late Wisconsin age; Loveland Loess (older) is light reddish brown versus Peoria Loess, which is generally pale gray or pale brownish gray; Peoria Loess is thicker and much more widely recognized than the Loveland Loess; less than 1 m to as much as 5 m (3.3–16.5 ft) thick.

Perry Farm Shale Member (of Lenapah Limestone)

Pennsylvanian (Desmoinesian Series): southeastern Kansas, western Missouri, southwestern Iowa.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, pt. 11, p. 337, 338, 339, 340, pl. 1. Includes calcareous fossiliferous shale above Norfleet Limestone Member and below Idenbro Limestone Member. Maximum thickness in Kansas about 10 ft (3 m); at type locality of Lenapah (Oklahoma) about 15 ft (4.5 m).

J. M. Jewett, 1955, Kansas Geological Survey, Bulletin 58, p. 69. Discussed as a cyclothem in Lenapah megacyclothem.

J. M. Jewett, H. G. O'Conner, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 26. Light- to dark-gray clay shale with nodules of limestone. Thickness ranges from 0 to 20 ft (0–6 m).

Reference section: Located in NW NE sec. 7, T. 34 S., R. 18 E. in Labette County, Kansas.

Peru sand

Peru–Wayside sand

Pennsylvanian (Desmoinesian): southern Kansas and northern Oklahoma.

D. W. Williams, 1921, American Association of Petroleum Geologists, Bulletin, v. 5, p. 293–297. Subsurface producing sandstone in Chautauqua County; equivalent to the Wayside sand in Montgomery County, Kansas; in the Nowata shale; above Altamont limestone and below Lenapah limestone; equated with the Ramsey sand of Washington County, Oklahoma; referred to as Peru–Wayside sand in figure on p. 296, but Wayside–Peru sand throughout text.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 85. Common name for subsurface sandstone bodies in the Labette shale, which occur below the Altamont limestone and above the Pawnee limestone; used widely, but misapplied in some areas to higher and lower beds; originated in the Peru oil-producing area (Peru–Sedan field), Montgomery County, Kansas; Englevale sandstone is the term applied in State Geological Survey reports to sandstone bodies in the Labette shale.

Pete terrane

Cretaceous: Kansas.

C. R. Keyes, 1915, Iowa Academy of Science, Proceedings, v. 22, p. 255. Shales, 50 ft (15 m) thick; underlies Brookville terrane (sandstones) and unconformably overlies Mentor terrane; top of Comanchean; included in Dakotan.

Derivation of name not stated.

Pfeifer Shale Member (of Greenhorn Limestone)

Cretaceous (Upper): northwestern and north-central Kansas.

N. W. Bass, 1926, Kansas Geological Survey, Bulletin 11, p. 32. Chalky shale interbedded with soft thin chalky limestones; the "fence-post limestone" forms the top bed; thickness 19–21 ft (5.1–6 m); top member of Greenhorn limestone in Russell to Hamilton counties; overlies Jetmore chalk member of Greenhorn limestone and underlies Fairport chalky shale member of Carlile shale.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 153. Chalky shale and chalky limestone in alternating layers; "Fencepost limestone bed" at top; blue-gray, weathers to light tan. In Hamilton County, the Pfeifer shale member and the underlying Jetmore chalk member are thicker than farther east; they cannot be distinguished and have been together designated the Bridge Creek limestone member. Thickness typically 19–21 ft (5.7–6 m) in Ellis and Russell counties; includes Fencepost limestone bed; underlies Fairport chalky shale member of Carlile formation.

H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 56. Top member of Greenhorn Limestone; limestone beds contain *Inoceramus labiatus*; average thickness 20 ft (6 m).

Named for exposures 2.5 mi (4 km) northwest of Pfeifer, Ellis County, Kansas.

Pierre Shale (of Montana Group)

Fort Pierre group

Upper Cretaceous: South Dakota, eastern Colorado, northwestern Kansas, western Minnesota, Montana, Nebraska, New Mexico, North Dakota, and eastern Wyoming.

F. B. Meek and F. V. Hayden, 1862, Philadelphia Academy, Natural Science Proceedings, v. 13, p. 419, 424. Consists of (top to bottom): 1) dark-gray and bluish fossiliferous plastic clays; 2) middle zone, nearly barren of fossils; 3) lower fossiliferous zone; and 4) dark bed of very fine unctuous clay containing much carbonaceous matter, with veins and seams of gypsum, masses of sulphuret of iron, and numerous small scales of fishes; thickness 700 ft (212 m) in Nebraska; overlies Niobrara division; underlies Fox Hills beds.

M. K. Elias, 1931, Kansas University Bulletin, v. 32, no. 7. Pierre Shale in northwestern Kansas includes: Beecher Island Shale Member, Salt Grass Shale Member, Lake Creek Shale Member, Weskan Shale Member, Sharon Springs Shale Member. Overlies Niobrara Chalk.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Only formation of Montana group in Kansas; overlies Niobrara chalk; unconformably underlies Woodhouse clay; 1,250+ ft (379+ m) thick; consists of (top to bottom): Beecher Island shale member, undifferentiated black and gray shale member, Salt Grass shale member, Lake Creek shale member, Weskan shale member, and Sharon Springs shale member.

Pillsbury Shale (of Wabaunsee Group)
Pennsylvanian (Virgilian Series): Kansas and Nebraska.
R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,275–2,276. Includes strata below Stotler Limestone; above Zeandale Limestone. Replaces Langdon Shale of Condra and Reed (1943). Thickness 1–50 ft (0.3–15 m).
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 42. Bluish-gray clayey to sandy shale, containing persistent coal bed; channel sandstone occurs in upper part.
Type locality: In roadcut in SE NE NE sec. 28, T. 10 S., R. 9 E., Riley County, Kansas. Name derived from Pillsbury Crossing, a ford across Deep Creek in NE NW sec. 5, T. 11 S., R. 9 E., Riley County, Kansas.

Pilot coal bed (in Cherokee Group)
Pilot cyclothem
Pennsylvanian (Desmoinesian Series): southeastern Kansas.
A name for the Tebo coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 52.)
W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 68–69. Describes the Pilot coal bed as 3–7 inches (7.5–17.5 cm) thick, that has a distinctive black shale 12–20 inches (30–50 cm) above the coal followed by a 3-inch (7.5-cm) ironstone, limestone, or a peculiar red clay.
G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 22; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 195. Cherokee group is divided into 15-cyclic formational units. The Pilot, seventh in the sequence (ascending), occurs below the Scammon and above the Weir. Includes Pilot coal.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 98, 101. The Pilot cyclothem includes "fresh-water" limestone, underclay, coal (Pilot), black shale, dark pyritic limestone, and dark-gray shale. Thickness ranges from 15 to 20 ft (4.5–6 m).
A name for the Tebo coal bed.

Pink lime
Pennsylvanian (Desmoinesian): eastern Kansas.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 85. Used for the Pawnee limestone; the name "Big lime" is used in the same sense; some operators call the Pawnee limestone "Brown lime."

Pioneer coal (in Cherokee Group)
Pennsylvanian (Desmoinesian Series).
A local name for the Bevier coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 76; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 80).

Piqua limestone member
Pennsylvanian: southeastern Kansas.
G. I. Adams, 1904, U.S. Geological Survey, Bulletin 238, p. 20. Heavy-bedded limestones, 50 ft (15 m) thick, overlying Vilas shale and forming top formation exposed in Iola quadrangle.
F. C. Schrader and E. Haworth, 1906, U.S. Geological Survey, Bulletin 296, p. 12. A limestone 1–50 ft (0.3–15 m) thick, classed as the uppermost member of the Wilson formation in the Independence quadrangle; underlies Buxton formation.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 130, 131, 139. Synonymized with Stanton limestone.
Named for Piqua, Woodson County, Kansas.

Plains marl
Pleistocene, Pliocene, and Miocene: western Kansas.
R. Hay, 1893, Kansas State Board of Agriculture, 8th Biennial Report, p. 101. Tertiary deposits consist of plains marl (Pliocene), 175 ft (53 m) thick, and Loup Fork (Miocene), 50 ft (15 m) thick.
R. Hay, 1895, U.S. Geological Survey, 16th Annual Report, pt. 2, p. 570. Lime, sand, and clay; surface deposit on the high prairie, but is sometimes found forming the bottom land of valleys and sometimes occurs in patches on the slopes. Thickness few feet to 200 ft (60 m). Probably begins in Pliocene with last part deposited during the Quaternary. Overlies Miocene grit. Where thickest, its lower parts are often more arenaceous than the upper.
E. Haworth, 1897, University of Kansas Geological Survey, v. 2, p. 257–280. Plains marls and mortar beds of Cragin have no definite stratigraphic position, but are convenient terms to designate difference in physical properties. The mortar beds occur at all positions from base to summit of Tertiary. They contain Loup Fork fossils in some places and Pleistocene fossils in other places, as do the plains marls.
M. K. Elias, 1931, Kansas Geological Survey, Bulletin 18, p. 163–180. Proposed Sanborn formation for the Pleistocene loess, with some gravel and sand at base, that is widely distributed on the divides in western Kansas. The name is intended as a substitute for "Tertiary marl" or "Plains marl."
J. C. Frye, 1952, Kansas Geological Survey, Bulletin 99, p. 110. Listed with locally named units that are properly classed at least in part as Sanford formation.
Derivation of name not given, but presumably named from occurrence on high plains of western Kansas.

Platte Series
Upper Cretaceous: from Rocky Mountains eastward.
F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 49. Occurs in area of North American Interior Plateau, which extends from Rocky Mountains eastward and constitutes the higher part of the Plains. Named for Platte River, which, in Colorado and Nebraska, cuts all divisions of the series.

Platteville Formation (of Simpson Group)
Platteville Limestone
Platteville Dolomite or Group
Middle Ordovician (Blackriveran Series): southwestern Wisconsin, northwestern Illinois, northeastern Kansas, eastern Iowa, and southern Minnesota.
H. F. Bain, 1905, U.S. Geological Survey, Bulletin 246, p. 18–19. Beds previously called Trenton limestone in the Mississippi Valley region, but older than Trenton. Consists of (top to bottom): 1) thin beds of limestone and shale, 10–20 ft (3–6 m) thick; 2) thin-bedded brittle limestone breaking with a conchoidal fracture and at times called "glass rock," 25–30 ft (7.5–9 m) thick; 3) buff to blue magnesian heavy-bedded limestone, frequently a dolomite, 20–25 (6–7.5 m) ft thick; and 4) blue shale and sandy shale, 1–5 ft (0.3–1.5 m) thick. Overlies St. Peter sandstone; underlies massive Galena limestone.

units in type Plattsmouth section can be recognized, it seems best to restrict Plattsmouth to limestone beds between Kereford (Heumader Shale absent at Plattsmouth) and Heebner Members of Oread.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5); 1949, Kansas Geological Survey, Bulletin 83, p. 126 (fig. 22), 149. Plattsmouth Limestone Member of Oread Formation; underlies Heumader Shale Member; overlies Leavenworth Limestone Member. Classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma.

T. E. Welp, L. A. Thomas, and H. R. Dixon, 1957, Iowa Academy of Science, Proceedings, v. 64, p. 418 (fig. 1.), 419. Thickness about 5 1/2 ft (1.7 m) in measured section near Winterset, Madison County; consists of blue-gray uneven beds separated by thin shales, some black chert; lower 1 ft (0.3 m) a persistent massive bed.

H. G. O'Connor, 1960, Kansas Geological Survey, Bulletin 148, p. 41, pl. 1. Thickness about 18 ft (5.5 m) in Douglas County where it is composed mostly of light-gray to nearly white wavy-bedded limestone which weathers a light gray to tan; scattered blue-gray chert nodules persistent near middle of bed.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 20-21, fig. 5. As exposed in Montgomery County, includes thin upper cherty limestone, thick section of shaly limestone containing abundant fusulinids, and lower unit containing less shale and fewer fusulinids. Thickness about 20 ft (6 m). In Cass County, thickness is about 13 ft (4 m) including thin-bedded limestone; fusulinid-bearing argillaceous limestone; calcareous olive shale containing abundant brachiopods, crinoid columnals, and large ramose bryozoans; and argillaceous to sublithographic cherty fossiliferous limestone. In Madison and Adair counties, includes 12 ft (3.6 m) of Osagia-bearing, wavy-bedded dense limestone, shale, alternating cherty limestone and platy shale, and of massive limestone containing *Ottonosia* at base. Overlies Heebner Shale Member; underlies Heumader Shale Member.

J. M. Jewett, H. G. O'Connor, D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 36, pl. 1. Plattsmouth is thickest limestone member of the Oread Limestone. Commonly it is light bluish-gray, light-weathering, wavy-bedded, dense limestone. Chert is locally abundant in the northern part of the outcrop. Fossils include fusulinids, corals, bryozoans, brachiopods, and mollusks. Thickness is commonly 15 to 30 ft (4.5–9 m).

Type locality: In Missouri River bluffs in vicinity of Plattsmouth, Cass County, Nebraska.

Pleasanton Group

Pleasanton Formation

Pleasanton Shale

Pennsylvanian (Missourian Series): eastern Kansas, southwestern Iowa, western Missouri.

E. Haworth, 1895, Kansas University Quarterly, v. 3, p. 274, pl. opposite p. 290; 1895, American Journal Science, 3rd, v. 50, p. 457, pl. opposite p. 466. Rocks between uppermost Pawnee Limestone and base of Hertha Formation.

R. C. Moore, 1932, Kansas Geological Society, Guidebook, Sixth Annual Field Conference, p. 90. Name was dropped. Interval from disconformity at base of Missourian to base of Hertha Limestone called Bourbon Group.

H. S. McQueen and F. C. Greene, 1938, Missouri Geological Survey and Water Resources, 2nd series, v. 25, p. 20, 25–26, p. 5. Upper boundary of Henrietta Group has been placed at approximate position of unconformity which separates the Des Moines and Missouri, and base of Pleasanton Group has been raised to correspond. Underlies Hertha Limestone of Kansas City Group. Thickness 100–200 ft (30–60 m).

L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, no. 1, p. 26–27 (fig. 2). Thins northward from Missouri into Appanoose County, Iowa.

J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. Columnar section, Jackson and Cass counties, Missouri, shows Pleasanton group comprises (ascending) Warrensburg channel sandstone, Sni Mills Limestone, Dawson Coal horizon, Wayside sandstone, Exline Limestone, and Knobtown sandstone. Thickness 120–262 ft (36–79 m). Overlies Henrietta Group; underlies Kansas City Group.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,028, 2,031 (fig. 4). According to interstate agreement, lowermost deposits of Missourian age, mostly clastics, called Pleasanton. Name Bourbon will be suppressed. Overlies Marmaton Group; underlies Kansas City Group.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 69–74. Group includes Hepler Sandstone at base, Checkerboard limestone, and some massive sandstones known collectively as Knobtown sandstone. Thickness 35 to 150 ft (11–45 m) along outcrop in Kansas.

C. M. Cade, 3rd, 1953, Tulsa Geological Society, Digest, v. 21, p. 130–133. Boundary between Missouri series and Des Moines series in area investigated (Nowata and Craig counties, Oklahoma) is marked by erosional unconformity, with Seminole formation lying unconformably on Lenapah Limestone. Two members of Pleasanton group, Checkerboard and Seminole were mapped.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 28–29 (fig. 5). Group composed primarily of shale with some sandstone, thin limestones, and minor amounts of coal. Not subdivided into formations although distinctive units such as Exline Limestone and Ovid Coal are recognized. Top of Desmoinesian Series is an erosional surface; hence, thickness of Pleasanton varies considerably. Thickness 19 ft (6 m) in Madison County. Upper boundary at base of Hertha limestone.

J. M. Jewett, P. A. Emery, and D. A. Hatcher, 1965, Kansas Geological Survey, Bulletin 175, pt. 4, pl. 1, 11 p. Composed in ascending order of Seminole Formation, Checkerboard Limestone, and Tacket Formation (new). Introduce South Mound Shale Member for the upper member of the Seminole Formation whose lower member is the Hepler Sandstone. "Bourbon flags" named for thick sequence of dark limestone and shale beds.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 27–28. Rocks between base of Hertha Limestone and the disconformity that separates Missourian from Desmoinesian beds are Pleasanton Group.

R. L. Ravn, J. W. Swade, M. R. Howes, J. L. Gregory, R. R. Anderson, and P. E. Van Dorpe, 1984, Iowa Geological

underlies "Grayhorse" limestone member. Further southward continuation of unit appears likely but its extent is not known.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 16–18. In the northern part of Kansas where the Grayhorse limestone member is absent, the Pony Creek shale member cannot be distinguished from the Plumb shale member; beds of maroon shale present locally in middle part north of Lyon County; beds/lenses/channels of sandstone common north of Lyon County, less common south of Lyon County; upper part of unit contains fossiliferous shale not seen in other stratigraphically close shales; thickness of up to 23 ft (7 m) reported for Pony Creek–Plumb shale interval.

C. G. Bisby, 1986, Kansas Geological Survey, Open-file Report 86–4, p. 15–16. Upper part contains marine fossils in places; channel sandstone locally developed within Pony Creek Shale; some thin limestone beds (less than 2 inches [5 cm] thick) present in upper half.

Type locality (selected by Nebraska Geological Survey): On Towle Farm 2 1/2 mi (4 km) southwest of Falls City, Richardson County, Nebraska. Named for exposures east of Pony Creek, between Kansas–Nebraska line and 2 mi (3.2 km) south of Falls City.

Pottawatomie formation

Pennsylvanian: eastern Kansas.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 92–94. Group of strata well limited stratigraphically by Pleasanton shales below and Lawrence shales above.

H. Hinds and F. C. Greene, 1915, Missouri Bureau of Geology and Mines, v. 13. Divided Pottawatomie formation into Kansas City, Lansing, and lower part of Douglas formations.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 10, 76, 95, 96, 124. Synonymized with beds from the base of the Bronson group to the top of the Lansing group.

Named for Pottawatomie River, southeastern Kansas.

Pottawatomie series

Pennsylvanian: Kansas, Missouri, Iowa, Nebraska, and Oklahoma.

R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference, Guidebook, correlation chart. Extends from unconformity at top of shale overlying Iatan limestone down to top of Pleasanton shale. Underlies Virgil series and overlies Des Moines series.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 88, 96. Abandoned Pottawatomie series and revived Missouri series for the rocks between Virgil series and Des Moines series.

Derivation of name not given, but presumably named for exposures along the Pottawatomie River in southeastern Kansas.

Potwin chat

Pennsylvanian: southern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 85. Used for detrital chert deposits at the top of the Mississippian limestone in the Potwin field, Butler County, Kansas.

Prairie Creek limestone lentil (in Geuda Springs shale member of Wellington formation)

Permian: south-central Kansas.

W. A. VerWiebe, 1937, Wichita Municipal University, Bulletin, v. 12, no. 5, p. 13. Uppermost 40 ft (12 m) of the Geuda Springs consists of drab clays that weather greenish. They are delimited by two thin limestones separated by about 5 ft (1.5 m) of shale. The limestones are rarely much more than 1 ft (0.3 m) thick, but are almost invariably accompanied by prominent veins of secondary calcite that produce a honeycomb rock. Traced from Gore Township (T. 30 S., R. 2 E.) northward to a point east of Furley in Lincoln Township (T. 25 S., R. 2 E.).

Named for occurrence along Prairie Creek, southeast of Furley, Sedgwick County, Kansas.

Preston limestone (of Wabaunsee group)

Pennsylvanian: southeastern Nebraska, Kansas.

G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science Publication, v. 9, no. 2, p. 16, 26, 28. In Missouri River section between La Platte, Nebraska, and Charleston Creek, Kansas, Preston limestone is hard, massive, bluish, breaks into boxlike blocks, and is 2.5–3 ft (0.8–0.9 m) thick. Separated from overlying Tarkio limestone by 40–50 ft (12–15 m) of shale.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 60, 63. "Preston" limestone is same as Emporia limestone; Emporia has priority.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 96. Used Emporia limestone in place of Preston limestone.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 10. Discarded Emporia limestone and replaced it with Preston limestone.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 45. Preston limestone formation was named to include two limestones separated by a shale. This formation lies between the Willard and Auburn shales. When it was found that these beds represent the "Emporia" of older Kansas surveys, the Nebraska Survey accepted and used name Emporia for a few years, that is, until it was discarded by Moore (1936, Kansas Geological Survey Bulletin 22), when he revived names Elmont and Reading, gave the name Harveyville to shale located between these limestones, and ranked the three divisions each as formations. Although the authors [Condra and Reed] believe that these units represent only members of the Preston limestone their formational rank is accepted, and name Preston limestone is dropped.

Type locality: Near level of railroad at bridge, west of Preston, Richardson County.

Prue sand

Pennsylvanian (Desmoinesian): southern Kansas and northern Oklahoma.

B. Mills–Bullard, 1928, Oklahoma Geological Survey, Bulletin 40-Q, p. 128. Named from Prue field (T. 21 N., R. 10 E.), Osage County, Oklahoma; about 150 ft (45 m) below the top of the "Oswego" limestone; correlative with the "Squirrel," "Bixler," and "Perryman" sands.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 85. Sandstone in the upper part of the Cherokee group in southern Kansas and northern Oklahoma.

Quindaro Shale Member (of Wyandotte Limestone)
Pennsylvanian (Missourian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.
R. C. Moore, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 92, 97. Cited manuscript by N. D. Newell naming unit. Very dark or black fissile shale at the base of the Argentine limestone at some exposures.
N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 59. Gray argillaceous or limy shale, 3± ft (0.9± m) thick, underlying Argentine limestone member and overlying Frisbie limestone member. Derivation of name and type section given.
E. B. Branson, 1944, Missouri University Studies, v. 19, no. 3, p. 282. Member of Iola Limestone; consists of gray calcareous shale 1–2 ft (0.3–0.6 m) thick.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,031 (fig. 4), 2,033; 1949, Kansas Geological Survey, Bulletin 83, p. 103. Quindaro Shale Member of Wyandotte Formation; underlies Argentine Limestone Member; overlies Frisbie Limestone Member. This is classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947. The Frisbie Limestone, Quindaro Shale, and Argentine Limestone, which were indicated as members of Iola Limestone in western Missouri, are classified with overlying Island Creek Shale and Farley Limestone as members of Wyandotte.
T. L. Welp, L. A. Thomas, and H. R. Dixon, 1957, Iowa Academy of Science Proceedings, v. 64, p. 420. Thickness 4 ft (1.2 m) in vicinity of Winterset, Iowa.
H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 25, fig. 5. Member of Wyandotte. Top poorly defined. Argentine–Quindaro contact arbitrarily placed where limestone is subordinate and shale dominates section. In Madison and Union counties, Quindaro Shale consists of black fissile shale overlain by gray to olive-gray fossiliferous shale and underlain by gray shale. Thickness about 3.7 ft (1.1 m). Overlies Frisbie Limestone Member. Although Condra and Upp (1933, Nebraska Geological Survey, Paper 4) did not recognize Quindaro in their Middle River traverse in Iowa, it is recognized here.
H. G. O'Conner, 1971, Kansas Geological Survey, Bulletin 203, p. 16–17. Up to 7.5 ft (2.3 m) thick along Kansas River in Johnson County, Kansas.
Type section: Exposures at Bayne's quarry (NW sec. 30, T. 10 S., R. 25 E.) in Quindaro Township, northeast of Welborn in northeastern Wyandotte County; 3 ft (0.9 m) of tan to dark-gray shale.

Quitman limestone
Pennsylvanian: northwestern Missouri, eastern Kansas.
J. A. Gallaher, 1898, Missouri Bureau of Geology and Mines, Bicentennial Report, p. 54–55. *Quitman cap rock*—Massive argillaceous limestone capping Quitman or No. 9 coal.
H. Hinds and F. C. Greene, 1915, Missouri Bureau of Geology and Mines, 2nd series, v. 13, p. 33. Same as Howard limestone; classed as member of Shawnee formation.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 204. Same as Howard limestone; name preoccupied by a Cretaceous formation in Texas.
Named for exposures at Quitman, Nodaway County, Missouri.

Quivira Shale Member (of Cherryvale Shale)
Quivira Shale Member (of Dewey Limestone)
Quivira Shale (of Kansas City Formation)
Quivira Formation (of Kansas City Group)
Pennsylvanian (Missourian Series): northeastern Kansas, southwestern Iowa, and northwestern Missouri.
R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference, Guidebook, correlation chart. Cited by Moore from manuscript of N. D. Newell. Comprises shale with a carbonaceous layer between Westerville Limestone and Cement City Limestone.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 85, 91, 97. Shale forming top member of Cherryvale shale in southern Kansas; underlies Drum limestone; overlies Dekalb limestone.
N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 18, 43. Thin argillaceous and bituminous shale underlying Cement City member of Drum limestone and overlying Westerville limestone; was erroneously considered lower part of Chanute shale by Missouri geologists.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 102. Thickness from 4 to 11 ft (1.2–3.3 m), averaging 7.5 ft (2.3 m) in Kansas City section. Noted that N. D. Newell is the author of this name.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,030 (fig. 4); 1949, Kansas Geological Survey, Bulletin 83, p. 96–97. Quivira Shale Member of Cherryvale Formation; overlies Westerville Limestone Member; underlies Cement City Limestone Member of Drum Limestone. This classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma. However, Kansas proposed to deviate from interstate classification by adopting Dewey instead of Cement City.
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 37. In Nebraska, considered a formation in Kansas City Group. Underlies P. W. A. Quarry Limestone Member (new) of Drum Formation; overlies Westerville Limestone Member of Sarpy Formation (new). Type locality stated.
T. L. Welp, A. Thomas, and H. R. Nixon, 1957, Iowa Academy of Sciences, Proceedings, v. 64, p. 420. Thickness 5 ft (1.5 m) in section measured near Winterset, Iowa.
H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 26, fig. 5. Formation in Kansas City Group. Thickness about 6 ft (1.8 m) near Crescent, Pottawatomie County; here it is brownish calcareous fossiliferous shale containing thin coquina limestone seams. Thickness about 1 ft (0.3 m) in Madison County. Underlies Drum Limestone; overlies Westerville Limestone.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 13. Quivira Shale reclassified as lower member of Dewey Limestone. Overlies Nellie Bly Formation and underlies Cement City Member of Dewey Limestone.
Type locality: At Quivira Lake, near Kansas River east of Holliday, Johnson County, Kansas.

Member of Chanute Shale. Thickness 5–8 ft (1.5–2.4 m). Overlies Muncie Creek Shale Member.

R. C. Moore, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 92. Cited manuscript of N. D. Newell. Notes that the Raytown bed, instead of being a member of the Chanute Shale, is in reality the upper, main part of the Iola Limestone.

J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, v. 27, pl. 1. Member of Chanute Shale. Underlies Liberty Memorial Shale Member (new).

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,031 (fig. 4), 2,032; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. vi (fig. 2), 13. Miscorrelation of Iola Formation by Haworth and Bennett (1908) in tracing limestone in this part of section northeastward to Kansas City has been responsible for long-standing error in nomenclature of Missourian units in northeastern Kansas and northwestern Missouri. Settlement of Iola problem has led to changes in Missouri Survey's classification of middle and upper Kansas City beds so as to bring interstate agreement in nomenclature. Paola Limestone, Muncie Creek Shale, and Raytown Limestone, which were treated as members of Chanute Shale, are recognized as belonging to Iola Formation. Underlies Lane Shale (redefined for Missouri).

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 26, fig. 5. Member of Iola Limestone. As recognized in Middle River section in Madison County, is composed of a 9-ft (3-m) sequence of light-gray wavy-bedded fossiliferous limestones separated into two or three units by thin shales. This unit differs from the Raytown of Condra and Upp (1933, Nebraska Geological Survey, Paper 4). They describe it as several thin limestone beds, all of which are quite fossiliferous and report a thickness of about 3 ft (0.9 m). Overlies Muncie Creek Shale Member; underlies Lane Shale.

P. H. Heckel and J. Cocke, 1969, American Association of Petroleum Geologists, Bulletin, v. 53, p. 1,058. Raytown Limestone Member up to 40 ft (12 m) thick in Allen and northwest Neosho counties where it forms phylloid algal mound complex.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 14–15. Higher beds of limestone separated by thin shale in Miami, Anderson, Allen, and Neosho counties belong to the Wyandotte Limestone. Thin shale is remnant of Liberty Memorial Shale (new).

Named for Raytown, Jackson County, Missouri.

Reading Limestone Member (of Emporia Limestone)

Reading Limestone (of Wabaunsee Group)

Pennsylvanian (Virgilian Series): eastern Kansas, northwestern Missouri, southeastern Nebraska, southwestern Iowa, north-central Oklahoma.

A. J. Smith, 1905, Kansas Academy of Science, Transactions, v. 19, p. 150. *Reading blue limestone*—Fossiliferous limestone, 3 ft (9 m) thick, formerly called *Emporia blue limestone*. Extends across Greenwood, Lyon, and Osage counties, and probably much farther. Underlies Olpe shales (restriction of Adams' definition of Olpe) and overlies Humphrey shales.

G. E. Condra, 1935, Nebraska Geological Survey, Paper no. 8, p. 10. *Reading limestone*, bluish gray, one or two beds, weathers brownish; 3± ft (0.9± m) thick. Basal member of Preston ("Emporia") limestone formation. Underlies Harveyville shale (member of Preston formation) and overlies Auburn shale formation. The Preston is overlain by Willard shale.

R. C. Moore, 1936 (1935), revised classification, Kansas Geological Survey, Bulletin 22, p. 49, 224, 225. Showed *Reading limestone* 1) as basal member of old Emporia limestone (which he discarded); 2) as underlying Harveyville shale; and 3) as overlying Auburn shale, the latter shale resting on Wakarusa limestone. On p. 219, Moore stated: Beede's original Wakarusa limestone is identified as unit here called *Reading limestone*, and Wakarusa limestone as now defined by usage, mainly by Condra, was included in upper part of Beede's "Stanton" (=Burlingame) limestone. The name Wakarusa (Beede, 1898, Kansas Academy of Science, Transactions) has priority over *Reading*, and if we are correct in concluding that Beede's term was applied to same unit later called *Reading*, then proper designation for this limestone is *Wakarusa*. Application of latter name to another unit by Condra, however, and desirability of retaining this usage as applied to many sections in recent papers, lead us to selection of Smith's term as next one available. Thickness is 1 1/2–15 ft (0.5–4.5 m), and formation is continuous from southern Nebraska to northern Oklahoma.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 184–185. Reading limestone is lower part of Stonebreaker limestone in northern Oklahoma.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,275. Rank reduced to member status in Emporia limestone here recognized and used as originally defined. Underlies Harveyville shale member; overlies Auburn shale.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 56–57. Described in Pawnee County, where it is 15–26 ft (4.5–8 m) thick. Underlies Harveyville shale member; overlies Auburn shale. Unit not easily traced and both northern and southern extremities in county are indistinct. Occurs south of Pawnee County, but southern extent not yet known.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 13, fig. 5. Geographically extended into southwestern Iowa where it is classified as formation in Wabaunsee group. Consists of two beds of gray crinoidal limestone which characteristically weather to deep brown; commonly fossiliferous with crinoid and brachiopod fragments. Thickness about 3 ft (0.9 m). Underlies Harveyville shale; overlies Auburn shale.

Type locality: In vicinity of Reading, Lyon County, Kansas. Well exposed in roadcut near northwest corner sec. 33, T. 17 S., R. 13 E., 1 mi (1.6 km) north of Reading.

Reagan Sandstone

Upper Cambrian: Oklahoma, eastern and central Missouri, and Kansas subsurface.

J. A. Taff, 1902, U.S. Geological Survey, Atoka Folio, No. 79. In Atoka quadrangle is represented by a single outcrop; incorrectly spelled "Regan" on map legends.

J. A. Taff, 1903, U.S. Geological Survey, Tishomingo folio, No. 98. Lower part where formation is thickest rests

K. C. Heald, 1916, U.S. Geological Survey, Bulletin 641, p. 24. A number of distinct beds of limestone between which are beds of shale in some localities; top bed of the limestone in much of the Foraker quadrangle shows an abundance of tiny grains of crystalline calcite on fresh surfaces, giving the surface the appearance of having been covered with frost or light snow; thickness up to 17 ft (5.1 m), usually much less; lies 18 ft (5.5 m) above the Foraker limestone and 71 ft (21.5 m) below the Neva limestone.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 84, 86, 88. Named the three beds (Glenrock limestone, Bennett shale, Howe limestone) that he later (Condra, 1935, Nebraska Geological Survey, Paper 8, p. 8) called members of the Red Eagle Limestone.

N. W. Bass, 1936, Kansas Geological Survey, Bulletin 23, p. 41. Correlated members of Red Eagle Limestone from type section of formation in Oklahoma to Chase County, Kansas.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 50. Transferred unit to Council Grove group in "Permian."

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, part 4, p. 167–168. Red Eagle Limestone includes: Howe Limestone Member, Bennett Shale Member, Glenrock Limestone Member. Underlies Roca Shale; overlies Johnson Shale; thickness averages 19 ft (5.6 m) across state. Council Grove Group. Wolfcampian.

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 37–41. Members not easily distinguished south of Greenwood County because formation is entirely limestone; average thickness about 11 ft (3.3 m) north of Lyon County; thickens to as much as 28 ft (8.5 m) in northern Lyon County (where it contains a biostrome); ranges from 10 to about 25 ft (3–7.6 m) south of Lyon County.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in,* D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 46. Thickness 6–33 ft (1.8–10 m).

D. L. Baars, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed raising Virgilian–Wolfcampian boundary upward to base of Neva Limestone. Reassigned rocks below Neva, including Red Eagle Limestone, to Admire Group; Virgilian Series (Upper Pennsylvanian).

Type locality: Named for exposures near Red Eagle School, southwest of Foraker, Osage County, Oklahoma.

Red Fork sand

Pennsylvanian (Desmoinesian): eastern Kansas and northern Oklahoma.

B. Mills-Bullard, 1928, Oklahoma Geological Survey, Bulletin 40–Q, p. 180. Sand in the Red Fork oil field, Tulsa County, Oklahoma, that lies about 675 ft (205 m) below the top of the "Oswego" limestone and about 45 ft (14 m) above the "Bartlesville"; equivalent to the "Skinner" sand.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 86. Used in some places in eastern Kansas for sandstone in the upper part of the Cherokee group, but commonly for deposits that are lower than what locally is called "Squirrel sand."

Red limestone (of Cherokee Group)

A name used by Pierce and Courtier (1937, p. 40) and Williams (1937, p. 107, 110), both in Kansas Geological Survey, Bulletin 24, for a limestone bed above a local coal that is present above the Mineral coal in Labette County. This coal is probably the Robinson Branch coal.

Reeder sandstone

Cretaceous (Upper): south-central Kansas.

F. W. Cragin, 1895, American Geologist, v. 16, p. 381, 382. The leaf-bearing Reeder (Dakota?) sandstone surmounts Kiowa shales in upper valley of Medicine Lodge River near post office at Reeder.

C. N. Gould, 1896, American Journal of Science, 4th series, v. 5, p. 169–175. Cragin's term Reeder sandstone is here used to include all sandstone between Kirby clays below and true leaf-bearing Dakota sandstone above. Consists of 20–150 ft (6–45 m) of dark-brown massive sandstone, often cross-bedded, containing many pebbles and nodular concretions; top formation of Medicine beds (the transition series), separated from underlying Kiowa shale by (top to bottom) Kirby clays, Greenleaf sandstone, and Spring Creek clays.

W. H. Twenhofel, 1920, American Journal of Science, 4th series, v. 49, p. 281–297. Discarded Medicine beds and treated Reeder sandstone and Kirby clay as members of his "Dakota" formation.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 153. Dakota formation as herein defined contains stratigraphic units formerly called Rocktown channel sandstone, Ellsworth formation, Solomon formation, Reeder sandstone, Marquette sandstone, Spring Creek clay, and others.

Named for exposures in upper valley of Medicine Lodge River (Kiowa and Barber counties, Kansas) near post office at Reeder, Kansas.

Reed Springs formation

Mississippian.

J. R. Clair, 1948 [1948], Kansas Geological Society, p. 11–12, pl. 1 [World Oil, v. 129, no. 8, p. 62, 66]. Fern Glenn [sic] formation in Kansas composed of Reed Springs member (25–98 ft [7.6–30 m] thick) above and St. Joe member (15–65 ft [4.5–19.7 m] thick) below. [Misspelling for Reeds Spring.]

M. W. Lambert, 1988, Kansas Geological Survey, Open-file Report 88–37, p. 2, 4. The Reed Springs/Gilmore City is a combination of the two most widely used names for the formation immediately above the Sedalia/Northview. It is commonly called "Reed Springs" in southern Kansas and "Gilmore City" in the northern part of the state. It may be a limestone or cherty limestone, and is more rarely a dolomitic limestone; pinches out in Reno County. [Misspelling for Reeds Spring.]

Reeds Spring Limestone

Reeds Spring Formation

Reeds Spring Member (of Chouteau Formation)

Reeds Spring Chert Member (of Boone Formation)

Mississippian (Osagean Series): subsurface south-central and southeastern Kansas.

R. C. Moore, 1928, Missouri Bureau of Geology and Mines, 2nd series, v. 21, p. 143–145, 161–163, 169, 170, 190, 191, 193, 225. *Reeds Spring limestone member of Boone formation*—Blue limestone, very compact, fine-grained subcrystalline, in thin beds alternating with dark flinty bands of chert. In some sections a thin bed of shale (4 inches to 1

L. V. Davis, 1955, Oklahoma Geological Survey, Bulletin 73, p. 64. Relay Creek dolomite beds included in upper part of Marlow Formation. Consists of two thin beds separated by 15–20 ft (4.5–6 m) of red sandy shale.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shown on chart as Relay Creek Dolostone Member of Whitehorse Formation.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 89, p. 52–53. Member consists of two beds of dolomite separated by 21 ft (6.4 m) of red and white fine-grained sandstone. The dolomite beds found only in Comanche County, and in places one or both may be absent. Locally includes anhydrite or gypsum. Thickness about 22 ft (6.6 m).

Named for exposures near Relay Creek in T.15 N., R.12 W., Oklahoma.

Republican River formation

Pliocene (lower): northern Kansas and south-central Nebraska.

H. F. Osborn, 1907, American Museum of Natural History, Bulletin, v. 23, p. 250, 251; W. B. Scott, 1907, Textbook of Geology, p. 724. Name applies to lower Pliocene strata that form part of Ogallala formation.

A. L. Lugn, 1939, Geological Society of America, Bulletin, v. 50, p. 1,271–1,273. Exposures generally referred to the Republican River beds in southwestern Nebraska and parts of Kansas are now known to belong to lower part of Ogallala group, that is, they are equivalent to upper part of Valentine formation and lower part of Ash Hollow formation.

Named for exposures along the Republican River in southern Nebraska and northern Kansas.

Reserve shale member (of Falls City limestone)

Pennsylvanian: northeastern Kansas and southeastern Nebraska.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 5, 9. Middle member of Falls City limestone formation; blue-gray, argillaceous, about 4.5 ft (1.4 m) thick; underlies Lehmer limestone member; overlies Miles limestone member.

Type locality: In upland near state line, northwest of Reserve, Brown County, Kansas.

Rexroad Formation

Rexroad Member (of Ogallala Formation)

Pliocene: Kansas and Oklahoma.

H. T. U. Smith, 1940, Kansas Geological Survey, Bulletin 34, p. 95–99, 112. Alternating beds of gray to reddish mudstone, buff sandy silt, rusty sand and gravel, and a few thin seams of lignite; some Rexroad beds are indistinguishable from typical Ogallala; individual exposures do not exceed 35 ft (11 m), but thickness probably at least as great as local relief (about 80 ft [24 m]); contact with overlying Ogallala not exposed; underlies Kingsdown formation in some areas (e.g., Clark County).

J. C. Frye and C. W. Hibbard, 1941, Kansas Geological Survey, Bulletin 38, pt. 13, p. 395, 399, 400, 407–410. Beds called Rexroad by Smith (1940) called Rexroad member (upper Pliocene) of Ogallala formation; thickness 50–250 ft (15–76 m); unconformably overlain by basal sand and gravel of Meade formation of Pleistocene age. Lower and thicker part of Rexroad member does not crop out at surface in Meade basin area; therefore thickness and character of member are known only from test-hole samples and well logs. Upper beds of member (exposed at surface) consist of blue-gray, tan, and gray sand, silt, and clay.

C. W. Hibbard, 1949, Michigan University Museum of Paleontology, Contributions, v. 7, no. 5, p. 91–105. Includes XI member in lower part; overlies Laverne formation, angular unconformity.

C. W. Hibbard, 1950, Michigan University Museum of Paleontology, Contributions, v. 8, no. 6, p. 113–192. Rexroad has been called many things by many people working in western Kansas; history of terms Rexroad and Meade traced and relationship of Rexroad fauna to other faunas is given.

J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 65. Rexroad formation originally described and named by Smith (1940) from exposures now classed as Blanco formation.

C. W. Hibbard, 1958, American Journal of Science, v. 256, no. 1, p. 55, 56. Underlies Angell member of Ballard formation. Rexroad formation was included in Blanco formation of former State Geological Survey of Kansas classification. Formation now recognized as older than Meade group; considered to be of late Pliocene age.

C. K. Bayne and H. G. O'Connor, 1968, Kansas Geological Survey, Bulletin 189, p. 59. The Rexroad Formation, which is late Pliocene in age, is probably equivalent to the upper part of the Ogallala.

Type locality: Named from exposures along tributaries of Crooked Creek on Rexroad Ranch, sec. 22, T. 33 S., R. 29 W., Meade County, Kansas.

Rhinoceros Hill Beds (in Ogallala Formation)

Rhinoceros Hill Beds (in Ash Hollow Formation)

Pliocene (lower): western Kansas.

M. K. Elias, 1931, Kansas Geological Survey, Bulletin 18, p. 159–163. Rhinoceros Hill beds and diatomaceous marl of the Ogallala occur in northeastern part of Wallace County, in a basin of the north fork of the Smoky Hill River near Marshall ranch; according to the rich vertebrate fauna collected in them they must be contemporaneous with Ogallala formation. The large collection of fossil mammals (referred to by H. T. Martin as Lower Pliocene) occurred in greenish-gray sand immediately underlying a bed of snow-white diatomaceous marl (4–11 ft [1.2–3.3 m] thick) that lies near the top of the local Tertiary section. The marl is capped by a thin ledge of white limestone, overlain by 10 ft (3 m) of slightly cemented grit, containing fragments of similar mammal bones, which completes the 115-ft (35-m) local Tertiary section. Another quarry, about 3 mi (4.8 km) north and a little west of Rhinoceros Hill in Sherman County, with similar mammal bones was excavated and is slightly older than Rhinoceros Hill sediments. The unconsolidated fine silty beds of Sherman County, called by Martin "Edson beds" (from a small town in Sherman County), must be about 50–80 ft (15–24 m) lower than the Rhinoceros Hill beds, but still lower Pliocene. Pierre shale must not be far below Edson beds.

M. K. Elias, 1942, Geological Society of America, Special Paper 41, p. 144, 145. Included in Ash Hollow formation (Ogallala group); about 10–15 ft (3–4.5 m) of unconsolidated sand with mammalian remains and a 6- to 7-ft (1.8–2.1-m) deposit of white diatomaceous marl (above) that

L. L. Brady, 1990, Geological Society of America, Coal Geology Division guidebook, p. 107–127. General distribution and resources of the Riverton coal in Kansas (p. 118, fig. 8D).

Name derived from the town of Riverton in southeastern Cherokee County, Kansas.

Riverton formation
Riverton cyclothem

Pennsylvanian (Desmoinesian Series): southeastern Kansas and southwestern Missouri.

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 21; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 196. Cherokee Group is divided into 15-cyclic formational units. Riverton, first in the sequence (ascending), occurs below the Neutral formation (cyclothem) and unconformably overlies eroded surface of the Mississippian. Average thickness of formation is 38 ft (11.4 m). Includes Riverton coal, 3–10 inches (7.5–25 cm) thick.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as Riverton formation in Krebs group. Underlies Warner formation.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 29–32. Described in southeastern Kansas as a formation in Krebs subgroup of Cherokee Group. Thickness 10–20 ft (3–6 m); average 15 ft (4.5 m). Consists of a basal shale 4 or 5 ft to 13 ft (1.4 or 1.5–4 m) thick, an underclay 2–4 ft (0.6–1.2 m) thick, and Riverton coal. Overlies leached chert rubble derived from underlying Mississippian rocks.

Name derived from the town of Riverton in southeastern Cherokee County, Kansas.

Robinett flags

Pennsylvanian: southeast Kansas.

E. E. Haworth and M. Z. Kirk, 1894, Kansas University Quarterly, v. 2, p. 108. The flagging stone on the Neosho River may be called Robinett flags, while of course those at Fort Scott will retain the name of the city near which they occur.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,822. Trade name of sandstone in Pleasanton group in southeast Kansas.

Presumably named from quarrying operations on land of A. G. Robinett in sec. 13, T. 30 N., R. 20 E.

Robbins Shale Member (of Lawrence Formation)
Robbins Shale

Pennsylvaninian (Virgilian Series): southeastern Kansas and southeastern Nebraska.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 146, 153, etc. Marine gray silty shale, 1–100 ft (0.3–30 m) thick, forming top member of Stranger Formation in southern Kansas. In Chautauqua County, some massive sandstone beds appear abruptly in the Robbins and probably continue into Oklahoma. Is unconformably overlain by Ireland Sandstone and underlain by Haskell Limestone. Heretofore included in Lawrence Shale, but unconformity at base of Ireland Sandstone Member of Lawrence Shale (restricted) extends across Kansas. Therefore Lawrence Shale is restricted to beds above the unconformity. Type locality designated.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 29. Stranger-age beds are exposed in three small areas on Table Rock–Richfield anticlines in Cass and Sarpy counties in North Branch Weeping Water Creek valley, Eightmile Creek valley, and Platte River bluffs in vicinity of South Bend. Well logs show that these beds extend into subsurface through Forest City basin and rise to surface in outcrop areas of Missouri and Kansas. Stranger section in Cass County is Robbins Shale above and Cass Formation below. Robbins Shale is about 3 ft (0.3 m) thick in Burlington quarries near South Bend. Rests conformably on Haskell Member of Cass Formation, but its upper boundary is at post-Stranger unconformity below the Lawrence Formation.

H. C. Wagner and L. D. Harris, 1953, U. S. Geological Survey, Oil and Gas Investigations, Chart OC–48. Described in Fredonia quadrangle, Kansas, where it is more than 120 ft (36 m) thick in southern part of quadrangle, thins to 50 ft (15 m) in northern part. Predominantly a light-olive-gray slightly silty shale that is characterized by beds and lenses of small ironstone concretions. Overlies Haskell Limestone Member; underlies Ireland Sandstone Member of Lawrence Shale.

H. G. O'Connor, 1963, American Association of Petroleum Geologists, Bulletin, v. 47, p. 1,873–1,877. Kansas Geological Survey, based on comprehensive stratigraphic studies of Douglas and Pedee Group rocks in Kansas, Oklahoma, Nebraska, Missouri, and Iowa by S. M. Ball, abandoned the term Pedee and amended and redefined the Douglas Group to include all rocks between Stanton Limestone below and Oread Limestone above. Divided the redefined Douglas Group into two formations, the Stranger below and Lawrence above. Amended and redefined Stranger Formation to include (ascending): Weston Shale Member, Iatan Limestone Member, Tonganoxie Sandstone Member, Westphalia Limestone Member, and Vinland Shale Member. Amended and redefined the Lawrence Formation to include (ascending): Haskell Limestone Member, Robbins Shale Member, and a member to be named in the forthcoming report.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 35, pl. 1. Member consists of gray and yellowish-gray marine shale, which is locally eroded and overlapped by Ireland Sandstone Member in Franklin County and southern Douglas County. Phosphatic concretions and black fissile shale occur in a zone at the base of the member in the northern part of the outcrop area. Locally a molluscan fauna occurs in the lower beds. Thickness is 0–120 ft (0–36 m).

Type locality: Robbins Farm, sec. 11, T. 26 S., R. 15 E., southwest of Yates Center, Woodson County, Kansas.

Robinson Branch coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

W. V. Searight, 1955, Missouri Geological Survey and Water Resources, Report of Investigations 20, p. 39. Top of the formation is the Robinson Branch coal bed. In lower part, in places in Vernon and Bates counties, Missouri, in southeastern Kansas and in northeastern Oklahoma, contains a bed of black calcareous shale.

Named for Robinson Branch, a stream in Vernon County, Missouri. Complete succession was formerly exposed in

Named for exposures high in Missouri River bluffs northeast of Rock Bluff, Cass County, Nebraska.

Rock Lake Shale Member (of Stanton Limestone)
Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, and southeastern Nebraska.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 41, 59, 156, 157. Basal 6 ft (1.8 m) of Scranton Shale. Upper 1–2 ft (0.3–0.6 m) bluish; rest maroon. Underlies South Bend Limestone; overlies Howard Limestone. Type locality designated.
G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 11, 13, 26, 27, 31, 32, 33, 34, 36. Rock Lake Shale and overlying South Bend Limestone belong in top of Stanton Limestone. Rock Lake Shale rests on Stoner Limestone, also included in Stanton Limestone.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 135–136. Victory Junction Shale Member of Kansas is possibly same as Rock Lake Shale of Condra in Nebraska, which was originally erroneously included in Scranton Shale, but which belongs in Stanton Limestone.
G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 51. Rock Lake Shale was named in Nebraska but was named Victory Junction Shale by Newell (1935) from exposures in Kaw Valley area, Kansas. On basis of subsequent studies, it is agreed that original name is valid.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,031 (fig. 4); 1949, Kansas Geological Survey, Bulletin 83, p. 68 (fig. 14), 119. Rock Lake Shale Member of Stanton Formation; underlies South Bend Limestone Member; overlies Stoner Limestone Member. Classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 32. Average thickness 6 ft (1.8 m) in Nebraska; 3–4 ft (0.9–1.2 m) in northwestern Missouri; 3–8 ft (0.9–2.4 m) in Kansas. Old type locality now badly covered; co-type locality designated.
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 33, pl. 1. Gray and olive-gray argillaceous to sandy shale and sandstone that weathers yellowish gray to yellowish orange comprise most of this member. Sandstone contains *Myalina* and *Aviculopecten*. Locally the Rock Lake includes a conglomerate; elsewhere a thin, laminated gray limestone is present. Thickness ranges from about 1 to 15 ft (0.3–4.5 m) in most of eastern Kansas, but is as much as 30 ft (9 m) locally in Montgomery County.
Type locality: Exposures in vicinity of Rock Lake located in SW sec. 13, T. 12 N., R. 10 E., Sarpy County, Nebraska; co-type locality is in Platte River Bluffs just east of south gate of State fish hatcheries across Platte River northeast of South Bend.

Rocktown channel sandstone member (of Dakota sandstone)
Rocktown Sandstone Member (of Ellsworth Formation)
Cretaceous (Upper): north-central Kansas.
W. W. Rubey and N. W. Bass, 1925, Kansas Geological Survey, Bulletin 10, p. 16, 57–65. Series of very discontinuous, highly crossbedded sandstone strata occurring locally at almost any horizon from top to 125 ft (38 m) below top of Dakota sandstone in Russell County; thickness 15–100± ft (4.5–30± m).
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Member of Ellsworth formation of Dakota group; overlies Terra Cotta shale member.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 153. Dakota formation, as defined herein, contains stratigraphic units formerly called "Rocktown channel sandstone," "Ellsworth formation," "Solomon formation," "Reeder sandstone," "Marquette sandstone," "Spring Creek clay," and others.
Named for exposures at and near the large group of "hoodoos" or house-like blocks of sandstone in NW sec. 4, T. 13 S., R. 11 W., locally known as Rocktown, Russell County, Kansas.

Root Shale (of Wabaunsee Group)
Pennsylvanian (Virgilian Series): east-central Kansas.
R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,275. Defined to include strata between Wood Siding formation above and Stotler limestone (new) below. Thickness ranges from about 30 to 90 ft (9–27 m) and averages 60 ft (18 m). Comprises (ascending) Friedrich shale, Jim Creek limestone, and French Creek shale members.
M. R. Mudge and H. R. Burton, 1959, U.S. Geological Survey, Bulletin 1068, p. 15 (table 2), 30–33. Originally, strata comprising Root shale was included in McKissick Grove shale member of Wabaunsee group by Condra (1927, Nebraska Geological Survey, Bulletin 1, 2nd series). Moore (1936, Kansas Geological Survey, Bulletin 22) discarded name McKissick Grove and divided strata into 11 formations of which three, Friedrich shale, Jim Creek limestone, and French Creek shale, are now classified as members of Root shale. Average thickness 38 ft (11.5 m) in Wabaunsee County [this report].
M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 10–13. Better exposures (than type section) of Root Shale are in road cuts in the NW NE sec. 7, T. 22 S., R. 11 E., Greenwood County, Kansas; varies considerably in thickness, ranging from 35 to 86 ft (11–26 m).
Type section: In a roadcut along east-flowing stream near center of N/2 SE sec. 20, T. 21 S., R. 11 E., Lyon County. Name derived from Root Station on Atchison, Topeka, and Santa Fe Railroad.

Rossville shales and sandstone
Pennsylvanian: northeastern Kansas.
J. W. Beede, 1898, Kansas Academy of Science, Transactions, v. 15, p. 31. *Rossville shales and sandstone*—Nearly unfossiliferous shales and soft sandstones of various colors, with occasional streaks of limestone. Thickness about 100 ft (30 m). [From statement on p. 28, appear to constitute topmost part of Upper Coal Measures in Shawnee County and to overlie Dover limestone.]
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 235, 255. Discarded this term but did not explain its limits.
Apparently named for Rossville, Shawnee County.

Runnymede Sandstone (of Nippewalla Group)
Runnymede sandstone member (of Ninnescah Shale)
Permian (Leonardian Series): south-central Kansas.
G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,773–1,774. Blue-green to gray shaly sandstone 7–8 ft (2.1–2.4 m) thick, with intercalated layers of red shale and sandstone. Topmost bed of Ninnescah at its northernmost outcrop.
Bailey Rascoe, Jr., 1988, Midcontinent SEPM Special Publication No. 1, p. 7–10, fig. 1. Regional unconformity at base of Runnymede Sandstone or Stone Corral Formation where Runnymede is absent, separates Sumner Group from overlying Nippewalla Group. Raised Runnymede Sandstone to formation rank and assigned it to the basal formation of the Nippewalla Group.
Named for Runnymede, Harper County, Kansas.

Russell formation
Cretaceous (Upper): central and western Kansas.
F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 49. Alternating limestones and bluish carbonaceous to light-gray calcareous shales, constituting lower formation of Benton division in Kansas. Underlies Victoria clays or upper formation of Benton division in Kansas. Includes Downs or Fence-post limestone and *Globigerina bulloides* "Lincoln marble."
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,857. Same as Greenhorn limestone plus Fairport chalky shale member of Carlile shale.
Named for exposures at Russell, Russell County, Kansas.

Russell Creek Limestone Member (of Senora Formation)
Pennsylvanian (Desmoinesian): southeastern Kansas, northeastern Oklahoma, and southwestern Missouri.
C. C. Branson, 1954, Oklahoma Academy of Science, Proceedings, v. 33, p. 191. Name applied to limestone that forms cap rock of the Mineral coal; underlies Broken Arrow coal.
C. C. Branson, 1955, The Hopper, v. 15, no. 12, p. 137. Ferruginous clayey carbonaceous gray limestone, 10 inches to 2 ft (25 cm–0.6 m) thick in one bed; contains fusulinids.
Type section: On Leep Farm on east bank of Russell Creek where it is flowing south in NE SW sec. 15, T. 29 N., R. 20 E., Craig County, Oklahoma.

Rutland Limestone Bed (in Stanton Formation)
Pennsylvanian (Missourian): southeast Kansas.
P. H. Heckel, 1975, Kansas Geological Survey, Bulletin 210, p. 17–18. Tan to orange-brown, coarse-grained, bioclastic calcarenite; about 6 ft thick; overlies Timber Hill Siltstone Bed.
Type section: Quarried ledge south of driveway in NE corner, sec. 2, T. 33 S., R. 14 E., Montgomery County, Kansas. Named for Rutland Township.

S

Sabetha limestone
Permian: eastern Kansas and southeastern Nebraska.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 232, 234. *Sabetha limestone*, about 12 ft (3.6 m) thick, underlies Speiser shale and overlies Easly Creek shale. Consists of (descending): 1) Fossiliferous gray limestone, weathering gray or yellowish brown, 3–4 ft (0.9–1.2 m); 2) bluish-gray calcareous shale with limy nodules, 6–7 ft (1.8–2.1 m); 3) gray limestone, fossiliferous, 2–3 ft (0.6–0.9 m). Named for exposures on Omaha–Tulsa highway 1 mi (1.6 km) north of Sabetha, Kansas.
G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 21. Investigation shows that "Sabetha limestone" is correlative with Crouse limestone, which has about 10 years priority, and is here used instead of "Sabetha."
Named for exposures on the Omaha–Tulsa Highway, 1 mi (1.6 km) north of Sabetha, Nemaha County, Kansas.

Sacfox Subgroup (of Wabaunsee Group)
Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, eastern Kansas, and northwestern Missouri.
G. E. Condra, 1935, Nebraska Geological Survey, Paper 8, p. 4, 5, 10–11. Sac–Fox subgroup named to include (descending): Scranton shale, Howard limestone, and Severy shale.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 8, p. 2,036–2,037 (fig. 6); Kansas Geological Survey, Bulletin 83, p. 169–171; G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 18–20; F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 19–20. Subgroups (ascending): Sacfox, Nemaha, and Richardson by Condra (1935) included in interstate classification agreed upon by the state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma. Sacfox Subgroup in standard section includes (ascending): Severy Shale, Howard Formation, White Cloud Shale, Happy Hollow Limestone, Cedar Vale Shale, Rulo Limestone, and Silver Lake Shale.
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 39–40. Sacfox Subgroup includes: Scranton Shale, Howard Limestone, Severy Shale. Scranton Shale includes (ascending): White Cloud Shale, Happy Hollow Limestone, Cedar Vale Shale, Rulo Limestone, and Silver Lake Shale Members (formations of Moore, 1948). Thickness about 200 ft (60 m).
Type locality: In Missouri River bluffs in southeastern Richardson County, Nebraska, and adjacent part of northeastern Kansas between Rulo, Nebraska, and White Cloud, Kansas (between the mouth of the Big Nemaha and Iowa Point, Kansas). Name derived from the Iowa–Sac–Fox Indian Reservation in northeastern Kansas and southeastern Nebraska.

St. Genevieve Formation
G. Moore, 1983; *in*, J. M. Hills and F. E. Kottlowski (coordinators), AAPG–COSUNA Southwest/Southwest Midcontinent Correlation Chart. Subsurface part of Hugoton embayment in Kansas; 8 m (2.4 m) thick; misspelling of Ste. Genevieve.

roadside park in US–61, 0.5 mi (0.8 km) north of Ste. Genevieve (NE sec. 34, T. 38 N., R. 9 E.) may be regarded as the type section. Named for outcrops in Mississippi River bluffs 1 or 2 mi (1.6–3.2 km) below Ste. Genevieve, Ste. Genevieve County, Missouri.

St. Joe Limestone

Mississippian (Osagean Series).

T. C. Hopkins, 1893, Arkansas Geological Survey, Annual Report 1890, v. 4, p. 10, 212, 253–349, pl. 10. *St. Joe limestone*—Prominent bed of fossiliferous red chertless limestone, forming basal part of Boone chert and in places merging into overlying gray limestone of the Boone. Body of rock varies from light-pink to dark-chocolate color, interspersed with white, gray, or pea-green spots. Thickness 0–100 ft (0–30 m). Overlies Eureka [Chattanooga] shale, or, in its absence, the Sylamore sandstone or still older (Lower Silurian) rocks.

L. M. Cline, 1934, American Association of Petroleum Geologists, Bulletin, v. 18, no. 9, p. 1,137–1,141. Rank raised to formation.

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 47–53, pl. 2. Non-cherty limestone with green limy shale near base; locally includes red limestone and red shale; 0–90 ft (0–27 m) thick; limited to southeastern Kansas.

E. B. Branson, 1944, Missouri University Studies, v. 19, no. 3, p. 204–207. Limestone comprises Compton, Northview, and Pierson members.

J. R. Clair, 1948 [1949], Kansas Geological Society, p. 12, pl. 1 [World Oil, v. 129, no. 8, p. 62, 66]. Fern Glenn [sic] formation in western Kansas composed of Reed Springs [sic] member (25–98 ft [7.5–29.4 m] thick) above and St. Joe member (15–65 ft [4.5–19.5 m] thick) below.

C. P. Kaiser, 1950, American Association of Petroleum Geologists, Bulletin, v. 34, no. 11, p. 2,157–2,161. Formation typically consists of light-gray crinoidal limestone with a red to green silty and shaly zone near middle. Thickness 0–75 ft (0–22.5 m). Rests unconformably on Sedalia, Northview, Sylamore, and Chattanooga formations from north to south and at a few places on Ordovician. Conformably overlain by Reeds Spring limestone. Present only in southern part of area of southwestern Missouri. Recommended that term Pierson be dropped as a synonym for St. Joe.

T. R. Beveridge and E. L. Clark, 1952, Missouri Geological Survey and Water Resources, Report of Investigations 13, p. 75. Rank raised to group. Comprises (ascending) Compton, Northview, and Pierson formations. Kinderhook–Osage boundary is considered to be at contact of Northview with Pierson. Hence, St. Joe group straddles series line. In some parts of southwestern Missouri, the Northview, although persistent, is too thin to map. In such cases, the St. Joe group may be mapped as an undifferentiated unit. Overlies Chattanooga; underlies Reeds Spring.

G. G. Huffman, 1958, Oklahoma Geological Survey, Bulletin 77, p. 14 (fig. 2), 41–43, pls. 1–5. Group described on south and west flanks of Ozark uplift. Three-fold lithic development present. Basal part consists of about 10 ft (3 m) of gray nodular-weathering limestone which is thin bedded in upper parts; middle part composed of 3–5 ft (3–4.5 m) of olive-green soft limy shale; upper part consists of maximum of 25 ft (7.5 m) of gray, thick-bedded finely crystalline limestone. Maximum thickness 40 ft (12 m). Thins southward by loss of units and by unconformity at top. Unconformably overlies Chattanooga shale; unconformably underlies Reeds Spring formation. Kinderhookian–Osagean.

C. K. Bayne, 1962, State Geological Survey of Kansas, Bulletin 158, p. 23. Cowley Formation generally overlies St. Joe or Reeds Spring rocks in Cowley County, but rests on Chattanooga or older rocks in some localities.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 19, pl. 1. Member of the Fern Glen Limestone in Kansas; white, semigranular and coarsely granular noncherty crinoidal limestone in southeastern Kansas; reddish- and greenish-colored calcareous shale and dark-gray argillaceous shale in area south of Central Kansas uplift; some lithographic limestone in lower portion westward; 0–120+ ft (0–36+ m) thick.

W. J. Seevers, 1975, Kansas Geological Survey, Geology Series No. 1, p. 2–3. Lower member of Fern Glen Limestone; about 20 ft (6 m) thick in Cherokee County; crinoidal, dolomitic in part, green.

C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–68, 70, 73. Suggested that Pierson Limestone of Weller (1901) be used as a formation-level unit in Kansas instead of St. Joe Limestone Member.

Named for exposures at St. Joe, Searcy County, Arkansas.

St. Louis Limestone

St. Louis Limestone (of Blue River Group)

St. Louis Limestone (of Meramec Group)

Upper Mississippian (Meramecian Series): Missouri, Alabama, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Tennessee, and southwestern Virginia.

G. Englemann, 1847, American Journal of Science, 2nd series, p. 119–120. *St. Louis Limestone*— Hard light-yellowish or grayish rock, mostly pure carbonate of lime, in some strata mixed with sand, in others including irregular siliceous masses of a dark color, or light-colored thin siliceous strata; some strata compact and fine-grained; other strata coarser and even completely crystalline. Thickness 200–300 ft (60–90 m). Uppermost bed of carboniferous or Mountain limestone in eastern Missouri and southern Illinois. Overlain by coal-bearing strata. Rests on 50–100 ft (15–30 m) of soft, friable light-yellowish sandstone with thin coal bed at top.

G. C. Swallow, 1855, The First and Second Annual Reports of the Geological Survey of Missouri, p. 93, 174. *St. Louis Limestone*— Hard crystalline gray and bluish-gray cherty limestone with thin layers of argillaceous shale; some strata are impure silico-magnesian limestone, earthy fracture, others compact silico-argillaceous, drab or yellowish gray, conchoidal. Thickness 250 ft (75 m). Underlies Ferruginous Sandstone [Aux Vases] and overlies Archimedes Limestone [Warsaw].

B. F. Shumard, 1860, St. Louis Academy of Science, Transactions, v. 1, p. 406. St. Louis limestone [restricted] is conformably overlain by Ste. Genevieve Limestone [new name] and underlain by Third Archimedes limestone [Warsaw limestone] in St. Genevieve County, Missouri. It is 60–200 ft (18–60 m) thick. Upper 50 ft (15 m) cherty; middle 60 ft (18 m) light-gray sandy limestone; lower 20 ft (6 m) white, highly oolitic limestone [Spergen limestone].

E. O. Ulrich, 1904, Missouri Bureau of Geology and Mines, 2nd series, v. 2; and 1905, U.S. Geological Survey,

equivalents of the McLish Formation of the Simpson Group in Oklahoma.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 14. St. Peter Sandstone is an extremely pure quartz arenite. This unit and underlying green shales and sandstones are included in Simpson Group. It overlies older rocks (Precambrian basement through Cambrian–Ordovician Arbuckle Group) with angular unconformity and underlies Platteville Formation. Average thickness 50 ft (15 m) increasing southward to 109 ft (33 m) near Oklahoma border.

B. J. Witzke, 1980; *in*, T. D. Fouch and E. R. Magathan, Proceedings of Rocky Mountain Section, Society of Economic Paleontologists and Mineralogists, West Central United States Paleogeography Symposium 1, p. 1–18. A Chazyan age is assigned to the St. Peter Sandstone in the midcontinent based on conodont faunas at widely separated localities. Although it is a time-transgressive unit, the presence of these faunas immediately adjacent to the Transcontinental arch (the area reached at maximum transgression) suggests that it may not be as diachronous as previously thought.

Type section: At Fort Snelling, Hennepin County, Minnesota. Named for exposures on St. Peter River, now called Minnesota River, southern Minnesota.

Salem Limestone

Salem Formation

Mississippian (Meramecian Series): subsurface.

E. R. Cummings, 1901, Journal of Geology, v. 9, p. 232–233; American Geology, v. 27, p. 147. *Salem limestone*—Gray oolitic limestone formerly called Bedford Limestone (preoccupied). Overlain by bastard limestone, which forms basal part of Mitchell Limestone, and underlain by bryozoan limestone forming upper zone of Harrodsburg Limestone.

J. M. Weller and A. H. Sutton, 1940, American Association of Petroleum Geologists, Bulletin, v. 24, no. 5, p. 766 (fig. 1), 811–813. Discussed use of terms Salem and Spergen. Salem placed in Meramec Group, Iowa series.

W. Lee, 1943, Kansas Geological Survey, Bulletin 51, p. 75. Mapped the Salem Limestone from Missouri into northwest Kansas.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, no. 2, chart 5. Shown on correlation chart in Meramecian Series.

T. L. Thompson and E. D. Goebel, 1968 [1969], Kansas Geological Survey, Bulletin 192, p. 4, 6, 11–13. Reported conodont fauna from Salem Limestone in subsurface of Kansas; most of the Salem is preserved in structural basins as a noncherty, yellowish-gray granular limestone interstratified in the upper part with noncherty, saccharoidal dolomite; specimens of Endothyra are present; silt and masses of sponge spicules are present. In southwestern Kansas the Salem consists mainly of semigranular and granular limestone, in part dolomitic. Where the Salem Limestone is oolitic, it is difficult to distinguish from the overlying St. Louis Limestone. The Salem is differentiated from the Warsaw on the basis of smaller proportions and a different kind of chert, generally abundant *Endothyra*, sparse glauconite, local oolitic lenses, and dolomitic limestone and saccharoidal dolomite. The formation increases in thickness southward from 0 ft along the outline of the Pennsylvanian subcrop pattern to more than 200 ft (60 m) in the Hugoton embayment. Warsaw, Salem, and St. Louis equivalents are probably widespread in the southern portion of the Sedgwick basin but have not been recognized because of the "Cowley facies" and because either the chert residuum of the "Mississippi chat" or chertified rocks conceal them.

V. B. Cole, 1975, Kansas Geological Survey, Open-file Report, 75–8, sheet 4, scale 1:1,200,000. Compiled thickness map for Spergen [=Salem] Limestone in southwestern Kansas; ranges from 0 to 350 ft (0–105 m) thick.

W. J. Ebanks, Jr., R. M. Euwer, and D. E. Nodine–Zeller, 1977, American Association of Petroleum Geologists, Bulletin, v. 61, p. 309–330. Paleontologic evidence indicates that beds of Salem age are present in the so-called "Warsaw" of the Bindley field, Hodgeman County, area.

G. Moore, 1983; *in*, J. M. Hills and F. E. Kottlowski, coord., AAPG–COSUNA Southwest/Southwest Midcontinent Correlation Chart. "Salem" (Spergen) Formation noted as being 1.6–4 m (5.3–13.2 ft) thick in Kansas part of Hugoton embayment; but Salem Formation noted as 0–25 m (0–82.5 ft) thick in Kansas part of Las Animas arch.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 4, 6–8, 10, 11, 13, 66, 101, 104, 106–110, 115–117. Presents nomenclatural history and use of the term Salem Limestone, especially as applied to Missouri.

C. B. Rexroad, 1986, Indiana Geological Survey, Bulletin 59, p. 132–133. Gives history of Salem Limestone in Indiana.

M. E. Wilson, 1988, Kansas Geological Survey, Open-file Report 88–50, p. 33. The Salem Limestone is distinguished from the Warsaw on geophysical logs by decreased gamma-ray count, indicating lower clay content, and by decreased neutron-porosity values relative to density-porosity, representing decreased dolomite content; the contact is placed at the base of the first pure limestone bed approximately 20 ft (6 m) thick.

Type locality: No type section was designated by Cummings (1901); however, he referred to a section described by Gorby (1886, p. 143). This section has been removed by quarrying. Smith (1970) noted that an abandoned part of the Hoosier Stone and Concrete Corporation quarry (NE sec. 24, T. 2 N., R. 3 E., west edge of Salem, Washington County, Indiana) is in nearly the same place as Gorby's section and designated it as the principal reference section.

Salem Point Shale Member (of Grenola Limestone)

Pennsylvanian (Virgilian Series): eastern Kansas, southeastern Nebraska, and north-central Oklahoma.

G. E. Condra and C. E. Busby, 1933, Nebraska Geological Survey, Paper No. 1, p. 10, 15. *Salem Point shale member of Grenola formation*—The Grenola formation is divided into following members (descending): Neva limestone, Salem Point shale, Burr limestone, Legion shale, and Sallyards limestone. The Salem Point member consists of gray shale with a thin sandy-limy layer at Roca, Nebraska; of gray argillaceous shale with a thin nonfossiliferous sandy zone in southern Nebraska and northern and central Kansas; of gray calcareous and sandy shale thinning to past Hooser, Kansas, and Burbank, Oklahoma, becoming red shale at Fairfax, Ralston, and Pawnee, Oklahoma. It is less organic in origin and therefore less fossiliferous than Legion shale and Sallyards limestone. Thickness 3 1/2–10 ft (1.1–3 m).

(descending): Dog Creek formation, Cave Creek gypsum, Glass Mountain formation, and Kingfisher formation or Harper sandstone. Underlies Kiger stage and overlies Sumner stage.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 25, 26. Recorded as Salt Fork group from subsurface composite section of southern Nebraska and vicinity of Wray, Colorado; thickness 633 ft (189.9 m; top eroded); includes (descending): Dog Creek–Blaine formations, Flowerpot shale formation, Cedar Hills–Salt Plains–Harper section, Stone Corral formation, and Ninnescah formation.

Named for Salt Fork, Comanche and Barber counties, Kansas.

Salt Grass Shale Member (of Pierre Shale)

Cretaceous (Upper): northwestern Kansas.

M. K. Elias, 1931, Kansas Geological Survey, Bulletin 18. Gray, clayey shale, with few thin bentonite beds, medium-sized limestone concretions, many with cone-in-cone structure, and limonite concretionary streaks in abundance; thickness 60 ft (18 m); lowest zone in many places contains several layers of light-gray to nearly white limestone concretions and in places irregular bodies of limestone in which *Lucina occidentalis* is very abundant; overlies Lake Creek shale member of Pierre and lies 600–700 ft (180–210 m) below top of Pierre shale in Wallace County, Kansas.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 22, 23. Gray clayey shale that contains numerous thin bentonite beds, limestone concretions, and concretionary limonite zones; overlies Lake Creek Shale Member; underlies an unnamed shale 500–600 ft (150–180 m) thick that in turn underlies Beecher Island Shale Member.

Named for Salt Grass Canyon, the southern tributary of Goose Creek in secs. 1 and 12, T. 12 S., R. 42 W., Wallace County, Kansas.

Salt Plain Formation (of Nippewalla Group)

Salt Plain Shale (of Cimarron Group)

Salt Plain shale member (of Enid formation)

Permian (Leonardian Series): central southern Kansas.

F. W. Cragin, 1896, Colorado College Studies, v. 6, p. 3, 20–24. Red clay shales, probably with some sandstone, 155 ft (46.5 m) thick, impregnated with salt and constituting what may be regarded as upper or secondary salt measures of the Kansas Permian; overlies Harper sandstones; underlies Cedar Hills sandstones; included in Salt Fork division.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Abandoned; Harper and Cedar Hills shown as members of Enid formation with intervening Salt Plain shale member dropped.

G. H. Norton, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,762–1,763 (fig. 2), 1,764–1,765 (fig. 3), 1,786–1,789. Included in Nippewalla Group (new). Overlies Harper Sandstone; underlies Cedar Hills Sandstone. Cimarronian Series.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 39. Formation consists chiefly of red, flaky, silty shale and some siltstone. Includes Crisfield sandstone bed about 115 ft (34.5 m) below top. Thickness 265 ft (79.5 m). Overlies Harper Sandstone; underlies Cedar Hills Sandstone. In Nippewalla Group. Leonardian.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shows Salt Plain Siltstone with Crisfield sandstone bed in upper part.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 51. Includes Crisfield sandstone bed, about 29 ft (8.7 m) thick, 115 ft (34.5 m) below the top. Crops out in eastern Barber, Harper, and southern Kingman counties, forming surface of low relief.

Named for Great Salt Plain of Cimarron River, Kansas.

Sanborn Formation

Sanborn Group

Pleistocene: western Kansas.

M. K. Elias, 1931, Kansas Geological Survey, Bulletin 18, p. 163. Pleistocene loess, with some gravel and sand at base; widely distributed on divides; name applied only to loess section on divides and not reworked down hillsides and into valleys; 180 ft (54 m) thick in northwest corner of Cheyenne County, Kansas; 20–60 ft (6–18 m) thick in other parts of the county. The name Sanborn formation is intended as a substitute for the old terms "Tertiary marl" or "Plains marl," introduced for this formation by Hay (1893).

A. L. Lugn, 1934, Nebraska State Museum, v. 1, Bulletin 41, p. 355. "Sanborn formation" (Elias, 1931) of western Kansas is a composite of sand, gravel, and loess, ranging in age from early Pleistocene (Kansan and perhaps older) to Peorian or younger (the "yellow dirt"). The separate parts of "Sanborn formation," especially the loess, are differentiated in Nebraska and should not have been grouped together as a formation; at least a new formation name should not have been assigned.

A. B. Leonard and J. C. Frye, 1943, American Journal of Science, v. 241, p. 453–462. Pleistocene age (based on fossil snails); unconformably overlies Ogallala beds.

C. W. Hibbard, J. C. Frye, and A. B. Leonard, 1944, Kansas Geological Survey, Bulletin 52, p. 3–26. Essentially the entire Pleistocene section exposed in north-central and northwestern Kansas, exclusive of some distinct terrace beds of local extent; occur from western Jewell County westward for more than 200 mi to (320 km) Yuma County, Colorado. Formation consists of an upper gray silt bed that is persistent over the entire area, an underlying soil zone that occurs only in north-central Kansas, and pre-soil deposits consisting of a wide variety of lithologies.

J. C. Frye and O. S. Fent, 1947, Kansas Geological Survey, Bulletin 70, p. 40, 41. Proposed that late Pleistocene loesses, associated deposits, and lateral facies generally occurring in northern and central Kansas, be classed as Sanborn formation and the Loveland silt, Peoria silt, and Bignell silt and their lateral coarse-textured facies be assigned rank as members; type section designated.

J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 106–110. Includes deposits of two stages (Illinoian and Wisconsinan); includes two unconformities, defined by the Sangamon and Brady buried soils; and represents three distinct cycles of deposition. Includes (top to bottom): Bignell silt member; unnamed Wisconsinan alluvial deposits; Peoria silt member, commonly containing Brady buried soil; unnamed early Wisconsinan alluvial deposits; Loveland silt member, commonly containing

silt and some sand; in south-central Kansas sheetlike deposits laid down by coalescing streams are present; in northern and central Kansas these deposits underlie a prominent terrace adjacent to the principal stream valleys; in northwestern Kansas these deposits underlie a dissected terrace adjacent to the major streams; locally contains the distinctive Pearlette ash bed; thickness commonly 20 ft (6 m).

Named from exposures in abandoned volcanic ash mine of Cudahay Packing Co., near Orleans in Sappa Township, Harlan County, Nebraska.

Scammon coal bed (in Cabaniss Formation, Cherokee Group)
Scammon formation
Scammon cyclothem

Pennsylvanian (Desmoinesian Series): southeastern Kansas, southwestern Missouri, and northeastern Oklahoma.

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 22; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 196. Cherokee Group is divided into 15-cyclic formational units. The Scammon, eighth in the sequence (ascending), overlies the Pilot and underlies the Mineral. Average thickness 33 ft (11 m). Includes a thin coal here designated Scammon.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 98, 101. The Scammon cyclothem includes in ascending order: sandstone or impure limestone, underclay, coal (Scammon), black shale, and gray shale. Thickness ranges from 20 to 30 ft (6–9 m).

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as Scammon formation in Cabaniss group. Underlies Mineral formation; overlies Tebo formation.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22, 52–60. Formation in Cabaniss subgroup of Cherokee Group. Includes beds above Tebo coal and extends to top of Scammon coal. Complete succession included in formation is exposed at only one Kansas locality (strip-pit highwall in SE NE sec. 24, T. 28 S., R. 25 E., Crawford County). Following divisions recognized in Kansas: dark-gray to black fissile shale at base, including single limestone bed (Tiawah); fine-grained sandstone and siltstone; medium- to dark-gray shale; sandstone (Chelsea); underclay; Scammon coal bed. In some areas in Kansas and Missouri, the Chelsea sandstone rests on an erosion surface extending down through the lower beds and locally through the Tiawah limestone and underlying Tebo coal. Thickness of formation is 28–32 ft (8.4–9.6 m) in eastern Crawford County; 35–45 ft (10.5–13.5 m) in central and southern Crawford County and northern Cherokee County.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. The Scammon coal bed is about 0.7 ft (0.2 m) thick and is present about 16 ft (4.8 m) below the Mineral coal bed and is separated from the coal by underclay, sandy and silty shale.

Type locality: Along Cherry Creek, northwest of Scammon, Cherokee County, Kansas.

Scandian Sub-Age
Scandian Substage

Pleistocene: midcontinent region.

J. C. Frye and A. B. Leonard, 1955, American Journal of Science, v. 253, p. 359, 362. Provincial time-stratigraphic and time term used to designate the interval from the end of Sangamonian to the beginning of Bradyan.

Type locality: Section of fossiliferous silt (NW sec. 5, T. 3 S., R. 4 W.), 40 ft (12 m) thick, resting on Sangamon soil developed in thin Loveland silt that overlies the Greenhorn limestone, in the bluff of the Republican River valley north of the town of Scandia, Republic County, Kansas.

Schroyer Limestone Member (of Wreford Limestone)

Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 33. Top member of Wreford Limestone. Chert-bearing limestone, 8 or 9 ft (2.4–2.7 m) thick in vicinity of Cambridge, Cowley County, Kansas, and about 20 ft (6 m) thick in Big Blue Valley, in vicinity of Randolph. In Nebraska maximum exposed thickness is about 10 ft (3 m), in a small creek valley 3 mi (4.8 km) southeast of Wymore. Type locality designated. Overlies Havensville Shale and underlies Wymore Shale Member of Matfield Formation.

D. E. Hattin, 1957, Kansas Geological Survey, Bulletin 124, p. 43–49, pls. 1–3. Three units invariably present in Schroyer (ascending): 1) basal cherty limestone, which locally contains some shale in northern Kansas; 2) a shaly unit, which commonly contains a cherty limestone bed, and 3) algal limestone. No exposure examined includes more than 13 ft (3.9 m) of Schroyer. On basis of lithology, much of what has been called Schroyer at type locality should be included in underlying Havensville Shale. At several places in Marshall and Pottawatomie counties, the Havensville includes a molluscan-limestone phase. At first appearance, this molluscan limestone seems to belong to the Schroyer; however, placement of this unit in the Havensville is harmonious with respect both to cycles of sedimentation and to observed thicknesses of shaly exposures of the Havensville. Therefore only 5 ft (1.5 m) of cherty limestone at type section should be classified as Schroyer, and at present only 1.6 ft (0.4 m) of Schroyer is actually exposed. In this report, boundary between Schroyer Limestone and Havensville Shale is placed at the contact of chert-bearing limestone on shale or noncherty limestone, the strata above and below the contact thus being lithologically and stratigraphically compatible units. Wolfcampian Series.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 48, and pl. 1. Schroyer Member is a light-gray to nearly white limestone, mostly chert-bearing, but commonly containing a noncherty bed about 3 ft (0.9 m) thick in the upper part. Thickness ranges from about 6 to 13 ft (1.8–3.9 m; Hattin, 1957).

Type locality: East side of Big Blue Valley, about 1 1/4 mi (2 km) below Schroyer, Marshall County, Kansas.

Schubert Creek limestone

Pennsylvanian: eastern Kansas and northwestern Missouri.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 90, 97. As described

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 35–40, pl. 2. Sparsely cherty buff dolomite in northeastern Kansas; 0–22 ft (0–6.6 m) thick; not definitely referable to either Kinderhookian or Osagean series.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, no. 2, p. 100, 150–155, chart 5. In standard Mississippian section, Sedalia limestone is included in Easley group (new) of Kinderhookian series; overlies Chouteau limestone; underlies Gilmore City limestone.

C. P. Kaiser, 1950, American Association of Petroleum Geologists, Bulletin, v. 34, no. 11, p. 2,143–2,154. In much of the area of southwestern Missouri, Sedalia dolomite lies conformably on Chouteau limestone. Where Chouteau is absent, the Sedalia rests either on Sylamore sandstone or on rocks of Ordovician age. In southern area, upper noncherty zone of Sedalia conformably overlaps Northview formation. Unconformably overlain by Osagean rocks, ranging in age from St. Joe to Burlington. Thickness 0–70 ft (0–21 m); gradual thickening from east to west. Kinderhookian.

T. R. Beveridge and E. L. Clark, 1952, Missouri Geological Survey and Water Resources, Report of Investigations 13, p. 71, 72 (fig. 1), 74. [Reprinted from Kansas Geological Society, Guidebook, 16th Regional Field Conference.] Chouteau redefined as group to comprise (ascending) Compton, Sedalia, and Northview formations, Kinderhookian. Note on Moore's type section.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 18, pl. 1. Lower part of the Sedalia Dolomite thins southward, and in southeastern Kansas it is equivalent to the Northview Shale. Lower Sedalia contains more chert than the upper part; the upper part of the Sedalia Dolomite consists of noncherty or sparsely cherty buff to gray dolomite, which extends from outcrops in Missouri westward in the Kansas subsurface to the northeastern flank of the Central Kansas uplift. The upper Sedalia overlies conformably the lower part of the Sedalia east of the Nemaha anticline, but overlaps upon the Chattanooga Shale to the west. In northwestern Kansas, the upper part of the Sedalia occurs locally below the Gilmore City Limestone.

E. D. Goebel, 1968, American Association of Petroleum Geologists, Bulletin, v. 52, p. 1,734, 1,747–1,751, 1,753. Upper member of the Sedalia Dolomite is a buff to brown, locally gray, generally noncherty, saccharoidal dolomite. In stratigraphic cross section the upper member of the Sedalia Dolomite is extended (locally) from Dundy County, Nebraska, into Cheyenne County, Kansas.

G. Moore, 1983; *in*, J. M. Hills and F. E. Kottlowski, coord., AAPG–COSUNA Southwest/Southwest Midcontinent Correlation Chart. Sedalia Dolomite noted as being 0–30 m (0–99 ft) thick in Kansas part of Las Animas Arch.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 36, 37, 39, 47, 48–52. Presents nomenclatural history and synonymy of Sedalia Formation.

M. W. Lambert, 1988, Kansas Geological Survey, Open-file Report 88–37, p. 2, 4. Sedalia Dolomite/Northview Shale overlie the Compton Limestone in the Salina basin; the Sedalia and Northview are facies of the same formation; the Sedalia is a dolomite or shaly dolomite, and the Northview is a dolomitic shale or shale; mostly represented as Northview Shale in the Salina and Sedgwick basins, except for an area of Sedalia Dolomite in Geary County and one well with Sedalia Dolomite in Harvey County.

C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–69, 73. Suggested that Sedalia Formation be used in Kansas rather than Sedalia Dolomite. Noted that Sedalia Formation occurs below (not above) or instead of (facies relationship with) the Northview Formation.

Type locality: Missouri, Kansas, and Topeka Railroad Sweeney quarry (SW SW SE sec. 4, T. 46 N., R. 19 W.), Clifton City 7 1/2-min quadrangle, Cooper County, Missouri.

Seminole Formation (of Pleasanton Group)
Seminole Formation (of Skiatook Group)
Seminole Conglomerate

Pennsylvanian (Missourian Series): Oklahoma and southeastern Kansas.

J. A. Taff, 1901, U.S. Geological Survey, Geological Atlas, Folio 74. Lower 50 ft (15 m) is a conglomerate of white chert in brown-sand matrix; the upper 100 ft (30 m) is brown sandstone; overlies Holdenville shale.

R. C. Moore, N. D. Newell, R. H. Dott, and J. L. Borden, 1937, Kansas Geological Society, 11th Annual Field Conference, Guidebook, p. 40 (table). Included in Skiatook Group.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 27. Included in Pleasanton Group. In southeastern Kansas, overlies disconformity at base of Pleasanton Group; underlies Checkerboard Limestone. Thickness 1–25 ft (0.3–7.5 m). Includes South Mound Shale Member and Hepler Sandstone Member.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file 94-34, p. 5. Largely equivalent to the Hepler Member of the Pleasanton Formation and is dropped.

Type locality: Southeast part of Seminole Nation, now Seminole County (probably T. 6 N., Rgs. 7 and 8 E.), Oklahoma.

Severy Shale (of Wabaunsee Group)
Severy Shale (of Shawnee Group)
Severy Shale Member (of Shawnee Formation)

Pennsylvanian (Virgilian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, southeastern Nebraska, and northern Oklahoma.

E. Haworth, 1908, Kansas University Geological Survey, v. 3, p. 66. *Severy shale*—Includes beds between top of Topeka limestone and base of Howard limestone; 50–75 ft (15–22.5 m) thick.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 22, p. 203, 206. Severy shale is basal formation of Wabaunsee group.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 171. Overlies Coal Creek limestone member of Topeka limestone where recognized, but where Hartford is the only identified member of the Topeka, the lower boundary of the Severy is the top of the Hartford. Sandy zone near top of Severy is distinctive and widespread; better developed in Oklahoma than in Kansas.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 63. Underlies Bachelor Creek Limestone Member of Howard Limestone; overlies Coal Creek Limestone Member of Topeka Limestone. Thickness 70–80 ft (21–24 m).

65 ft (19.5 m) consists of flaky, somewhat bituminous black shale and, rarely, porous light-gray shale, both with abundant fish scales, gigantic septarian and smaller ordinary tough limestone concretions, also abundant soft concentric concretions, and very few thin bentonite streaks. Lower 90 ft (27 m) consists of flaky, somewhat bituminous black shale with abundant small fish bones and scales, also gray, somewhat rusty shale; thin limonite streaks rare; concretions nearly absent. Underlies Weskan shale member of Pierre shale and overlies Niobrara chalk. Is thought to extend into Nebraska and South Dakota.

R. C. Moore, 1935, Rock formations of Kansas: Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Sharon Springs shale member of Pierre shale is 155-ft (46.5-m)-thick member at base of Pierre; black flaky shale with large septarian concretions; underlies Weskan shale member of Pierre shale; overlies Smoky Hill chalk member of Niobrara chalk.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 1,969. Listed as Sharon Springs member of Pierre shale.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 23. Sharon Springs shale member is shale, flaky, black, somewhat bituminous, with large septarian and ordinary limestone concretions abundant in upper part; a few beds of light-gray shale, with locally thin chalk beds in lower part; thickness 155 ft (46.5 m).

Named for exposures at and around Sharon Springs, Wallace County, Kansas.

Shawnee Group

Shawnee Formation

Pennsylvanian (Virgilian Series): eastern Kansas, southwestern Iowa, northwestern Missouri, and southeastern Nebraska.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 93–94. Alternating limestones and shales in general characterization decidedly similar; extends from top of Oread limestone to base of Burlingame limestone.

R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference, correlation chart. Redefined Shawnee group to include Topeka limestone at top and Oread limestone at base.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 48 (fig. 10), 159–199. Redefined group comprises: Topeka Limestone, Calhoun Shale, Deer Creek Limestone, Tecumseh Shale, Lecompton Limestone, Kanwaka Shale, Oread Limestone. Overlies Douglas Group; underlies Wabaunsee Group.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,034–2,036. Interstate agreement recognized Shawnee Group as interval base of Oread Formation to top Topeka.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. vii (fig. 3), 16–18. Shawnee Group redefined to accord with interstate agreement.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 15–23, fig. 5. Group in Iowa includes interval from base Oread to top Topeka.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller; *in*, D. E. Zeller, ed., 1968, Kansas Geological Survey, Bulletin 189, p. 35–39. Average thickness of Shawnee Group about 325 ft (97.5 m).

Named for exposures in Shawnee County, Kansas.

Sheepcreekian Age

Miocene: western North America.

R. W. Wilson, 1960, University of Kansas, Paleontological Contributions, Vertebrata, Article 7, p. 5–19. Age proposed for correlation of some North American and European fossil faunas; overlies Marslandian; underlies Mascallian; shown on chart in lower part of the Herringfordian (p. 16); also shown on chart in upper part of the Herringfordian above Marslandian and below Valentinian (p. 14); chart on p. 14 credited to Schultz and Stout, Stout, from various sources.

C. B. Schultz and T. M. Stout, 1961, Nebraska University State Museum, Special Publication 2, p. 8. On correlation chart of the Miocene and Pliocene of the central Great Plains; Sheepcreekian at top of Herringfordian; above Marslandian and below the Pliocene Valentinian.

M. C. McKenna, 1965, American Museum Novitates, no. 2228, 21 p. Rejected terms of Wilson (1960).

Named for the Sheep Creek Formation, Sheep Creek, Sioux County, Nebraska.

"Sheet ground" formation

G. M. Fowler and J. P. Lyden, 1932, American Institute of Mining and Metallurgical Engineers, Transactions, v. 102, p. 218. Important ore bed in a few mines [in the Tri-state mining district]; contains round, flat nodules (2–4 inches [5–10 cm] by 3–6 ft [0.9–1.2 m]) embedded with cherty bands 1–4 inches (2.5–10 cm) thick; in some mines contains interbedded layers of nearly pure galena or sphalerite, or both, varying in thickness from a fraction of an inch to several inches; these sheets of ore are often very persistent over large areas; such mineralization comprised the "sheet ground" formation and mines in the area.

Sheldon Limestone Member (of Topeka Limestone)

Sheldon Limestone (of Calhoun Shale)

Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, northeastern Kansas, and northwestern Missouri.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 47. Limestone underlying Iowa Point Shale and overlying Jones Point Shale is not Meadow Limestone (which belongs in Stanton Limestone), and is here named Sheldon Limestone. In Sand Point section, Cass County, Nebraska, it consists of 3 1/2 ft (1.1 m) of massive bluish-gray fossiliferous limestone that weathers buff or brownish. It is middle member of Calhoun Shale. [Derivation of name not stated.]

R. C. Moore and G. E. Condra, 1932, Revised classification chart of Pennsylvanian rocks of Kansas and Nebraska. Transferred Sheldon Limestone and underlying Jones Point Shale to Deer Creek Limestone and restricted Calhoun Shale to beds they had previously called Iowa Point Shale. This change made Sheldon Limestone the top bed of Deer Creek Limestone.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 11. Divided Calhoun Shale into (descending): Iowa Point Shale, Sheldon Limestone, and Jones Point Shale

"Gray group" (Pennsylvanian: ?Atokan), or Cherokee Group (Pennsylvanian: Desmoinsesian).

C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–68, 71–73. Cited work of Abegg (1994) and adopted Shore Airport Formation for that part of the Kansas subsurface in southwestern part of state previously referred to as "unnamed Chester."

Type locality: Subsurface; Amoco #1 Breeding F core (SW sec. 34, T. 31 S., R. 40 W.), from 5,232.05 to 5,322.65 ft (1,585–1,613 m) core depth. Named for core taken in Shore Airport SW 7.5-min quadrangle, Morton County, Kansas.

Short Creek Oolite Member (of Keokuk Limestone)

Short Creek Oolite Member (of Boone Formation)

Mississippian (Osagean Series): surface exposures in southeastern Kansas, southwestern Missouri, and northeastern Oklahoma; subsurface of adjacent areas in Kansas, Missouri, and Oklahoma.

W. S. T. Smith and C. E. Siebenthal, 1907, U.S. Geological Survey, Atlas, Folio 148. *Short Creek oolite member (of Boone formation)*—Thin but persistent bed of oolitic limestone, 1 1/2–8 ft (0.5–2.4 m) thick. Generally a single massive homogeneous bed, but in some places divides into two beds which may have slightly different characteristics. Lies about 100 ft (30 m) above Grand Falls chert member and about 100 ft (30 m) below Carterville formation. Named for exposures along Short Creek, a stream flowing westward between Galena and Empire in Cherokee County, Kansas.

C. E. Siebenthal, 1908, U.S. Geological Survey, Bulletin 340, p. 190. Short Creek oolite member of Boone formation occurs in eastern half of Wyandotte quadrangle wherever its horizon is exposed, but west of Spring and Neosho rivers it usually pinches out or loses its oolitic character.

R. C. Moore, 1928, Missouri Bureau of Geology and Mines, 2nd series, v. 21, p. 241–245, 256. Presents faunal lists from several measured sections, including type section.

R. C. Moore, G. M. Fowler, and J. P. Lyden, 1939, Geological Society of America, Special Paper 24, p. 3, 10, pl. 1. Named subdivisions of Keokuk are Short Creek oolite near top and Grand Falls chert near base. Short Creek is light-gray massive oolitic limestone which commonly appears as single bed 4–5 ft (1.2–1.5 m) thick. Appears to be continuous throughout southwestern Missouri and in adjoining states whenever proper stratigraphic horizon is present.

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 61, 62. A bed of oolite 5–10 ft (1.5–3 m) thick, tentatively correlated with the Short Creek oolite of the outcrops in southwestern Missouri, occurs in occasional wells from Cherokee County to Rice County; the oolite is gray, and the ovules are moderately well sorted as to size; the bed is erratic in occurrence, being absent in many of the wells examined.

E. B. Branson, 1944, Missouri University Studies, v. 19, no. 3, p. 236. Included in Keokuk in this report with reservation that evidence for including it in Warsaw is equally strong. Occurs either at top of Keokuk or base of Warsaw. Until fauna is thoroughly studied, solution of problem of its age cannot be reached.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948 [reprinted 1956], Geological Society of America, Bulletin, v. 59, p. 148. Noted confusion of several oolite zones as Short Creek oolite.

E. L. Clark and T. R. Beveridge, 1952, Kansas Geological Society, Guidebook, 16th Field Conference, p. 13 (fig. 1), 46 (fig. 19), 47 (fig. 20); reprinted as Missouri Geological Survey and Water Resources Report Investigations 13. Shown as member of Keokuk. Osagean.

G. G. Huffman, 1953, Oklahoma Geological Survey, Guidebook 1, p. 7. In northeastern Oklahoma, Boone formation is divided into (ascending) St. Joe, Reeds Spring, and Keokuk members. In Ottawa and northern Delaware counties, a bed of white oolite, 2–10 ft (0.6–3 m) thick, known as the Short Creek is present in upper Keokuk.

W. Lee, 1956, Kansas Geological Survey, Bulletin 121, p. 82. In southeastern Kansas, where the Burlington limestone is absent, an oolitic bed (probably the Short Creek oolite) occurs high above the base of the Keokuk limestone.

C. H. Behre, Jr., and A. V. Heyl, Jr., 1959, Deutsche Geologische Gesellschaft, Zeitschrift, v. 110, pt. 3, p. 517 (fig. 2). Chart shows Short Creek member of Boone formation in upper part of formation. Thickness 1–3 ft (0.3–0.9 m) thick. Disconformably underlies Cherokee shale.

C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 12, 16. Short Creek oolite member of the Burlington–Keokuk formation is 2–10 ft (0.6–3 m) thick (5 ft ± [1.5± m]) at the top of the "M bed" of Fowler and Lyden (1932).

E. T. McKnight and R. P. Fischer, 1970, U.S. Geological Survey, Professional Paper 588, p. 13, 20, 37–40. Discuss thickness, lithologic character, correlation, and age of the Short Creek Oolite Member (Boone Formation) in the Tri-state mining district; basal part of Meramec Series.

W. J. Seevers, 1975, Kansas Geological Survey, Geology Series No. 1, p. 3. Oolitic limestone near top of Keokuk Limestone in Cherokee County.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 70, p. 68, 94–96, 98, 102. Presents nomenclatural history and synonymy of Short Creek Oolite Member of Keokuk Formation. Because there is no faunal evidence for a Meramecian–Osagean boundary in western and southwestern Missouri, the Short Creek Oolite designates the top of the Osagean Series in that region. It also defines the Keokuk–Warsaw contact for regional mapping purposes, because the lower Warsaw strata are lithologically similar to upper Keokuk limestones. Regionally, the Short Creek is a member of the Keokuk Limestone, and the top is the marker for the base of the Warsaw Formation. Occasional reports allude to the presence of more than one oolitic limestone zone in upper Keokuk strata of southwestern Missouri, but no such zone has yet been reported.

Type locality: South-facing bluff, approximately 250 ft (76 m) north of the crossing of the Missouri, Kansas, and Texas and Frisco railways (just north of line separating secs. 14 and 15, T. 34 S., R. 25 E., Baxter Springs 7 1/2-min quadrangle, Cherokee County, Kansas).

Shunganunga shale

Pennsylvanian: northeastern Kansas.

J. W. Beede, 1898, Kansas Academy of Science, Transactions, v. 15, p. 29. *Shunganunga shale*—Very fossiliferous shale, 10 inches (25 cm) to 10 ft (3 m) thick, varying in color from dark olive to bluish or even jet black. Included in Upper Coal Measures of Shawnee County. Underlies Wabaunsee formation.

Burlingame limestone and overlies Rulo limestone. Can be traced practically continuously from Nebraska across eastern Kansas into northern Oklahoma. Rank raised to formation in Wabaunsee group. Term Scranton abandoned. Average thickness about 25 ft (7.5 m).

L. W. Wood, 1941, Iowa Geological Survey, v. 37, p. 3,090 (fig. 14). Graphic section of Pennsylvanian in western Adams County shows Silver Lake shale underlying Burlingame and overlying Elmo coal which in turn overlies Cedar Vale (Cedarvale) shale.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,275. Rank reduced to member status in Scranton shale here reintroduced as a formation with stratigraphic span as assigned to it by Haworth and Bennett (1908, Kansas Academy of Science, Transactions, v. 21). Overlies Rulo limestone member; underlies Burlingame limestone member of Bern limestone (new).

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 13, fig. 5. Bright-gray shale, well-bedded, with some limonitic bands at base. Thickness about 11 ft (3.3 m). Underlies Burlingame limestone; overlies Cedar Vale shale. Rulo limestone which underlies Silver Lake in some areas, not identified in Iowa. Wabaunsee group.

Type locality: Northeast of Silver Lake, Shawnee County, Kansas.

Simpson Group

Simpson Formation

Middle Ordovician: Oklahoma and Kansas.

J. A. Taff, 1902, U.S. Geological Survey, Geologic Atlas, Folio 79. Sandstones and fossiliferous limestone, with interbedded greenish clay shales and marls separable into several quite distinct members; 1,600 ft (480 m) thick; underlies Viola limestone; overlies Arvuckle limestone.

C. E. Decker, 1933, Tulsa Geological Society, Digest, p. 55–57. Group comprises (ascending): Joins, Oil Creek, McLish, Tulip Creek, and Bromide Formations. Overlies Arbuckle Group; underlies Viola Group; Chazyan.

Constance Leatherock, 1945, Kansas Geological Survey, Bulletin 60, pt. 1, pl. 1. Simpson lies unconformably over Arbuckle. Unconformities also separate the Platteville from the St. Peter and the Platteville from the overlying Viola Limestone. Lower part of Simpson Group in north-central Kansas correlates with St. Peter Sandstone of Missouri; upper part correlates with Platteville in northwestern Missouri.

E. C. Dapples, 1955, American Association of Petroleum Geologists, Bulletin, v. 39, p. 444–467. States slight uncertainties of correlation between Simpson of Oklahoma and St. Peter of northern midcontinent are encountered crossing the Nemaha uplift. East of this structural barrier, thin sands separated by thin shales grade into typical St. Peter sheet sandstones. Southwest of the Nemaha uplift, sand, shale, and carbonates of the Simpson occur, shale increasing as the unit increases in thickness southward. "Nemaha uplift appears to be a bounding element between the monolithic sandstone unit of the St. Peter and the interbedded sand and shale of the Simpson in the southwest."

R. W. Harris, 1957, Oklahoma Geological Survey, Bulletin, v. 75, 333 p. Studies of ostracod fauna indicate both Bromide and McLish Formations of Simpson Group in Oklahoma are Blackriveran in age.

M. W. Schramm, 1964, American Association of Petroleum Geologists, Bulletin, v. 48, p. 1,164–1,195. Lithofacies, lapout, and paleogeologic maps for formations in Simpson Group of Oklahoma indicate only two formations, the Bromide and the McLish significantly extend northward into Kansas. Oil Creek Formation extends into Kansas less than 5 mi (8 km) into Harper, Sumner, and Clark counties.

H. A. Ireland, 1965; *in*, Symposium on the Simpson, Tulsa Geological Society Digest, v. 33, p. 74–89. McLish Formation (Chazyan) of the Simpson Group in Oklahoma correlates to the St. Peter Sandstone of Kansas whereas the underlying Oil Creek is present only as a featheredge in extreme southern Kansas. Tulip Creek Formation (Blackriveran) (which lies between the McLish and the Bromide) is correlated to the upper St. Peter. Bromide (Blackriveran) is laterally equivalent to the Platteville. Basal sandstone in the McLish Formation verges northward with the basal sandstone in the Tulip Creek to become the monolithic St. Peter Sandstone of Kansas. Tyner Shale pinches out northward to become an unnamed unit in Kansas but may correlate to the green shale in the middle of the St. Peter in Kansas. Bromide correlates to the upper part of the Platteville in Kansas.

M. W. Schramm, 1965; *in*, Symposium on the Simpson, Tulsa Geological Society, Digest, v. 33, p. 26–34. McLish is one of the most widespread Simpson formations and is postulated to be Blackriveran in age. A hiatus is suggested between the McLish and the underlying Chazyan-age Oil Creek Formation. McLish equivalents in Kansas include the St. Peter Sandstone and part of the overlying Platteville. Bromide is Blackriveran in age and is correlative to the upper part of the Platteville in northeast Kansas.

A. T. Statler, 1965; *in*, Symposium on the Simpson, Tulsa Geological Society, Digest, v. 33, p. 161–211. Lithostratigraphic correlations indicate that the Oil Creek Formation of the Simpson Group in Oklahoma extends only a few miles (less than five) northward into Kansas. Thickness varies between 0 and 25 ft (0–7.5 m); greatest thickness is extreme southern Barber County. McLish ranges between 0 and 100 ft (0–30 m) thick in Kansas with the thickest section being in extreme southern Harper and Sumner counties. Bromide varies between 0 and 100 ft (0–30 m) in Kansas with thickest section present in extreme southern Harper, Barber, and Sumner counties.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 14–15. Simpson Group present in Kansas except on parts of the major uplifts. About 90 ft (27 m) thick in Hugoton embayment, and thins toward north and west. Group in Kansas includes: Platteville Formation and St. Peter Sandstone. Platteville Formation is Blackriveran age.

W. L. Adkison, 1972, U.S. Geological Survey, Professional Paper 702, 33 p. Top of Simpson in Sedgwick basin and adjacent areas in south-central Kansas is identified in well cuttings by occurrence of sandy carbonates, sandstone, or shale. Some drillers place carbonate rocks in Simpson with the overlying Viola Limestone and place the top of the Simpson at the first sandstone or green shale below the Viola. Sandstone in the Simpson is commonly loosely cemented, quartzose, dominantly fine- to medium-grained, subangular to well-rounded, and generally found in the

used for the limestone at the base of the Kansas City formation in Kansas City. It extends from Kansas City and beyond to near the Linn–Bourbon County line. Thickness at Kansas City is as much as 12 ft (3.6 m), but where present in Kansas it generally is less than 8 ft (2.4 m) thick.

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 25. Lower member of Hertha limestone; thick-bedded ferruginous fine-grained limestone, generally drab or gray when fresh, weathering brown; uppermost part is granular; generally consists of a single bed.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 193. Uppermost member of Hertha. Overlies Mound City Shale Member; underlies Ladore Shale. Thickness as much as 10 ft (3 m); average about 5 ft (1.5 m).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 8. Commonly well exposed as massive ledge of skeletal wackestone ranging in thickness from 2 to 20 ft (0.6–6 m). Overlies Mound City Shale Member; underlies Elm Branch Shale as renamed.

Named for Sniabar Creek just east of Kansas City, Missouri.

Sni Mills Limestone Member (of Lost Branch Formation)

Sni Mills Limestone Member (of Lenapah Formation)

Pennsylvanian (Desmoinesian Series): eastern Kansas, western Missouri.

F. C. Greene; *in,* R. C. Moore, 1936, Kansas Geological Society, Guidebook, 10th Annual Field Conference, p. 19, 20. Gray or thin band of calcareous fossiliferous marl; "brecciated" and algal in thicker phase; thickness 0–1 ft (0–0.3 m); in lower part of Bourbon formation, higher than Warrensburg sandstone.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 9. Allocated to member status in Lenapah Formation. Uppermost member; overlies Perry Farm Shale Member; underlies Memorial Formation.

L. M. Cline and F. C. Greene, 1950, Missouri Geological Survey and Water Resources, Report of Investigations 12, p. 25. Name Sni Mills has priority over name Idenbro, and term Idenbro is suppressed as a synonym for Sni Mills.

R. L. Ravn, J. W. Swade, M. R. Howes, J. L. Gregory, R. R. Anderson, and P. E. Van Dorpe, 1984, Iowa Geological Survey, Technical Information Series 12, p. 49. "Lost Branch" Formation defined consisting of Sni Mills Limestone, unnamed shale, and Cooper Creek Limestone Members. Basal member resting on Laredo Coal of northern Missouri and Dawson coal of southern Kansas and Oklahoma.

J. W. Swade, 1985, Iowa Geological Survey, Technical Information Series 14, p. 38, 39 (fig. 15). In core CP #37 (NE SE NE sec. 2, T. 72 N., R. 26 W., Clarke County, Iowa) consists of 0.1–0.15 ft (0.03–0.05 m) of light-gray skeletal calcilutite.

P. H. Heckel, 1991, Kansas Geological Survey, Geology Series 4, 67 p. Describes lithofacies and stratigraphy of Sni Mills.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 5. Basal member of the Lost Branch Formation.

Named for outcrops at Sni Mills, Jackson County, Missouri.

Snyderville Shale Member (of Oread Limestone)

Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, eastern Kansas, and northwestern Missouri.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 32, 33, 38. Snyderville Shale, in Oread Limestone Member; in most exposures its upper part is bluish or grayish and lower part is reddish. Thickness 11 ft in southeast Nebraska, 15–17 ft (4.5–5.2 m) in northwest Missouri, and 12–16 ft (3.6–4.8 m) in Kansas. Underlies Leavenworth Limestone and overlies Weeping Water Limestone. Type locality designated. Named for exposures in Heebner Creek east of Snyderville quarry, located between 3 and 4 mi (4.8–6.4 km) west of Nehawka, Nebraska.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,035 (fig. 5); 1949, Kansas Geological Survey, Bulletin 83, p. 126 (fig. 22), 147–148. Snyderville Shale Member of Oread Formation; underlies Leavenworth Limestone Member; overlies Toronto Limestone Member. Classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 26. In Nebraska, overlies Toronto (Weeping Water) Limestone Member. Type locality stated.

T. L. Welp, L. A. Thomas, and J. R. Dixon, 1957, Iowa Academy of Science, Proceedings, v. 64, p. 418 (fig. 1), 419. Thickness 2 ft (0.6 m) in measured section near Winterset, Madison County.

H. G. O'Connor, 1960, Kansas Geological Survey, Bulletin 148, p. 38–40, pl. 1. In Douglas County, consists chiefly of green and gray silty shale, claystone, and siltstone. Thickness 1–45 ft (0.3–13.5 m); average 10–15 ft (3–4.5 m).

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 23 fig. 5. Poorly exposed and thin limestone bed occurring at base is difficult to recognize. In Adair County, about 8 ft (2.4 m) of shale, slightly silty and red at base, occurs between the Leavenworth and limestone tentatively called the Toronto.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 36, pl. 1. This member contains gray to bluish-gray, red and green claystone and shale. In northern outcrops, the lower and middle parts are a structureless underclay-like deposit; in southern outcrops, the member becomes more sandy and locally contains sandstone and nodular, argillaceous limestone. Marine fossils, especially *Chonetes*, occur in the uppermost part. Thickness in the northeastern part of the state averages about 12 ft (3.6 m), but in southeastern Kansas it increases to about 75 ft (22.5 m).

Type locality: In Heebner Creek valley, east of Snyderville quarry, about 3 mi (4.8 km) west and 1 1/4 mi (2 km) north of Nehawka, Cass County, Nebraska.

Soapstone coal (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Croweburg coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 71–72).

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 41, 58. South Bend Limestone, 9 ft (2.7 m) thick, is in lower part of Scranton Shale. It overlies Rock Lake Shale and underlies Plattford Shale. Named for exposures just north of South Bend.

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 11, 13, 27, 32. In Ashland section what was supposed to be South Bend Limestone is Iatan Limestone. South Bend Limestone underlies Weston Shale and overlies Rock Lake Shale and is top bed of Stanton Limestone Member. [This is definition adopted by R. C. Moore and Condra in their 1932 revised classification chart of Pennsylvanian rocks of Nebraska and Kansas.]

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 51. South Bend Limestone was named in Nebraska but was named Little Kaw Limestone by Newell (1935) from Kaw Valley area, Kansas. On basis of subsequent studies, it is now agreed the original name is valid.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,031 (fig. 4); 1949, Kansas Geological Survey, Bulletin 83, p. 68 (fig. 14), 119. South Bend Limestone Member of Stanton Formation; overlies Rock Lake Shale Member; underlies Weston Shale of Pedee Group. Classification was agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 32. Thickness 8–12 ft (2.4–3.6 m) in Platte and Weeping Water valleys; 4–5 ft (1.2–1.5 m) in northwestern Missouri; 4–6 ft (1.2–1.8 m) in Kansas. Top of this subdivision in Nebraska exposures is at the post-Missourian contact and shows evidence of shoreline deposition. Type locality stated.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 34, pl. 1. Upper member of the Stanton is a medium- to thick-bedded, dense, fine-grained, medium- to dark-gray or bluish-gray, fossiliferous limestone that weathers yellowish-gray to yellowish-brown. Lower part commonly is sandy or conglomeratic. South Bend ranges from about 1 to 6 ft (0.3–1.2 m) in thickness along its outcrop except in Montgomery County, where it is as much as 27 ft (8.1 m) thick.

Type locality: In Platte River bluffs 1 1/2 mi (2.4 km) northwest of South Bend, Cass County, Nebraska.

South Fork limestone

South Fork limestone member (of Burlingame formation)

Pennsylvanian: southeastern Nebraska and northeastern Kansas.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 5, 10. Burlingame limestone formation divided into (descending): 1) *South Fork limestone* (one massive bed, or two or three beds separated by shale, 2 1/2 ft [0.8 m]); 2) Winnebago shale (bluish, argillaceous, some limy fossiliferous seams, 8–12 ft [2.4–3.6 m]); 3) Taylor Branch limestone (bluish-gray, massive, weathering brownish, 2–4 1/2 ft [0.6–1.3 m]). The South Fork lies high in hill 3/4 mi (1.2 km) southwest of DuBois (Pawnee County, southeast Nebraska), at west side of South Fork Valley; traced through Kansas to Oklahoma.

E. H. Wenberg, 1942, Iowa Academy of Science, Transactions, v. 49, p. 343 (fig. 6). Listed as South Fork limestone in insoluble residue correlations of Missouri and Virgil strata in Iowa.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 45–46. In Nebraska, Burlingame limestone includes (ascending) Taylor Branch limestone, Winnebago shale, and South Fork limestone members. [Never recognized by the Kansas Geological Survey, but still used by the Nebraska Geological Survey.]

Well exposed in hill on west side of South Fork Valley 3/4 mi (1.2 km) southwest of DuBois, Pawnee County, Nebraska.

South Mound Shale Member (of Seminole Formation)

South Mound Shale Member (of Hepler Formation)

Pennsylvanian (Missourian Series): southern Kansas.

C. R. Singler, 1965, The Compass, v. 42, p. 63–72. Includes strata from top of Hepler Sandstone Member of Seminole Formation to base of Checkerboard Limestone; gray to brown shale, micaceous and silty at some localities; thin lignitic coal occurs near the middle of the member in Labette County, Kansas; thickness up to 10 ft; name credited to P. A. Emery in an unpublished thesis.

J. M. Jewett, P. A. Emery, and D. A. Hatcher, 1965, Kansas Geological Survey, Bulletin 175, pt. 4, 11 p. Formal proposal of name; 7.8 ft thick at type section.

P. H. Heckel, 1991, Kansas Geological Survey, Geology Series 4, p. 26. Base of South Mound Shale redefined to exclude coal and overlying sandstone; South Mound now comprises only thin argillaceous limestone overlain by shale that forms bulk of unit. Designates principal reference section.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 5. The South Mound Shale is restricted to southern Kansas. Shale overlies unnamed coal bed in Hepler Formation or the Checkerboard limestone bed in extreme southern Kansas.

Type section: Just south of Mound Valley (center SE SW sec. 2, T. 33 S., R. 18 E.) in western Labette County, Kansas.

Principal reference section: Complete exposure along a road 1 mi (1.6 km) east of South Mound (N line W of NE corner NW sec. 15, T. 30 S., R. 20 E.)

Speiser Shale (of Council Grove Group)

Permian (Wolfcampian Series): southeastern Nebraska, eastern Kansas.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 232, 234. *Speiser shale*—top division of Garrison shale member, consists of (descending): 1) Greenish-blue shale with small calcareous bodies, 9± ft (2.7± m); 2) argillaceous shale in bluish and reddish bands, 10 ft (3 m); 3) two beds of light-gray limestones, separated by 4–5 ft (1.2–1.5 m) of shale, 7–8 ft (2.1–2.4 m); 4) bluish or bluish-gray shale, with a thin band of maroon shale near base, small calcareous concretions in the grayish zones, 18–23 ft (5.4–6.9 m). Total thickness of Speiser shale, 47± ft (14.1± m). Overlies Sabetha limestone.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 232, 234. *Speiser shale*, top division of Garrison shale member, consists of (descending): 1) greenish-blue shale with small calcareous bodies, 9± ft (2.7± m); 2) argillaceous shale in bluish and reddish bands, 10 ft (3 m); 3) two beds of light-gray limestones, separated by 4–5 ft (1.2–1.5 m) of shale, 7–8 ft (2.1–2.4 m); 4) bluish or bluish-gray shale, with a thin band of maroon shale near base, small calcareous concretions in the grayish

agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 24. Average thickness 3–5 ft (0.9–1.5 m). In Nebraska, Iowa, Missouri, and northeastern Kansas, member was formerly miscorrelated with Oread Limestone. Type locality and derivation of name stated.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 20, fig. 5. Massive gray cherty limestone separated into two or three beds by thin shales. Thickness 5–10 ft (1.5–3 m). Underlies Doniphan Shale Member; overlies Kanwaka Shale.

H. G. O'Connor, 1960, Kansas Geological Survey, Bulletin 148, p. 43, pl. 1. Thickness 8–14 ft (2.4–4.2 m) in Douglas County. Lowest 5 ft (1.5 m) is massive light tan or light gray brown in unweathered state but yellow brown where weathered; overlying part made up of shaly limestone, shale, and limestone commonly 3–8 ft (0.9–2.4 m) thick. Underlies Doniphan Shale Member; overlies Stull Shale Member of Kanwaka Shale.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37, and pl. 1. Spring Branch Limestone Member is a gray, somewhat sandy limestone that weathers deep brown and occurs in massive, slightly uneven beds. Fusulinids are abundant in most outcrops. In northeastern Kansas thickness is commonly 5 ft (1.5 m), but locally as much as 14 ft (4.2 m), with shale and earthy limestone in the upper part. In southeastern Kansas member locally is very sandy, impure limestone about 4 ft (1.2 m) thick.

Type locality: On Spring Branch north of Big Springs, Douglas County, Kansas.

Spring Creek clays

Spring Creek shale member (of Belvidere formation)

Cretaceous (Lower): south-central Kansas.

C. N. Gould, 1898, American Journal of Science, 4th, v. 5, p. 170–174. Bluish-white clay, with clay-ironstone concretions; 20–80 ft (6–24 m) thick; underlies Greenleaf sandstone and overlies Kiowa shales; basal division of Medicine beds.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 2,044. Noted that name was discarded by USGS in 1921, the bed (in Kiowa shale) being regarded as so local as to have no stratigraphic value. Also noted that W. H. Twenhofel (1924, Kansas Geological Survey, Bulletin 9) revived the name as Spring Creek shale member of Belvidere formation.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 153. Dakota formation contains stratigraphic units formerly called "Rocktown channel sandstone," "Ellsworth formation," "Solomon formation," "Reeder sandstone," "Marquette sandstone," "Spring Creek clay," and others.

Named for Spring Creek, 12 mi (19.2 km) southwest of Belvidere, Kiowa County, Kansas.

Spring Hill Limestone Member (of Plattsburg Limestone)

Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, and southeastern Nebraska.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 93, 97. [See under Merriam Limestone. On p. 46, Spring Hill Limestone is described as consisting of 15–21 1/2 ft (4.5–6.5 m) of gray even-bedded limestone.]

N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 18, 71–73. Upper member of Plattsburg Limestone. Lower half is even gray limestone containing brachiopods and bryozoans. Remainder is oolitic or granular and contains large molluscan element. Overlies Hickory Creek Shale Member and underlies Vilas Shale. Named for exposures at town of Spring Hill, Johnson County.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 45, 129–130. Stated that Newell is author of this name.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,031 (fig. 4); 1949, Kansas Geological Survey, Bulletin 83, p. 116. Spring Hill Limestone Member of Plattsburg Formation; overlies Hickory Creek Shale Member; underlies Vilas Shale. Classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 33. Consists of two limestones separated by shale. Thickness in Kansas 6–40 ft (1.8–12 m); average 15 ft (4.5 m); 4–6 ft (1.2–1.8 m) in Nebraska. Type locality stated.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 33, and pl. 1. Spring Hill Limestone Member is chiefly gray, fine-grained, even to slightly wavy-bedded limestone that weathers yellowish-orange. Along most of its outcrop in eastern Kansas, it has a fine- to medium-grained texture and contains abundant fossils. Oolitic limestone comprises part of the middle or upper beds. In Wilson County the middle part of the member is coarsely crystalline limestone containing *Archaeolithophyllum* (Wray, 1964). Lower part is a fragmental, pelletal limestone, and the upper part is a calcarenite (Harbaugh, 1959). Member has a thickness of 7–23 ft (2.1–6.9 m) in northern outcrops and ranges from 0 to 88 ft (0–26.4 m) in southern outcrops.

Type locality: In railroad cut near center east side of sec. 14, T. 15 S., R. 23 E., southern Johnson County, Kansas.

Spring Rock limestone

Pennsylvanian: eastern Kansas.

G. C. Swallow and F. Hawn, 1865, Kansas Geological Survey, Report on Miami County, p. 9. *Spring Rock*—Hard bluish-gray fine-grained limestone, 2–4 ft (0.6–1.2 m) thick, containing many fossils and crystalline particles of calcareous spar. Forms bed 16 of geology section of Miami County.

G. C. Swallow, 1866, Geological Survey of Kansas, Preliminary Report, Lawrence, p. 21. Erroneously applied this term to his bed No. 162, and identified it at Beaver Creek, Marais des Cygnes, west of Topeka, and at Lecompton, confusing it with several limestones.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 204. Howard limestone is part of Spring Rock limestone of Swallow, which is abandoned because the name is inappropriate.

Named for fine springs which come to surface from crevices in the rock.

Type locality: In roadcut near SE corner sec. 3, T. 13 S., R. 21 E., and adjacent area along Captain Creek. Named for Stanton, Miami County, Kansas.

Stanton limestone series
Pennsylvanian: eastern Kansas.
G. C. Swallow, 1866, Kansas Geological Survey, Preliminary Report, p. 20. Series of limestones, sandstones, and shales, 74 ft (22.2 m) thick, including beds Nos. 151–155, inclusive, of geological section of eastern Kansas; includes at top Stanton limestone, 6–28 ft (1.2–8.4 m) thick; underlain by Cave Rock series (of which Cave limestone is top bed) and overlain by Chocolate limestone series.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 2,054. Preoccupied by Stanton limestone member of Lansing formation; included Stanton limestone and Vilas shale members of Lansing formation.
Derivation of name not given; probably named for uppermost bed at top, Stanton limestone.

Stapleton zone
Ordovician: southern Kansas.
J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 87. Name applied to highly productive rocks found next below Pennsylvanian sediments in the El Dorado field; porous zone of beveled Ordovician rocks that lies immediately below Pennsylvanian beds; zone includes weathered pre-Pennsylvanian outcrops of Viola limestone, St. Peter sandstone, and Arbuckle rocks; the term "Varner" is used in essentially the same sense.

Stark Shale Member (of Dennis Limestone)
Stark Shale Member (of Hogshooter Formation)
Upper Pennsylvanian (Missourian Series): eastern Kansas, western Missouri, southwestern Iowa, southeastern Nebraska, and northern Oklahoma.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 91, 97. Black fissile shale that overlies the Dennis formation.
J. M. Jewett, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 99, 102, 103. Overlies Canville limestone; underlies Winterset limestone. Lower part is dark or black and carbonaceous; upper part commonly is yellow, although the yellow upper part is not persistent; rests directly on Galesburg shale where Canville limestone is absent; thickness 8–11 ft (2.4–3.3 m).
M. C. Oakes, 1940, Oklahoma Geological Survey, Bulletin 62, p. 43; 1952, Oklahoma Geological Survey, Bulletin 69, p. 59. In Oklahoma, considered member of Hogshooter Formation. Overlies Canville Limestone Member; underlies Winterset Limestone. Thickness 3–10 ft (0.9–3 m).
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,031 (fig. 4). Shale member of Dennis Formation. Overlies Canville Limestone Member; underlies Winterset Limestone Member. This is classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.
T. L. Welp, L. A. Thomas, and H. R. Nixon, 1957, Iowa Academy of Science, Proceedings, v. 64, p. 421. Thickness about 4 ft (1.2 m) near Winterset, Iowa.
Type locality: Near Stark, Neosho County, Kansas. Typical exposures are found in the SE sec. 18, T. 27 S., R. 21 E., and NW sec. 28, T. 27 S., R. 20 E.

Stearns Shale (of Council Grove Group)
Permian (Wolfcampian Series): southeastern Nebraska and eastern Kansas.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 230–237. Stearns shale, in Garrison shale member of Council Grove formation, consists of (descending): 1) Grayish calcareous shale, 1 1/2–2 ft (0.45–0.6 m); 2) bluish-gray argillaceous crumbly shale, 4–6 ft (1.2–1.8 m); 3) chocolate or reddish crumbly argillaceous shale, 5–8 ft (1.5–2.4 m); 4) light-gray, limy, loosely indurated shale, 2+ ft (0.6+ m). Total thickness 14–18 ft (4.2–5.4 m). Overlies Morrill limestone and underlies Eiss limestone.
G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 18, 19. Stearns shale is 17–18 ft (5.1–5.4 m) thick in Nebraska and about 8 ft (2.4 m) in southern Kansas.
G. E. Condra and R. C. Moore in 1932 included this shale in the Garrison, but Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 7, treated it as distinct formation.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 46; K. L. Walters, 1954, Kansas Geological Survey, Bulletin 106, p. 48, pl. 1. Contains minor amount of impure limestone; mostly gray to olive but red shale occurs in middle and lower parts; locally contains thin coal bed in Lyon and Morris counties, Kansas. Thickness 7 ft (2.1 m) in southern Kansas to 20 ft (6 m) in northern Kansas. Underlies Bader Limestone; overlies Beattie Limestone. Wolfcampian Series.
Type locality: South of Stearns School, 1.5 mi (2.4 km) northeast of Humboldt, Richardson County, Nebraska. Type section now obscured, but typically exposed along a north-south road, 6 mi (9.6 km) south and 1.5 mi (2.4 km) east of Humboldt.

Stevens Member (of St. Louis Limestone)
Mississippian (Meramecian Series); subsurface of southwestern Kansas.
F. E. Abegg, 1994, Kansas Geological Survey, Bulletin 230, p. 24, 39–48, 50–57, 59–64. *Stevens Member*—Upper of two new members of St. Louis Limestone; predominantly skeletal packstone/wackestone with intercalated oolitic grainstones and minor quartzose grainstone. Underlying contact with Hugoton Member placed at change from dolomitic carbonate and anhydrite to skeletal packstone/wackestone (commonly marked by a skeletal-ooid grainstone to packstone 3 ft [0.9 m] or less in thickness). Overlying contact with Ste. Genevieve Limestone is placed at the stratigraphically lowest prominent quartzose grainstone. Where the quartzose facies are not present, the boundary can be placed at the base of a small positive gamma-ray shift immediately above the uppermost porous, presumably oolitic, limestone.
C. G. Maples, 1994, Kansas Geological Survey, Bulletin 230, p. 67–68, 71–73. Cited work of Abegg (1994) and adopted Stevens Member as upper member of St. Louis Limestone.
Type locality: Subsurface; Mobil #1 Foster core (sec. 5, T. 34 S., R. 36 W.), Stevens County, Kansas, from 6,660 ft to 6,804 ft (2,018–2,062 m) core depth. Presumably named for Stevens County, Kansas.

eastern Kansas; said to be the same as the "Dutcher sand"; latter name is applied to sand deposits in the basal part of the Cherokee shale; seemingly the names "Burgess" and "Tucker" are used interchangeably with "Stone Bluff" and "Dutcher."

Stone Corral Formation (of Nippewalla Group)
Stone Corral Formation (of Sumner Group)
Stone Corral Dolomite (of Enid Formation)
Stone Corral Member (of Harper Sandstone)
Permian (Leonardian Series): central Kansas.
G. H. Norton, 1935, American Association of Petroleum Geologists (abs.), Program 20th Annual Meeting, p. 17. Dolomitic limestone; 6 ft (1.8 m) thick at its northern limit in Rice County, Kansas; can be traced southward about 50 mi (80 km), thins, splits into two or three thin layers, and finally disappears as a distinct unit north of the Oklahoma line (identifiable only as a zone of huge halite casts); occurs in middle part of Harper sandstone.
E. A. Koester, 1935, American Association of Petroleum Geologists, Bulletin, v. 19, p. 1,410. Name used in table; placed in Cimarron Series.
R. C. Moore and K. K. Landes, 1937, Geologic map of Kansas (1:500,000): Kansas Geological Survey. Mapped as dolomite member of Enid Formation. Cimarron Series.
G. H. Norton, 1937, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,774–1,781. Middle member of Harper Sandstone.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 39, p. 91. Sumner Group comprises: Stone Corral Dolomite, Ninnescah Shale, Wellington Shale, Leonardian Series.
J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Chart shows Stone Corral Formation at top of Sumner Group. Underlies Harper Siltstone; overlies Ninnescah Shale.
H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; in, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 51. Composed of dolomite, anhydrite, gypsum and salt; color gray, with streaks of red and pink. A "key bed" because of geophysical characteristics; maximum outcrop thickness 6 ft (1.8 m).
Bailey Rascoe, Jr., 1988, Midcontinent SEPM Special Publication No. 1, p. 7–10, figs. 1, 5, 7. Regional unconformity at base of Runnymede Sandstone, or Stone Corral Formation where Runnymede is absent, separates Sumner group from overlying Nippewalla Group. Assigned Stone Corral Formation to Nippewalla Group. Overlies Runnymede Sandstone, where present; underlies Harper Sandstone.
Type locality: Sec. 11, T. 20 S., R. 6 W., Rice County, Kansas. Named for exposures near historic Stone Corral Fort, where wagon trains of pioneers forded Little Arkansas River on Santa Fe Trail.

Stoner Limestone Member (of Stanton Limestone)
Pennsylvanian (Missourian Series): southeastern Nebraska and eastern Kansas.
G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, 2nd series, p. 11, 26, 27, 31, 33, 34, 36, 37. Louisville Limestone is preoccupied hence Stoner Limestone is proposed for this unit to include also Kiewitz Shale and so-called Du Bois Limestone. Thickness 14–16 ft (4.2–4.8 m). Type locality designated. Underlies Rock Lake Shale; overlies Eudora Shale.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 134–135. The term Stoner limestone is possibly applicable to the member of the Stanton that is here called Olathe limestone. That is not certain, however, because it is not possible to trace the Platte beds southward to northeastern Kansas outcrops. There has been much confusion in the classification and correlation of the Platte valley section, and it seems inadvisable, at least on the basis of present knowledge, to introduce in Kansas such terms as Stoner and other platte valley units that are thought to belong to the Stanton but are not certainly placed.
R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 68 (fig. 14), 118–119. Overlies Eudora Shale Member; underlies Rock Lake Shale Member (classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947). Thickness along Kansas River and elsewhere in northeastern Kansas 11–15 ft (3.3–4.5 m); in parts of southern Kansas about 50 ft (15 m).
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 32. In Nebraska, includes (ascending): Dyson Hollow limestone zone (new), Keiwitz shale zone, and unnamed limestone. Thickness at type locality 15–16 ft (4.5–4.8 m).
J. M. Jewett, H. G. O'Connor, and D. E. Zeller; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 33, and pl. 1. Stoner Limestone Member comprises thin to medium beds of medium- to very light gray wavy-bedded limestone. It is 10–20 ft (3–6 m) thick throughout most of eastern Kansas. Uppermost beds locally may be brecciated or nodular-appearing or calcarenitic. Member includes much fine- to medium-grained, light-gray-mottled limestone containing abundant coarsely crystalline calcite and some oolitic limestone in southern outcrops. Maximum thickness about 50 ft (15 m) in northern Montgomery County.
Type locality: On Stoner Farm, northwest of South Bend, Cass County, Nebraska.

Stony Hills formation
Permian: southern Kansas and western Oklahoma.
F. W. Cragin, 1897, American Geologist, v. 19, p. 358, 363. Suggested name to replace Dog Creek formation or shale, which in central Oklahoma becomes laminated with dolomites, which form a considerable part of its thickness, a large body of dolomite, called Chapman dolomite, forming its upper member.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 2,071. Same as Dog Creek shale, older name.
Named for Stony Hills, east of Watonga, Blaine County, Oklahoma.

Stormont limestone bed (in Wamego Shale Member of Zeandale Limestone)
Stormont Limestone Member (of Pierson Point Shale)
Pennsylvanian (Virgilian Series): northeastern Kansas.
H. G. O'Connor, 1953, Kansas Geological Survey, Vol. 12, p. 18–19, pl. 1. *Stormont limestone member*—Name applied to the lowest of three limestones near middle of Pierson Point shale. Member is variable in character but generally is sandy or silty and nonresistant to weathering; fossiliferous. Thickness averages 1–4 ft (0.3–1.2 m). At type locality, occurs about 12 ft (3.6 m) below Maple Hill limestone and 13 1/2 ft above Tarkio limestone. Occurs 12–18 ft (3.6–5.4 m) above Tarkio limestone where Tarkio is present and about 10 to 20 ft (3–6 m) above the Elmont where the Tarkio is absent. Because of its position between the

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 172. Name preoccupied by Strawn group, Pennsylvanian, of Texas; same as Lecompton limestone.

Named for Strawn, Coffey County, Kansas.

Strickler limestone (of Sumner group)

Strickler limestone member (of Donegal limestone)

Permian: northeastern Kansas.

R. C. Moore, 1935, Rock formations of Kansas; in, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Uppermost member of Donegal limestone; white, flaggy, unfossiliferous limestone; 2 ft (0.6 m) thick; overlies Newbern shale member of Donegal limestone; underlies Buckeye shale member of Wellington shale.

R. C. Moore, 1936, Kansas Geological Society, 10th Annual Field Conference, Guidebook, p. 12. Thickness 2.5 ft (0.8 m).

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 30. Strickler limestone and Newbern shale members of the Donegal limestone are not very persistent; name Donegal limestone is not well founded.

Type locality and derivation of name not stated.

Strong City beds

Permian: central Kansas.

L. C. Wooster, 1905, The Carboniferous rock system of eastern Kansas, Kansas State Teachers College, Emporia. *Strong City beds*—Includes Strong flints or Wreford limestone and underlying Crusher Hill alternating shales and limestones. Overlies Elmdale beds and underlies Cedar Point or Matfield shales. Elmdale beds as here used extend from top of Americus limestone to 12 ft (3.6 m) above Cottonwood limestone, or to what appears to be top of Florena shale member of Garrison formation. [Also Kansas Academy of Science, Transactions, v. 20, p. 80.]

Probably named for Strong, Chase County, Kansas.

Strong flint (of Chase group)

Permian: central Kansas.

C. S. Prosser, 1895, Journal of Geology, v. 3, p. 771–786, 799. Two beds of light-gray limestone containing an abundance of flint in layers, separated by 18 ft (5.4 m) of massive light-gray or whitish limestone; total thickness 35–45 ft (10.5–13.5 m); basal member of Chase formation; overlain by shales in Chase formation and underlain by Neosho formation.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 2,077. Said to be same as Wreford limestone, older name.

Named for Strong, Chase County, Kansas.

Stull Shale Member (of Kanwaka Shale)

Pennsylvanian (Virgilian Series): eastern Kansas, northwestern Missouri, and southeastern Nebraska.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 52, 94, 96. Stull Shale applied to top member of Kanwaka Shale in eastern Kansas. Overlies Clay Creek Limestone. Derivation of name not stated. Stull Shale is 26 ft (7.8 m) thick, of which upper 5 ft (1.5 m) consists of dark bluish and yellow shale, clay, and sand, the middle 11 ft (3.3 m) of light yellowish-brown soft, partly crossbedded sandstone, and the lower 10 ft (3 m) of bluish to yellowish shale, clay, and micaceous sand.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 171. Gave thickness as 30+ ft (9+ m) near Stull and 45 ft (13.5 m) near Atchison; and stated type locality is SE corner sec. 26, T. 12 S., R. 18 E., near village of Stull, Douglas County, Kansas. Type locality designated.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 24. Thickness 4 ft (1.2 m) in Weeping Water Valley, Cass County.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 62 (fig. 23), 67. Yellowish-brown sandy shale, locally one or more coal beds; sandstone containing land plant remains and partly filling channels occurs in upper part in northern Kansas; much or all of Elgin Sandstone in southern part of state may belong in this division. Thickness about 25 to at least 45 ft (7.5–13.5 m). Overlies Clay Creek Limestone Member; underlies Spring Branch Limestone Member of Lecompton Limestone.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 36, pl. 1. Stull Shale Member is a yellowish-brown to red, sandy shale, locally containing one or more coal beds. Sandstone, with somewhat plentiful land plants, occurs in the upper part of the member in northeastern Kansas. Stull Shale is identified northward in Elk County and tentatively in parts of southeastern Kansas. Thickness ranges from about 25 to at least 45 ft (7.5–13.5 m).

Type locality: SE corner sec. 26, T. 12 S., R. 18 E., near village of Stull, Douglas County, Kansas.

Stump Arroyo member (of Crooked Creek formation)

Pleistocene: southwestern Kansas.

C. W. Hibbard, 1949, Michigan University, Museum of Paleontology Contributions, v. 7, no. 4, p. 69, 71–73. Basal part of Crooked Creek formation; coarse sand, reddish to light tan, and well sorted, containing white quartz pebbles; grades upward into finer more poorly sorted sand, with calcareous nodules at top; thickness a little more than 10 ft; unconformably overlies Missler member of Meade formation. In some areas where the Crooked Creek is not extensively developed, Pearlette ash member rests directly on the Stump Arroyo member.

C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55, 57. Underlies Atwater member.

C. K. Bayne and H. G. O'Connor, 1968, Kansas Geological Survey, Bulletin 189, p. 66. Noted usage of term by Hibbard for deposits in Meade County; did not employ Hibbard's stratigraphy.

Type locality: Sec. 21, T. 33 S., R. 28 W., Meade County, Kansas. Gravels of member form high surface rubble in sec. 10, T. 33 S., R. 29 W., along tributary of Stump Arroyo north of the Deer Park and west of the northwest corner of Deer Park. Name derived from tributary of Crooked Creek, which flows through Meade County State Park and empties into Crooked Creek in sec. 29, T. 33 S., T. 28 W.

Sugar Creek shale (of Bethany Falls limestone)

Pennsylvanian: northeastern Kansas and northwestern Missouri.

C. O. Dunbar and G. E. Condra, 1932, Nebraska Geological Survey, Bulletin 5, 2nd series, p. 17. Noted that Bethany Falls limestone had been divided into (top to bottom): Swope limestone, Sugar Creek shale, and Middle Creek limestone, and attributed divisions to R. C. Moore (1931).

Swallow belt, terrane, or formations
Swallowal group of strata or terrane
C. [R.] Keyes, 1933, Pan-American Geologist, v. 59, p. 132–135, 140. Permian is inappropriate term for the Carbonic red beds of Great Plains. For the miscellaneous collection of sediments or terranes now being called Permian, some such title as Swallow belt, terrane, or formations, or Dumble beds, might be adopted with great advantage. "Such course does not imply necessarily definite correlation, or specific geological age, but merely pertains to the broad body of strata which pioneer who first brought the formations as a whole into the attention of geologists."

Swope Limestone (of Kansas City Group)
Swope Limestone (of Bronson Group)
Swope formation
Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.
C. O. Dunbar and G. E. Condra, 1932, Nebraska Geological Survey, Bulletin 5, 2nd series, p. 17, table C. Revised correlation by R. C. Moore, 1931, divides Bethany Falls limestone in vicinity of Kansas City into (top to bottom): Swope limestone, Sugar Creek shale, and Middle Creek limestone.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 85 (fig. 2). p. 90, 97. Swope formation includes the following members (top to bottom): Bethany Falls limestone, Hushpuckney shale, Middle Creek limestone, Elm Branch shale, Sniabar limestone, Mound City shale, Critizer limestone, Tennison Creek shale, and Schubert Creek limestone.
N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 26–29. Persistent limestones and thin shales from top of Ladore shale to top of Bethany Falls limestone; in Johnson and Miami counties, Kansas, includes (top to bottom) Bethany Falls limestone member, Hushpuckney shale member, and Middle Creek limestone member.
J. R. Clair, 1943, Missouri Geological Survey and Water Resources, 2nd series, p. 27, pl. 1. Swope Limestone included in Kansas City Group. Underlies Galesburg Shale; overlies Ladore Shale.
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 192–193. Swope Limestone in Bronson Group includes, in descending order: Bethany Falls Limestone Member, Hushpuckney Shale Member, and Middle Creek Limestone Member. Average thickness 23 ft (6.9 m). Overlies Ladore Shale; underlies Galesburg Shale. Missourian Series.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 2,028–2,029, 2,031 (fig. 4). Included in Bronson Subgroup, Kansas City Group; classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma.
J. H. Mossler, 1973, Kansas Geological Survey, Bulletin 206, pt. 1, p. 9–10. Characterizes distinct diagenetic color mottling in Bethany Falls Limestone Member.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 9. Overlies Elm Branch Shale throughout Kansas; underlies Galesburg in northeastern Kansas, but underlies type Ladore Shale in southeastern Kansas. Designate principal reference section for Kansas. Named for Swope Park, Kansas City, Missouri.
Principal reference section: Roadcut 2 mi (3 km) northwest of Xenia (center south line SE sec. 20, T. 23 S., R. 22 E.) in northwestern Bourbon County.

Sylvan Shale
Upper Ordovician: eastern Kansas, southern and eastern Oklahoma.
J. A. Taff, 1902, U.S. Geological Survey, Geological Atlas, Folio 79. Soft greenish fissile shale; 50 ft (15 m) thick; increases in thickness westward in Arbuckle Mountains to nearly 300 ft (90 m); underlies Hunton limestone; overlies Viola limestone.
E. O. Ulrich, 1915, Missouri Bureau of Geology and Mines, v. 15, p. 234–239. Sylvan and Maquoketa Shales are correlative according to similar lithologic character and stratigraphic position.
Hall Taylor, 1947, American Association of Petroleum Geologists, Bulletin, v. 31, p. 1,594–1,607. Informally divides Sylvan in much of Kansas into an upper locally siliceous and cherty, hard gray dolomitic shale, and a lower relatively nondolomitic soft gray flaky shale in north-central Kansas, but grades into darker gray, brown, and even black shale in south-central Kansas. Contact between the upper and lower shales appears gradational. Maquoketa beds in Iowa are approximately equivalent to Sylvan beds in Oklahoma.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 106, 115, 117, 120. Sylvan (Maquoketa) shale characteristically consists of greenish-gray dolomitic shale or cherty silty dolomite in northeastern Kansas; in southern Kansas is more argillaceous and less cherty and dolomitic; obscure low angular unconformity separates Sylvan from underlying Viola limestone; not recognized in southwestern Kansas; occurs beneath Silurian rocks in eastern Kansas; thickness ranges from 155 ft (46.5 m) in the north to less than 40 ft (12 m) in the south; not continuous with Sylvan shale in Oklahoma (absent over Chautauqua arch).
W. Lee, 1956, Kansas Geological Survey, Bulletin 121, p. 35. Maquoketa Shale in Kansas is equivalent to Sylvan Shale in Oklahoma. Notes carbonate percentage increases westward in Salina basin, thereby causing uncertainty in identification of Sylvan versus Viola (p. 47). Local irregularities in thickness of Sylvan are largely caused by paleotopographic relief on underlying Viola Limestone.
J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Shown on chart as Maquoketa (Sylvan) Shale; overlies Viola (Kimmswick) Limestone; unconformably underlies "Hunton" Group.
H. A. Ireland, 1966; *in*, Symposium on the Viola, Fernvale, and Sylvan Formations, Tulsa Geological Society, Digest, v. 34, p. 26–40. Sylvan–Maquoketa is post-Fernvale Richmondian in age and disconformably overlies the Viola in Kansas.
W. L. Adkison, 1972, U.S. Geological Survey, Professional Paper 702, 33 p. Maquoketa in Kansas is synonymous with Sylvan Shale. Noted westward increase in carbonate rocks in south-central Kansas and that the upper part of the Viola may be indistinguishable from the Sylvan due to this increase in carbonate percentage. Lateral gradation from carbonate into shale is common. Shale in Sylvan is typically pale green to greenish gray or gray and may be very dolomitic. Dolomite in unit is generally gray to buff,

consists of dark-gray shale to black shale with thin limestone beds and nodule horizons.

Type exposure: In S sec. 7, and west side of sec. 17, T. 32 S., R. 19 E., Labette County. Name derived from Tackett (sic) Mound, Parsons West quadrangle, Labette County, Kansas.

Neostratotype: Tackett Mound, northeast side of hill near northeast corner, SW sec. 7, and creek bank in SW SW NE sec. 7, T. 32 S., R. 19 E., Labette County, Kansas.

Taloga formation (of Cimarron group)

Taloga formation (of Quartermaster group)

Permian (Guadalupe): southern Kansas and western Oklahoma.

F. W. Cragin, 1897, American Geologist, v. 19, p. 363–363. Includes all of Kiger division above Day Creek dolomite, the persistence of Hackberry shales and Big Basin sandstone in central Oklahoma being doubtful, and younger rocks of Kiger division being present farther west.

R. C. Moore and W. P. Haynes, 1917, Kansas Geological Survey, Bulletin 3. Discarded name Taloga and used Greer formation in its place.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 36, 37. Only formation of Quartermaster group in Kansas; red beds of silty shale, siltstone, and very fine feldspathic sandstone (Big Basin of some reports) underlain by about 25 ft (7.5 m) of mostly silty shale; outcrops in western Clark and eastern Meade counties; maximum thickness about 45 ft (13.5 m).

C. C. Branson, 1957, Oklahoma Geology Notes, v. 17, no. 11, p. 103. Abandoned by Oklahoma Geological Survey.

H. G. O'Connor, 1963, American Association of Petroleum Geologists, Bulletin, v. 47, p. 1,874, 1,875, 1,877. Abandoned by Kansas Geological Survey. Rocks above the Day Creek Dolomite in Kansas are not correlative with the type Taloga of central Oklahoma; replaced by Big Basin formation.

Named for Taloga, Dewey County, Oklahoma.

Tarkio Limestone Member (of Zeandale Limestone)

Pennsylvanian (Virgilian Series): eastern Kansas, northwestern Missouri, southeastern Nebraska, southwestern Iowa.

S. Calvin, 1901, Iowa Geological Survey, v. 11, p. 420, 422, 430–437. *Tarkio limestone*—Limestone, 27 ft (8.1 m) thick, interbedded with thin shale beds, and lying about 125 ft (37.5 m) above Nodaway coal. Constitutes second and last assemblage of limestones in Page County, Iowa.

G. L. Smith, 1915, Iowa Academy of Science, Proceedings, v. 22, p. 77–90, 273–282. *Tarkio limestone*—Yellow, blue, gray, and brown limestone and gray calcareous shale, 6–12 ft (1.8–3.6 m) thick. Underlies McKissick's Grove shales and overlies City Bluffs shale.

G. E. Condra and N. A. Bengston, 1915, Nebraska Academy of Science Publications, v. 9, no. 2, p. 9–18. Divided the rocks between McKissick Grove shales above and City Bluffs shales below into (descending): Tarkio limestone, 12± ft (3.6± m); shale, 30–40 ft (9–12 m); Preston limestone, 2 1/2–3 ft (0.8–0.9 m); shale, 17–21 ft (5.1–6.1 m); Fargo limestone, 11 ft (3.3 m); shale, 3–32 ft (0.9–9.6 m); Burlingame limestone, 5 ft 2 inches (1.5 m 5 cm); shale, 8–12 ft (2.4–3.6 m); Rulo limestone, 1 ft 4 inches (40 cm). They described Tarkio limestone as consisting of (descending): limestone, 4 ft (1.2 m); shale, 3 ft 11 inches (1.2 m); limestone, 6 inches (15 cm); shale, 6 inches (15 cm); limestone, 6 inches (15 cm); shale, 16 inches (40 cm); limestone, 6–11 inches (15–27.5 cm).

H. Hinds and F. C. Greene, 1915, Missouri Bureau of Geology and Mines, v. 13, 2nd series. *Tarkio limestone* is basal member of Wabaunsee formation and same as "Barclay" limestone and "Wyckoff" limestone, and Greene has little doubt it is same as Burlingame limestone.

J. L. Tilton, 1924, Iowa Geological Survey, v. 29, p. 230–264, divided the Wabaunsee of southwestern Iowa into (descending): McKissick Grove shale, 91–93 ft (27–28 m), *Tarkio limestone* (restricted), 4 ft (1.2 m); shale and soft limestone, 12 ft (3.6 m); Preston limestone, 1–2 ft (0.3–0.6 m); and included the Rulo, Burlingame, and Fargo limestones of Nebraska in Scranton shale.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 57, 90. *Tarkio limestone* is not same as Burlingame limestone but lies 80–100 ft (24–30 m) above Burlingame limestone. It belongs to Wabaunsee formation, 25 ft (7.5 m) higher than Emporia limestone. It overlies Willard shale member and underlies Pierson Point shale, the basal bed of McKissick Grove shale. [This is definition of Tarkio limestone adopted by R. C. Moore and G. E. Condra in their October 1932 revised classification chart of Pennsylvanian rocks of Kansas and Nebraska, by Condra in his 1935 report, and by Moore in his 1936 report.]

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 229, 230. S. Calvin, 1901, Iowa Geological Survey, v. 11, applied *Tarkio* to rocks on Tarkio Creek, north of Coin, Page County, Iowa. Condra, who has carefully studied type Tarkio, concludes the beds named Tarkio by Calvin are unquestionably beds that have been called Emporia in Kansas. Hinds and Greene (1915) misidentified Burlingame limestone as Tarkio limestone. Since usage of past 20 years has led to application of *Tarkio* to a limestone that is not recognized at the locality on Tarkio Creek, north of Coin, Iowa, and since it is desirable to use *Tarkio* in its currently understood sense, the exposures of the Tarkio on Mill Creek, southwest of Maple Hill, Kansas, may appropriately be chosen as a new "type locality." This procedure may at first seem anomalous, but it is theoretically and practically in accordance with principles of good stratigraphy. We follow the principle of usage in accepting *Tarkio* for the limestone thus designated by Condra and Bengston (1915). Thickness in vicinity of Maple Hill 1–10± ft (0.3–3± m). Can be traced from Nebraska southward to northern Lyon County, Kansas, but no outcrops identifiable as Tarkio have been found farther south.

H. S. McQueen and F. C. Green, 1938, Missouri Geological Survey and Water Resources, 2nd series, v. 25, pl. 5. In Missouri, Tarkio limestone is basal formation in Wabaunsee group. Overlies Willard shale and underlies Pierson Point shale.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. viii (fig. 4), 19, 20. Wabaunsee group is redefined for Missouri in accord with interstate agreement. Tarkio limestone overlies Willard shale and underlies Wamego shale.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 16–17. In 1910 Condra, traced Swallow's (1866; 1867, American Association of Advanced Science, Proceedings, v. 15) so-called "Chocolate" limestone through outcrops in Mill Creek and Kansas River valleys of Kansas, also in southeastern Nebraska and northwestern Missouri and into

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 27, 48, 178–181. Includes strata from top of Avoca limestone member of Lecompton limestone to base of Deer Creek limestone; clayey to sandy shale; mostly unfossiliferous; thickness ranges from about 70 ft (21 m) in type area to about 50 ft (15 m) in southern Kansas; contains three members in northernmost Kansas (top to bottom): Rakes Creek shale, Ost limestone, and Kenosha shale.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 62, 66, 71. Chiefly clayey and sandy shale, locally having a more or less discontinuous limestone (Ost) in the upper part; no subdivisions recognized; thickness ranges from 12 ft (3.6 m) in southern Kansas to about 65 ft (19.5 m) near Kansas River.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 37. Gray to bluish-gray, clayey and sandy shale. Gray sandstone locally present in upper part. Thickness 12 ft (3.6 m) in southeastern Kansas to 65 ft (19.5 m) near Kansas River.

Type locality: Tecumseh, Shawnee County, Kansas.

Ten-inch coal (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local name for the Croweburg coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 72).

Tennison Creek shale

Pennsylvanian: eastern Kansas.

R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 90, 97. The beds from the top of the Bethany Falls limestone down to the base of the Schubert Creek limestone clearly represent a single sedimentation cycle and are here named Swope formation. They are divided into (top to bottom): Bethany Falls limestone, Hushpuckney shale, Middle Creek limestone, Elm Branch shale, Sniabar limestone, Mound City shale, Critizer limestone, Tennison Creek shale, and Schubert Creek limestone.

J. M. Jewett, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 90, 100, 103. Strata overlying Schubert Creek limestone and underlying Critizer limestone; generally less than 5 ft (1.5 m) thick, yellow, locally fossiliferous, and contains local thin limestone beds; quite dark in a few places.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 80. The names, Elm Branch, Sniabar, Tennison Creek and Schubert Creek, are applicable to lithologic elements of the cyclothem in which the Hertha limestone is the dominant element, but these names are not required in order to delineate the features of stratigraphy. They will not be recognized, therefore.

Named for Tennison Creek, in the western part of Bourbon County, Kansas.

Terra Cotta Clay Member (of Dakota Formation)

Terra Cotta shale member (of Ellsworth formation)

Cretaceous: central and southern Kansas.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Lower member of Ellsworth formation; underlies Rocktown sandstone; unconformably overlies Mentor sandstone member of Belvidere formation.

N. Plummer and J. F. Romary, 1942, Kansas Geological Survey, Bulletin 41, pt. 9, p. 319, 329–336. Includes massive clay, silt, and sandstone comprising approximately lower two-thirds of Dakota formation; most conspicuous feature of member is widespread distribution of gray- and red-mottled massive clay; thickness up to 170 ft (51 m); underlies Janssen clay member, contact is not sharp but can be drawn within 5-ft (1.5-m) zone in most places; contact placed at top of zone of concentrated concretionary siderite, limonite, or hematite, which is overlain by bed of gray massive clay containing varying amounts of siderite pellets and with yellow to yellow-orange coloring along oblique joints; overlies Kiowa shale.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 23, 25, 26. Clay, shale, sandstone, and quartzitic sandstone, interbedded; red, gray, brown, and tan. Central and north-central Kansas. Sandstones are lenticular and weather brown, coarse-grained to fine-grained, abundant hematite and limonite concretions throughout. Quartzitic sandstone near top. Thickness 70–220 ft (21–66 m).

H. G. O'Connor, 1968, Kansas Geological Survey, Bulletin 189, p. 56. Interbedded claystone, shale, and siltstone, which are mainly gray or greenish-gray with abundant red mottles. Grains and pellets of siderite are common in the claystone and siltstone; contains abundant interbedded and lenticular, fine- to coarse-grained sandstone, cemented with iron oxide, and locally cemented with calcite; sandstone generally weathers brown. Carbonaceous matter and lignitic beds are common near the base. Thickness 70–200 ft (21–60 m).

V. J. Hamilton, 1989, Kansas Geological Survey, Open-file Report 89–41. Terra Cotta Clay Member in both "D" and "J" sequences. Top of Terra Cotta Clay Member marked by a flooding surface associated with transgression during deposition of the "D" sequence.

Entire section is well exposed in school district of Terra Cotta, comprising part of T. 15 S., R. 6 W., in east-central Ellsworth County.

Texhoman series

Tertiary (Late): Kansas.

C. R. Keyes, 1915, Iowa Academy of Sciences, Proceedings, v. 22, p. 255. Name introduced to include the late Tertiary deposits of Kansas.

Derivation of name not given.

Thayer coal bed (in Chanute Shale, Linn Subgroup, Kansas City Group)

Pennsylvanian (Missourian Series): eastern and southeastern Kansas, northeastern Oklahoma.

G. I. Adams, 1896, Kansas Geological Survey, Vol. 1, p. 24. Thayer coal named from exposures around Thayer, Neosho County, Kansas.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 111. Extends almost uninterrupted from Kansas City area to Oklahoma. In the north, ranges in thickness from less than inch to 3 or 4 inches (2.5–7.5 or 10 cm) and in some sections occurs very near top of the formation. Farther south the coal is found at an increasing distance below top of the Chanute up to 50 ft (15 m) or more. The coal has a maximum thickness of about 2.5 ft (0.8 m) and has been mined near Thayer and near Independence.

Tina limestone member (of Altamont limestone)
Pennsylvanian (Desmoinesian): Kansas and Missouri.
L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, p. 29, 40. Proposed for lower limestone member of Altamont; light-gray limestone, weathers buff; about 4 ft (1.2 m) thick in Livingston and Carroll counties, Missouri.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, pt. 2, p. 329, 330. Extended into eastern Kansas; thickness up to 16 ft (4.8 m); underlies Lake Neosho shale member; overlies Bandera shale. It is unlikely that all limestone included in the Tina in Kansas is precisely equivalent to type Tina.
F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 7. Name "Tina" abandoned; rocks chosen for type Tina are not Altamont limestone; name "Amoret" replaces Tina.
Type locality: About 2 mi (3.2 km) southeast of Tina, Carroll County, Missouri, in ravines in west-central part of sec. 7, T. 54 N., R. 22 W.

Ti Valley series
Pennsylvanian: Kansas, Oklahoma, Iowa, Missouri, and Texas.
C. L. Cooper, 1946, Illinois Geological Survey, Bulletin 70, p. 16, 18, 19. Used to include all Pennsylvanian formations in the midcontinent between base of Pennsylvanian System and base of Des Moines Series. Name is suggested as a solution for the Morrow–Atoka–Lampasas–Marble Falls nomenclatural problem.
Named for exposures in Ti Valley, on border between Arbuckle and Ouachita Mountains, Pittsburg County, Oklahoma, which contain beds ranging in age from Morrow through Atoka.

Tonganoxie Sandstone Member (of Stranger Formation)
Pennsylvanian (Virgilian Series): northeastern Kansas and northwestern Missouri.
R. C. Moore, M. K. Elias, and N. D. Newell, 1934, Stratigraphic sections of Pennsylvanian and "Permian" rocks of Kansas River valley: Kansas Geological Survey; R. C. Moore, 1935, Rock formations of Kansas in Kansas Geological Society: Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Lower member of Stranger formation in Kansas; underlies Vinland shale member; unconformably overlies Iatan limestone; average thickness 50 ft (15 m); maximum thickness 80 ft (24 m); massive, crossbedded sandstone, coal beds, and sandy shale with a persistent coal (Sibley) at top.
J. M. Jewett and C. C. Williams, 1935, Kansas Academy of Science, Transactions, v. 38, p. 191–198. Massive sandstone to sandy shale, mostly micaceous, fine-grained, and uniform, usually crossbedded, brown or gray; 30 ft (9 m) thick. Occurs on uplands in extreme western part of Johnson County. Included in Stranger Formation.
N. D. Newell, 1935, Kansas Geological Survey, Bulletin 21, p. 82. Dominantly sandy and nonmarine beds from top of Sibley coal (which lies 8–10 ft (2.4–3 m) below top of Stranger Formation) to base of Stranger Formation were termed Tonganoxie by J. M. Patterson, in unpublished thesis, from a town in Leavenworth County, Kansas.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 147, etc. Tonganoxie Sandstone was erroneously attributed by Newell (Bulletin 21) to J. M. Patterson. Name was originated by Moore. Is basal member of Stranger Formation. Includes heavy crossbedded channel sandstones, sandy shales, and several coal beds and extends up to Sibley coal. Nearly all of Tonganoxie Sandstone in Kansas is nonmarine. In much of Douglas, Leavenworth, and Wyandotte counties, it rests unconformably on various parts of Stanton, Weston, and Iatan Formations. Thickness varies from 3 to 4 ft (0.9–1.2 m) near Elk City, Kansas, to nearly 100 ft (30 m) in east part of Leavenworth County. Good exposures described.
T. W. Lins, 1950, Kansas Geological Survey, Bulletin 86, pt. 5, p. 108–140. Basal member of Stranger Formation. Represents fill of large southwest-trending valley, major feature of regional disconformity which separates Pedee Group or lower beds (Missourian) from overlying Douglas Group (Virgilian). Tonganoxie contains four lithologic units (ascending): conglomerate, sandstone, shale, and coal. Thickness 4–100 ft (1.2–30 m), no complete sections exposed and thickness determined from composite sections. Underlies Westphalia Limestone Member.
H. G. O'Connor, 1963, American Association of Petroleum Geologists, Bulletin, v. 47, p. 1,873–1,877. Kansas Geological Survey, based on comprehensive stratigraphic studies of Douglas and Pedee Group rocks in Kansas, Oklahoma, Nebraska, Missouri, and Iowa by S. M. Ball, abandoned the term Pedee and amended and redefined the Douglas Group to include all rocks between Stanton Limestone below and Oread Limestone above. Divided the redefined Douglas Group into two formations, the Stranger below and Lawrence above. Amended and redefined Stranger Formation to include (ascending): Weston Shale Member, Iatan Limestone Member, Tonganoxie Sandstone Member, Westphalia Limestone Member, and Vinland Shale Member. Amended and redefined the Lawrence Formation to include (ascending): Haskell Limestone Member, Robbins Shale Member, and a member to be named in the forthcoming report.
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 34, and pl. 1. Generally lenticular, massive, crossbedded sandstone and more continuous sandy shale, containing several discontinuous coal beds, occupying the middle part of the Stranger Formation in most places. Upper and lower Sibley coal beds, in the northern part of the outcrop area, are distinctive units. Locally, there is a disconformity at the base of the Tonganoxie where it cuts through the lower members of the Stranger and into the top of the underlying Stanton Limestone. In other places, where the intervening Iatan Limestone Member is absent, the lower contact is gradational into the Weston Shale Member. Thickness ranges from 0 to 120 ft (0–36 m). Formerly the base of the Tonganoxie Sandstone was regarded as marking the base of the Douglas Group and of the Virgilian Stage. Douglas Group has been expanded to include beds downward to the top of the Stanton Limestone (O'Connor, 1963). Ball (1964) has shown that there is no persistent disconformity on which the Tonganoxie Sandstone was deposited.
M. R. Gibling, H. R. Feldman, A. W. Archer, and W. P. Lanier, 1993, *in*, A. W. Archer, H. R. Feldman, and W. P. Lanier, eds., Kansas Geological Survey, Open-file Report 93–24, p. 3-1–3-39. A major unconformity between the Tonganoxie Sandstone and underlying rocks, the Tonganoxie Sandstone is a fluvial to estuarine sandstone deposited within paleovalleys.

of Nebraska; if this correlation is correct, the occurrence is in Iowa, Nebraska, Missouri and through Kansas into Oklahoma. Name Toronto has priority over Weeping Water Limestone of Nebraska, although Nebraska uses term Weeping Water.

H. G. O'Connor, 1960, Kansas Geological Survey, Bulletin 148, p. 38, pl. 1. Member, in Douglas County, is typically light yellow brown or light gray when fresh; weathers deep yellow brown. Average thickness about 10 ft (3 m).

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 35, pl. 1. Toronto Limestone Member is brownish-gray, massive limestone that weathers deep brown. Is typically developed from Woodson County northward, but it is thinner, sandy, or locally absent in southeastern Kansas. Member is absent also in parts of southern Douglas and western Franklin counties, where a limestone conglomerate occupies its approximate stratigraphic position. Fusulinids, corals, and small brachiopods are the most common fossils. Thickness in northern outcrops ranges from 5 to 12 ft (1.5–3.6 m). In southern outcrops it is generally less than 4 ft (1.2 m) thick.

Type locality: Toronto, Woodson County, Kansas.

Towanda Limestone Member (of Doyle Shale)
Towanda Limestone (of Chase Group)

Permian (Wolfcampian Series): eastern Kansas and southeastern Nebraska.

R. C. Moore, 1920, Kansas Geological Survey, Bulletin 6, pt. 2, p. 61. One bed of limestone, well exposed in western part of El Dorado field near Towanda, which was of great assistance in mapping the structure of the field, has been designated as Towanda bed.

A. E. Fath, 1921, Kansas Geological Survey, Bulletin 7, p. 54. Bluish-gray slabby limestone, 5–9 1/2 ft (1.5–2.9 m) thick in Eldorado oil and gas field, Butler County, Kansas. Lies 50–60 ft (15–18 m) below top of Doyle Shale and 35 ft (10.5 m) above base.

G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, p. 44. Towanda Limestone Member of Doyle Formation persists widely as a very irregular unit. In places (as northeast of Barnes, Kansas) it consists of three rather massive limestones and interbedded shale, but at most places between type locality and Nebraska it is represented by 5–10 ft (1.5–3 m) or more of drab-colored slabby limestones that weather very irregularly and yellowish brown. Overlies Holmesville Shale (basal member of Doyle) and underlies Gage Shale (top member of Doyle).

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Drab to greenish flaggy limestone with common gastropods; 11 ft (3.3 m) thick; overlies Holmesville shale; underlies Gage shale.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 44. Consists of limestone, light-bluish-gray to yellow slabby and platy in middle and lower parts; brecciated in upper; fossils rare. Thickness commonly 5–10 ft (1.5–3 m); in Geary County, Kansas, about 15 ft (4.5 m). Underlies Gage Shale Member; overlies Holmesville Shale Member.

H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 49, pl. 1. Member consists of light-bluish-gray to yellow, slabby and platy limestone that is commonly brecciated in the upper part. Fossils are generally rare. Thickness ranges from about 5–15 ft (1.5–4.5 m).

Named from exposures near Towanda, Butler County, Kansas.

Towle Shale Member (of Onaga Shale, Admire Group)
Towle shale (of Admire group)

Pennsylvanian (Virgilian Series): eastern Kansas and southeastern Nebraska.

R. C. Moore and G. E. Condra (October 1932 revised classification chart of Pennsylvanian rocks of Kansas and Nebraska). Underlies Aspinwall limestone; overlies Brownville limestone; basal bed of Admire shale.

G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 9. *Towle shale formation*—About 2–2 1/2 ft (0.6–0.8 m) of gray shale at top, 10–11 ft (3–3.3 m) of red shale in middle, and 1± ft (0.3± m) of gray shale at base. Total thickness 14± ft (4.2± m). Underlies Aspinwall limestone formation and overlies Brownville limestone formation. Basal formation of Admire group (Permian).

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Unconformably overlies Brownville limestone; basal formation of Admire group in Big Blue series of "Permian"; contains two members, an unnamed shale member above (green and red clayey and sandy shale, 16 ft [4.8 m] thick) and the Indian Cave sandstone member below (light-brown massive and crossbedded sandstone with lenses of conglomerate locally near base, 0–120 ft [0–36 m] thick).

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 2,173. Cites letter from E. C. Reed (Assistant State Geologist of Nebraska) dated October 16, 1936, in which type locality is established.

R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, p. 170. Includes Indian Cave sandstone member which is present only locally and fills channels as deep as 120 ft (36 m). Wolfcampian series.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 43, 51, 52. Clayey and silty shale, siltstone, sandstone, and locally thin limestone; gray, red, and green clay, locally sandy. The Indian Cave sandstone (up to 250 ft [75 m] thick) occurs in the lower part, filling channels cut into Pennsylvanian rocks. The thickness of Towle shale where Indian Cave is absent ranges from about 2 to 17 ft (0.6–5.1 m).

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273, 2,274 (fig. 1). Rank reduced to member status in Onaga shale. Locally contains Indian Cave channel sandstone bed. Underlies Aspinwall limestone member; overlies Brownville limestone member of Wood Siding formation.

C. G. Bisby, 1986, Kansas Geological Survey, Open-file Report 86–4, p. 22, 24. Contains a paleosol, interbeds of limestone, and thin, channel sandstones, locally.

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire

Named for exposures on Turner Creek, southeast of Du Bois, Pawnee County, Nebraska.

Twenty-two inch coal (22-inch; in Cherokee Group)
Pennsylvanian (Desmoinesian Series).
A local name for the Mineral coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 70; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 62).

Two-foot coal (in Cherokee Group)
Pennsylvanian (Desmoinesian Series).
A local name for the Fleming coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 68).

"Tuxedo Gray limestone"
Lower Permian.
Trade name. Probably the Americus Limestone Member, Foraker Limestone Formation, Council Grove Group. The name is based on the color and is quarried in southeastern Pottawatomie County and southwestern Jackson County.

Tyro oolite bed (in Captain Creek Limestone Member, Stanton Formation)
Pennsylvanian (Missourian): southeast Kansas, northernmost Oklahoma.
P. H. Heckel, 1975, Kansas Geological Survey, Bulletin 210, p. 20–23. Overlies Lane–Vilas Formation, underlies Eudora Shale and appears equivalent to Captain Creek Limestone Member which is lithically distinct. Tyro is crossbedded, fossiliferous oolite from 1 to 15+ ft (0.3–4.5+ m) thick.
Type section: Abandoned quarry northeast of Tyro (NW SW SE sec. 30, T. 24 S., R. 15 E., Montgomery County, Kansas.

U

Udall limestone lentil (in Geuda Springs shale member of Wellington formation)
Permian: southeastern Kansas.
W. A. Ver Wiebe, 1937, Wichita Municipal University, Bulletin, v. 12, no. 5, p. 5, 13. Limestone several feet thick that occurs in Geuda Springs about 160 ft (48 m) below Prairie Creek limestone lentil.
Named for exposures near Udall in Maple Township, T. 30 S., R. 3 E., Cowley County, Kansas.

"undifferentiated rocks of Chesterian age"
W. J. Seevers, 1975, Kansas Geological Survey, Geology Series 1, p. 1–7. Noted average thickness of surficial Chesterian rocks in Cherokee County, Kansas, to be 120 ft (36 m). [Probably this is a misprint.]

Uniontown limestone (of Bourbon group)
Pennsylvanian: southeastern Kansas.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 97. Bourbon group includes (top to bottom) Ladore shale, Uniontown limestone, and unnamed shale and sandstone.
J. M. Jewett, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook, p. 99. Bourbon group contains at least one very persistent formation, the "Uniontown limestone," which is generally less than 1 ft (0.3 m) thick, dark, earthy limestone bearing bellerophontids and ammonites, and everywhere overlying black shale containing phosphatic concretions and ranging up to several feet in thickness.
R. C. Moore, 1935, Kansas Geological Survey, Bulletin 20, opp. p. 14. Bourbon group underlies Hertha limestone and unconformably overlies Lenapah limestone; divided into (top to bottom) undifferentiated shale and limestone, "Uniontown" limestone, unnamed shale, and Warrensburg channel sandstone.
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Bourbon formation unconformably overlies unnamed shale of unknown thickness; underlies Hertha limestone; no subdivisions of Bourbon formation other than channel sandstones at the base (Warrensburg) noted. [Uniontown apparently abandoned.]
Presumably named for exposures near Uniontown, Kansas.

Unity Farm Shale Member (of Hepler Formation)
Unity Farm Shale Member (of Lees Summit Formation)
Pennsylvanian (Missourian Series): eastern Kansas.
W. B. Howe, 1982, Missouri Geological and Land Survey Division, Open-file Report 82–10–GI, 99 p. Gray, silty, micaceous, thinly laminated shale containing clay-ironstone concretions; overlies Exline Limestone Member of Lees Summit Formation; unconformably underlies Weldon River Sandstone Member of Shale Hill Formation; generally ranges from a few feet to about 50 ft (15 m) thick, but 65 ft (19.5 m) thick at type section.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 6. It constitutes most of the Pleasanton Group in northern Linn County where it is at least 100 ft (30 m) thick. The upper part is well exposed along a road down a hill vest of the north end of Pleasanton (near north line NW NW sec. 34, T. 21 S., R. 24 E.). Complete interval partially exposed in northern K–69, 0.4 mi (0.6 km) south of Pleasanton (center west line of sec. 19, T. 22 S., R. 25 E.), where it is 20 ft (6 m) thick.
Type section: Acme Brick and Tile Company shale quarry in NE NW sec. 27, T. 48 N., R. 32 W., at Vale, Jackson County, Missouri. Named for Unity Farm, sec. 25, T. 48 N., R. 32 W.

Upper seam coal (in Cherokee Group)
Middle Pennsylvanian (Desmoinesian Series).
A local name for the Mineral coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 70).

Upper shale member (of Tacket Formation)
Pennsylvanian (Missourian Series): southeastern Kansas.
W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 7. Overlies Middle Tacket Limestone and underlies Bethany Falls Limestone. Largely equivalent to Hushpuckney Shale.
Type section: J. M. Jewett et al., 1965, p. 7–8. Along west side of sec. 17, T. 32 S., R. 19 E., is poorly exposed, a neostratotype is established on the northeast side of Tacket Mound, NE corner SW sec. 7, and creek bank in SW SW NE sec. 7, T. 32 S., R. 19 E. in Labette County, Kansas.

base of Pleiocene, above Sheepcreekian and below the Clarendonian; chart credited to Schultz and Stout, Stout, from various sources.

C. B. Schultz and T. M. Stout, 1961, Nebraska University State Museum, Special Publication 2, p. 9. Shown on correlation chart of the Miocene and Pliocene of the central Great Plains; occurs above Herringfordian and below Clarendonian; correlated with the Messinian of the European Standard.

Named for the Valentine Formation, Valentine, Cherry County, Nebraska.

Valmeyer series

Mississippian.

R. C. Moore, 1933, Historical geology: New York, McGraw–Hill Book Company, p. 262–264. Valmeyer series (new) includes Osage group below and Meramec group above.

R. C. Moore, 1935, Kansas Geological Survey, Open-file Report 35–1, sheet. Valmeyer Series: light-gray, fine- to coarse-grained limestone with abundant chert (Boone), underlain in places by bluish noncherty limestone and greenish-blue or in part reddish shale (Fern Glen). Average thickness ±400 ft (±120 m). Absent along Nemaha granite ridge and other major uplifts. [Name used for Osage–Meramec Series, undifferentiated.]

Name derived from southern Illinois where rocks of series are well exposed.

Van Buren Formation

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 13. Originally recognized as a unit separate from the Gasconade Dolomite, it is now considered part of the Gasconade Dolomite.

Vanhem formation (of Sanborn group)

Pleistocene and Holocene: southwestern Kansas.

C. W. Hibbard, 1949, Michigan University Museum of Paleontology Contributions, v. 7, no. 4, p. 69, 84–87. Proposed for sediments deposited during cycle of deposition which followed entrenchment of streams into Kingsdown and older formations. Includes (bottom to top): 1) sand and gravel; 2) silt; 3) silt to clayey silt; and 4) loess. Thickness 68 ft (20.4 m) at type section. Type section of the Vanhem is the section given by Smith (1940) as a typical section of the Kingsdown. Most exposures previously referred to or mapped as Kingsdown silt are of deposits younger than the Kingsdown formation and are part of the Vanhem.

C. W. Hibbard, 1958, American Journal of Science, v. 256, p. 55. Upper formation in Sanborn group in southwestern Kansas.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 67. Noted that Hibbard (1949) proposed the name "Vanhem Formation" for deposits of Wisconsinan and Recent ages in Clark County, Kansas. Not recognized by Kansas Geological Survey.

Type locality: In N/2, sec. 13 and S/2, sec. 12, T. 30 S., R. 23 W., Pyle Ranch, on north side of Bluff Creek, Clark County, Kansas; type section is along west bluff of a small tributary of Bluff Creek in secs. 12 and 13, T. 30 S., R. 23 W.

Varner sand

Ordovician: southern Kansas.

G. F. Berry, Jr., and P. A. Harper, 1948, American Association of Petroleum Geologists, v. 3, p. 215. Term applied in Augusta field, Butler County, Kansas, for Simpson sandstone and Arbuckle dolomitic limestone, either singly or collectively.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 88–89. The name "Varner sand" seems to have very local application, such as in the Douglass field, Butler County, Kansas, where the "Varner" lies at a depth of about 2,835 ft (850.5 m); usage essentially is the same as that of "Stapleton zone."

Venteran substage

Pennsylvanian (Desmoinesian): Kansas, Iowa, Nebraska, Missouri, and Oklahoma.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748, 2,749. Named on northern midcontinent composite stratigraphic column. Venteran substage together with overlying Cygnian substage make up Desmoinesian stage. Comprises Seville limestone and lower "Cherokee" beds.

W. V. Searight, 1955, Missouri Geological Survey and Water Resources, Report of Investigations 20, p. 10. Type locality and derivation of name given.

Type locality: Venter Bluff on US–54, Cedar County, Missouri.

Verdigris Limestone Member (of Cabaniss Formation)

Verdigris limestone member (of Cherokee formation)

Verdigris formation

Pennsylvanian (Desmoinesian Series): Kansas, Oklahoma, and Missouri.

C. D. Smith, 1928, Oklahoma Geological Survey, Bulletin 40–U, map. Mapped in upper part of Cherokee formation; occurs above Chelsea sandstone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 56. The most important limestone in the Cherokee shale; occurs in the upper middle part of the Cherokee. The name Ardmore limestone appears to have priority, as applied to this bed, but the Oklahoma term Verdigris limestone has been more used.

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Verdigris formation in Cabaniss group shown on composite stratigraphic column of Desmoinesian rocks in northern midcontinent. Overlies Croweburg formation; underlies Bevier formation.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22, 72–78 (measured sections). Formation includes beds above Croweburg coal and extending to top of Wheeler coal (recognized as Bevier in Kansas). Underlies Bevier formation; overlies Croweburg formation. Takes its name from widespread Verdigris (Ardmore) Limestone which is its most prominent bed.

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas: Kansas Geological Survey. Verdigris Limestone Member of Cabaniss Formation shown on correlation chart.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. Forms the most easily identified "marker bed" (on outcrop) in the Cherokee Group. Generally a dark-gray, foraminiferal limestone with a thickness of about 2 ft (0.6 m).

Name derived from Verdigris River in southern Rogers County, Oklahoma.

and redefined the Douglas Group to include all rocks between Stanton Limestone below and Oread Limestone above. Divided the redefined Douglas Group into two formations, the Stranger below and Lawrence above. Amended and redefined Stranger Formation to include (ascending): Weston Shale Member, Iatan Limestone Member, Tonganoxie Sandstone Member, Westphalia Limestone Member, and Vinland Shale Member. Amended and redefined the Lawrence Formation to include (ascending): Haskell Limestone Member, Robbins Shale Member, and a member to be named in the forthcoming report.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in,* D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 34, pl. 1. This unit consists of gray to greenish-gray, clayey, calcareous shale, sandy shale, and sandstone. North of Anderson and Coffey counties, where the Westphalia Limestone Member is absent, the top of the upper Sibley coal is regarded as marking the base of the Vinland Shale. A persistent zone of septarian concretions occurs in the upper middle part of the member in northeastern Kansas. A faunal zone containing abundant mollusks, particularly myalinid clams, characterizes the upper part of the Vinland Shale. The thickness of the Vinland ranges from about 2 to 50 ft (0.6–15 m).

Type locality: About 2 mi (3.2 km) northeast of Vinland, Douglas County, Kansas.

Viola Limestone

Viola Limestone (of Patterson Ranch Group)

"Viola lime"

Viola (of Kimmswick Limestone)

Middle and Upper Ordovician (Blackriveran and Trentonian Series): central southern and southwestern Oklahoma, Kansas subsurface.

J. A. Taff, 1902, U.S. Geological Survey, Geological Atlas, Folio 79, p. 1–8. Massive white and bluish limestones with occasional irregular bands and nodular masses of chert or flint most abundant in lower and middle portions; some beds coarsely crystalline, others composed chiefly of shells and shell fragments; thickness 750 ft (225 m); overlies Simpson formation; underlies Sylvan shale.

R. C. Moore, 1935, Rock formations of Kansas; *in,* Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Gray to brown dolomite, coarsely crystalline and fine-grained limestone, in part cherty; 185 ft (54.5 m) thick in Morrison No. 2 well, sec. 20, T. 32 S., R. 2 W.; absent on major uplifts; unconformably underlies "Maquoketa shale"; unconformably overlies Simpson; Mohawkian stage.

W. Lee, 1943, Kansas Geological Survey, Bulletin 51, p. 60–61. Viola is predominantly dolomite in the northeast grading to limestone in south-central Kansas. Absence of argillaceous impurities is noted. Three divisions of the Viola include an upper non-cherty dolomitic limestone, a middle cherty member (which is itself divisible into three units, the middle one of which is non-cherty), and a basal sparsely cherty limestone. This sequence is correlative to what is recognized as Kimmswick Limestone in Missouri.

H. Taylor, 1947, American Association of Petroleum Geologists, Bulletin, v. 31, p. 1,242–1,282. Viola in central Kansas is divided into six informal members. From base to top, these include: 1) basal clastic member (zone 6—a sandy, cherty limestone, 0–20 ft [0–6 m] thick), 2) lower limestone member (zone 5—brown or gray crystalline limestone with small amounts of insoluble material, 0–50 ft [0–15 m] thick), 3) middle cherty member (zone 4—tan crystalline limestone, dolomitized in places with insoluble residues of dark-speckled, microfossiliferous rough and smooth chert, 0–100 ft [0–30 m] thick), 4) middle limestone member (zone 3—tan or gray dense to finely crystalline limestone with little insoluble residue, 0–40 ft [0–12 m] thick), 5) upper cherty limestone member (zone 2—finely crystalline limestone containing large amounts of microfossiliferous, brown or gray, sharp-edged, smooth chert, 0–25 ft [0–7.5 m] thick), and 6) upper limestone member (zone 1—gray coarsely crystalline dolomitic limestone containing abundant coarse dolomite rhombs, 0–20 ft [0–6 m] thick). Zone 1 may represent dolomitization immediately beneath an unconformity at the base of the Maquoketa–Sylvan Shale. Zone 4 is equivalent to the middle cherty member of Lee (1943). Zone 3 is equivalent to the upper non-cherty member. Zone 5 (and possibly zone 6) is equivalent to the lower sparsely cherty limestone.

W. A. Ver Wiebe, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, p. 126–128. Viola is divided into six zones in Barber County in south-central Kansas. From base to top, these include: 1) zone VI—white coarsely crystalline limestone (averaging 20 ft [6 m] thick), 2) zone V—dolomitic and cherty argillite with dark-gray chert (averaging 70 ft [21 m] thick), 3) zone IV—white to gray limestone with brown spots, locally crinoidal (averaging 30 ft [9 m] thick), 4) zone III—finely crystalline cherty dolomite with tripolitic chert (averaging 50 ft [15 m] thick), 5) zone II—white to gray limestone with brown spots (averaging 20 ft [6 m] thick), and 6) zone I—finely crystalline, chert dolomite (averaging 30 ft [9 m] thick). Author maintains that zone V was commonly mistakenly identified "by many" as Maquoketa.

W. Lee, 1956, Kansas Geological Survey, Bulletin 121, 167 p. Informal subdivisions of the Viola in central Kansas are contested, and it is maintained that the Viola in central Kansas "does not lend itself to accurate regional zoning."

J. M. Jewett, 1959, Graphic column and classification of rocks in Kansas; Kansas Geological Survey. Viola (Kimmswick) Limestone overlies Platteville Formation and underlies Maquoketa (Sylvan) Shale.

H. A. Ireland, 1966; *in*, Symposium on the Viola, Fernvale, and Sylvan Formations, Tulsa Geological Society, Digest, v. 34, p. 26–40. Viola was once considered Trentonian, but is now considered to be late Blackriveran, Trentonian, and early Richmondian in age. Basically all the carbonate sequence between the Sylvan–Maquoketa shales and Simpson clastics are called Viola in the subsurface of Kansas.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 15. Viola of Kansas is only part of Viola in Oklahoma. Consists of dolomite and limestone, some cherty beds. Unconformably overlies Platteville Formation (Simpson Group); unconformably underlies Maquoketa Shale. Thins to 0 ft over central Kansas, Chautauqua, and northern Nemaha uplifts. Thickness 0–300 ft (0–90 m).

E. D. Goebel, W. C. Sweet, and P. L. Hilpman, 1969, Geological Society of America, Abstracts with Programs, pt. 6, p. 18. Paleontological investigation of the Mobil #1 Cunningham Estate well in Stevens County records Devonian conodonts near the top of a limestone previously reported as being "Middle Ordovician Limestone" or

R. C. Moore and M. L. Thompson, 1949, American Association of Petroleum Geologists, Bulletin, v. 33, p. 297. Approximately upper third of Pennsylvanian System belongs to Kawvian Series (new). Kawvian rocks are divided into Missourian Stage below and Virgilian Stage above.

W. H. Bradley, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, p. 2,284–2,285. In midcontinent region, U.S. Geological Survey uses following series subdivision of the Pennsylvanian: Morrow, Atoka, Des Moines, Missouri, and Virgil. Virgil is Late Pennsylvanian.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 34–43. Virgilian is upper stage of Upper Pennnsylvanian Series as used in Kansas.

D. R. Boardman, J. E. Barrick, and P. H. Heckel, 1989, Abstracts with Programs, Geological Society of America, St. Louis, Missouri, p. A168. Based on biostratigraphic evidence, proposed the base of the Haskell Limestone as a provisional Missourian–Virgilian boundary, pending formal decision by a boundary commission.

D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform with global biostratigraphic usage. Revised Admire Group to include rocks up to base of the Neva Limestone: Admire (revised) assigned to the Virgilian Series (Upper Pennsylvanian).

Named for town in eastern part of Greenwood County, Kansas (sec. 8, T. 24 S., R. 13 E.). Type section along Verdigris River between Madison and central Wilson County, through the town of Virgil.

W

Wabaunsee Group

Wabaunsee Formation

Pennsylvanian (Virgilian Stage): eastern Kansas, southwestern Iowa, northwestern Missouri, southeastern Nebraska, and northern Oklahoma.

C. S. Prosser, 1895, Journal of Geology, v. 3, p. 688–697. *Wabaunsee formation*—Defined to include beds from the top of the "Osage coal" [=Nodaway coal] or "Silver Lake coal" [=Elmo coal; the two were erroneously thought to be equivalent] to the base of the Cottonwood limestone; about 575 ft (172.5 m) thick.

E. Haworth, 1898, Kansas University Geological Survey, v. 3, p. 94. Redefined base of Wabaunsee formation to exclude beds below the Burlingame limestone.

E. Haworth and J. Bennett, 1908, Kansas Academy of Science, Transactions, v. 21, p. 71–85; University of Kansas Geological Survey, v. 9. Restricted Wabaunsee formation to include only beds from top of Scranton shale to base of Cottonwood limestone.

H. Hinds and F. C. Greene, 1915, Missouri Bureau of Geology and Mines, 2nd series, v. 13, p. 34. Included beds above Scranton shale; basal member called [erroneously] Tarkio limestone.

G. E. Condra, 1935, Nebraska Geological Survey, Paper 8, p. 4, 5, 9–11. Subdivided Wabaunsee Group into three subgroups: Richardson (named from Richardson County, Nebraska), Nemaha (named from the Nemaha Valley areas of Nebraska), and Sac–Fox (named from the Iowa–Sac-Fox Indian Reservation in southeastern Nebraska and northeastern Kansas). Includes all units from top of Brownville limestone formation to base of Severy shale formation (about 351 ft [105.3 m).

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 200–202. Defined to include beds above the top of the Topeka limestone and below the unconformity at the base of the Towle shale. Shale is relatively much more prominent in the Wabaunsee group than in adjoining parts of the geologic section. Thickness of the Wabaunsee group in Kansas is about 500 ft (150 m) and varies little except where the Indian Cave sandstone cuts down into the group, reducing its thickness to 80–125 ft (24–37.5 m).

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 165–196. Uppermost major division of Virgilian strata. As adopted by interstate conference of geological surveys, includes (ascending) Severy shale, Howard formation, White Cloud shale, Happy Hollow limestone, Cedar Vale shale, Rulo limestone, Silver Lake shale, Reading limestone, Harveyville shale, Elmont limestone, Willard shale, Tarkio limestone, Wamego shale, Maple Hill limestone, Langdon shale, Dover limestone, Dry shale, Grandhaven limestone, Friedrich shale, Jim Creek limestone, French Creek shale, Caneyville limestone, Pony Creek shale, and Brownville limestone. Overlies Shawnee group. Top drawn at prominent disconformity just above Brownville limestone. Comprises Sacfox, Nemaha, and Richardson subgroups. Agreed that nomenclature in the several states may be required to deviate from this standard section by combination or omission of terms where certain named rock units are not recognizable.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. viii, 19–21. As redefined for Missouri, includes beds from top of Topeka formation to top of Pennsylvanian in Missouri, which is top of French Creek shale. Grandhaven limestone has not been identified in Missouri, and shale between Dover limestone and Jim Creek limestone is called Dry Friedrich shale. Lower limestone of Tarkio has been considered base of Wabaunsee and lower limestone (Elmont) and Willard shale included in Shawnee group.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 12–20. Nebraska follows interstate agreement on classification of Wabaunsee except in use of Pierson Point for Wamego, Morton formation for Grandhaven interval, and Wood Siding formation between French Creek formation and Brownville limestone. Thickness of group in Nebraska about 396 ft (118.8 m).

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin v. 40, no. 9, p. 2,271–2,278. Redefined. Includes ascending Severy shale, Howard limestone, Scranton shale, Bern limestone (new), Auburn shale, Emporia limestone, Willard shale, Zeandale limestone (new), Pillsbury shale (new), Stotler limestone (new), Root shale (new), and Wood Siding formation.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 25 (table 2), 44–71. Uppermost group of Virgilian series. Currently group includes beds upward from top of Topeka (Turkey Run limestone) to top of Brownville limestone. In Kansas, Wabaunsee deposits are cyclic and similar to those of underlying Shawnee group. Southward these deposits lose much of their cyclic character, and although alternating

W. Tomlinson, and J. Westheimer, 1944, Geological Society of America, Bulletin, v. 55, no. 6, chart 6 (column 32). Correlation chart shows Wakarusa limestone in Shawnee group in Missouri.

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 183. Thickness from about 2 ft to about 18 ft (0.6–5.4 m); more shale than limestone where thick. The so-called "Cryptozoon limestone" of Osage County, Oklahoma, is the fusulinid-bearing phase of the Wakarusa limestone.

F. C. Greene and W. V. Searight, 1949, Missouri Geological Survey and Water Resources, Report of Investigations 11, p. 20. Assigned to Wabaunsee group when that group was redefined for Missouri.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273 (fig. 1), 2,277. Rank reduced to member status in Bern limestone (new). Overlies Soldier Creek shale member; underlies Auburn shale.

P. B. Greig, 1959, Oklahoma Geological Survey, Bulletin 83, p. 53–54. As now defined, name Wakarusa is applied to first resistant limestone unit above Burlingame limestone in Kansas section. Fusulinid-bearing phase of Wakarusa extends into Oklahoma, where, in earlier reports, it was referred to as *Cryptozoan* limestone. Thickness in Pawnee County 2–9 1/2 ft (0.6–2.9 m). Overlies Hallett shale; underlies Auburn shale. Wabaunsee group.

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 13, fig. 5. Consists of two blocky, bluish-gray, fine-grained limestone beds separated by thin, gray, crinoidal shale. Underlies Auburn shale; overlies Soldier Creek shale. Wabaunsee group.

Type locality: Exposures along Wakarusa Creek immediately south of Auburn, Shawnee County, Kansas. Well exposed on K–10, west of Topeka, in sec. 35, T. 11 S., R. 13 E., and along creek north of highway.

Walker beds

Cretaceous (Lower): south-central Kansas.

F. W. Cragin, 1895, American Geologist, v. 16, p. 359. Name suggested as substitute for Belvidere beds in a broad sense (including Cheyenne sandstone, Champion shell bed, and Kiowa shales), in case conflicting uses of Belvidere should make that name not acceptable. Nevertheless, Belvidere seems preferable to Walker.

Named for Walker's Draw, a well-known branch of the Medicine Lodge River, south of Belvidere, Kiowa County, Kansas.

Wallace shale

Cretaceous: northwestern Kansas.

C. R. Keyes, 1941, Pan-American Geologist, v. 76, no. 4, p. 304. Name used for upper formation in Buckskinian series; shales about 300 ft (90 m) thick; overlies Gove chalk; underlies unnamed interval below Arickaree formation of Rawlinsian series.

C. R. Keyes, 1941, Pan-American Geologist, v. 76, no. 5, p. 374, 376. Proposed for so-called Pierre shales of Kansas.

Named for exposures in Wallace County, Kansas.

Walnut shale

Pennsylvanian: eastern Kansas and northeastern Oklahoma.

E. Haworth and J. Bennett, 1908, Kansas Academy of Science, Transactions, v. 21, pt. 1, p. 74. Shales overlying Altamont limestone and underlying Coffeyville limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 65. The name Walnut is preoccupied by a Cretaceous formation in Texas and therefore is not available for this shale in Kansas; synonymized with Nowata shale.

Named for exposures around Walnut, Crawford County, Kansas.

Walter Johnson Sandstone Member (of Nowata Shale)

Walter Johnson sandstone bed (in Nowata Shale)

Pennsylvanian (Desmoinesian Series): eastern Kansas, western Missouri, and northeastern Oklahoma.

J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, p. 292, 335. Lenticular sandstone in Nowata shale.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 95, 96. Thin-bedded to massive sandstone in the lower to middle Nowata shale in parts of southern Kansas; equivalent to the "Wayside sand" of the subsurface; outcrop thicknesses commonly 4–10 ft (1.2–3 m).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94–34, p. 3. Lowered to bed status within Nowata Shale because of lenticularity.

Named from Walter Johnson School in sec. 10, T. 35 S., R. 17 E., Montgomery County, Kansas.

Wamego Shale Member (of Zeandale Limestone)

Wamego Shale (of Wabaunsee Group)

Pennsylvanian (Virgilian Series): eastern Kansas, western Missouri, southeastern Nebraska.

G. E. Condra and E. C. Reed, 1943, Nebraska Geological Survey, Bulletin 14, p. 42–43. Name applied to shale between Maple Hill limestone above and Tarkio limestone below. Thickness at type locality 15–18 ft (4.5–5.4 m). Replaces Pierson Point shale of Condra (1927). [See explanation under Pierson Point.]

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 188–189. Bluish clay shale and yellowish-brown, sandy micaceous shale, 6–25 ft (1.8–7.5 m) thick; locally in the north the upper portion is nearly black. Some of the historically famous Nebraska City fossils, described in early writings by Geinitz (1866) and by Meek (1872), come from the Wamego shale.

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 15. Reference made to Pierson Point shale by Condra and Reed (1943) is in error; name Pierson Point retained and Wamego dropped.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,276. Rank reduced to member status in Zeandale limestone (new).

M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 6. Noted that lowest limestone bed of Moore's (1949) three-limestone-bed Dover limestone in southern Kansas correlates with a marl bed in the Wamego shale member in northern Kansas [see additional discussion under Dover Limestone Member].

Type locality: In bluffs north of US–40, about 4 mi (6.4 km) west of Wamego, Pottawatomie County, Kansas.

slightly calcareous geode-bearing shale above. Upper part of Warsaw has not been distinguished from overlying Salem everywhere in western Illinois and adjacent parts of Missouri. Upper division of Warsaw, at Warsaw, consists of about 40 ft (12 m) of bluish-gray shale with thin interbedded layers of argillaceous limestone, a few thin beds of fine-grained, bluish-gray sandstone, and several massive bluish-gray, dense to finely crystalline limestone strata which locally are irregularly and incompletely dolomitized. It thins northward and disappears from section a little north of Keokuk. South of Warsaw this part of formation becomes increasingly calcareous and has probably been included in Salem or Spergen formation.

L. R. Laudon, 1948, Journal of Geology, v. 56, no. 3, p. 289–290. Discussion of Warsaw problem and Osage–Meramec contact. Warsaw formation has been classified with beds of Meramec age or with beds of Osage age. Type section of Warsaw restudied.

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, no. 2, p. 99–100, chart 5. Shown on standard Mississippian section as basal formation in Meramecian series. Occurs below Salem limestone and above Keokuk limestone of Osagean series.

C. E. Robertson, 1967, Missouri Geological Survey and Water Resources, Report of Investigations 38, p. 16. Composed of B–J beds of Fowler and Lyden (1932) in Tri-state mining district.

E. D. Goebel, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 20. Limestone and dolomite, with large amounts of chert. Unconformable on Keokuk–Burlington beds in central and eastern Kansas, conformable in western Kansas. Thickness 30–250 ft (9–75 m). Meramecian. Typical exposure: Along creek known as Soap Factory Hollow, which joins the Mississippi from the east 1/2 mi (0.8 km) south of Lower Warsaw, Illinois. Named for exposures at Warsaw, Hancock County, Illinois.

E. D. Goebel, 1968, American Association of Petroleum Geologists, Bulletin, v. 52, p. 1,742–1,750, 1,762–1,765, 1,774. Presents discussion of Warsaw and "Cowley" problem. Warsaw Limestone outside of the area of the "Cowley" facies is semigranular to coarsely crystalline limestone interlaminated with saccharoidal dolomite; it contains varied amounts of gray mottled, opaque, microfossiliferous chert. The Warsaw thins toward the Central Kansas uplift and thickens southward toward the Panhandle of Oklahoma. It is more than 250 ft (75 m) thick at its maximum development in Meade County, Kansas.

T. L. Thompson and E. D. Goebel, 1968 [1969], Kansas Geological Survey, Bulletin 192, p. 4, 6–11. Reported conodont fauna from Warsaw Limestone in subsurface of Kansas. The Warsaw Limestone (outside the area of the "Cowley facies") is a semigranular to coarsely crystalline limestone interlaminated with saccharoidal dolomite; it contains varying amounts of gray, mottled, opaque, microfossiliferous chert; geodic and drusy quartz are local constituents; pyrite and glauconite are disseminated throughout the formation, and glauconite is locally concentrated near the base. The Warsaw thins toward structural highs and thickens southward toward the Oklahoma Panhandle; it is >250 ft (75 m) thick in its maximum development in Meade County, Kansas; it is 30–40 ft (9–12 m) thick in the Forest City and Salina basins. The Salem is differentiated from the Warsaw on the basis of smaller proportions and a different kind of chert, generally abundant *Endothyra*, sparse glauconite, local oolitic lenses, and dolomitic limestone and saccharoidal dolomite. Warsaw, Salem, and St. Louis equivalents are probably widespread in the southern portion of the Sedgwick basin but have not been recognized because of the "Cowley facies" and because either the chert residuum of the "Mississippi chat" or chertified rocks conceal them.

V. B. Cole, 1975, Kansas Geological Survey, Open-file Report 75–8, sheet 5, scale 1:1,200,000. Compiled thickness map for Warsaw in southwestern Kansas; ranges from 0 ft to 335 ft (0–100.5 m) thick.

W. J. Seevers, 1975, Kansas Geological Survey, Geology Series 1, p. 3. Crinoidal limestone with much gray chert in Cherokee County; 120 ft (36 m) thick.

W. J. Ebanks, Jr., R. M. Euwer, and D. E. Nodine–Zeller, 1977, American Association of Petroleum Geologists, Bulletin, v. 61, p. 309–330. Discussion of geology of "Warsaw" Formation, Bindley field, Hodgeman County, Kansas.

B. Coffey, 1983, Kansas Core Workshop Notes, p. 31–35. Core and electric log description of a Warsaw pay zone in Brandt–Sensenbaugh field, Butler County.

T. L. Thompson, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations, v. 70, p. 4–8, 10, 11, 13, 94, 97–99, 101–107, 117, 152, 153. Presents nomenclatural history and synonymy for Warsaw Formation. Also details history of Meramecian–Osagean boundary, near base of Warsaw.

M. E. Wilson, 1988, Kansas Geological Survey, Open-file Report 88-50, 115 p. The Salem Limestone is distinguished from the Warsaw on geophysical logs by decreased gamma-ray count, indicating lower clay content, and by decreased neutron-porosity values relative to density-porosity, representing decreased dolomite content; the contact is placed at the base of the first pure limestone bed approximately 20 ft (6 m) thick. Presents detailed description of petrology and petroleum geology of the Warsaw Formation in Kiowa and Comanche counties, Kansas.

Type locality: Along a creek at the northeastern edge of the town of Warsaw, extending upstream on the northeast side of the highway bridge (SE sec. 4, NE NE sec. 9, and NW sec. 10, T. 4 N., R. 9 W., Warsaw 7 1/2-min quadrangle), Hancock County, Illinois (see Thompson, 1986, p. 102, 103).

Watchorn formation (of Meramec group)

Mississippian.

W. Lee, 1940, Kansas Geological Survey, Bulletin 33, p. 84–89, pl. 2. Non-cherty limestone in lower part, overlain by non-cherty dolomite or dolomitic limestone, overlain by non-cherty white limestone with interbedded oolitic limestone and lithographic limestone in upper part; used as a convenient subsurface lithologic term where the subdivision of this sequence of strata into the Spergen [=Salem], St. Louis, and possibly Ste. Genevieve limestones is impracticable; 0–690 ft (0–207 m) thick; thick sections occur only in western Kansas; outliers of lower part are present in eastern Kansas. First penetrated in western Kansas in Clark County in 1931 in the Watchorn Oil and Gas Company No. 2 Morrison well (NE NW sec. 20, T. 32 S., R. 21 W.).

J. M. Weller, W. A. Bell, K. E. Caster, C. L. Cooper, P. B. Stockdale, and A. H. Sutton, 1948, Geological Society of America, Bulletin, v. 59, p. 145. The Spergen, St. Louis, and Ste. Genevieve limestones are believed to be present [in

geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947.

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 12. Overlies Block Limestone Member and underlies Westerville Limestone Member. Wea Shale Member has not been identified in southern Kansas. Middle Flaggy Limestone Member at similar stratigraphic position of Wea Shale Member in southern Kansas.

Type locality: SE sec. 31, T. 16 S., R. 24 E., and center of east side sec. 12, T. 18 S., R. 22 E., Miami County, Kansas. Named for Wea Creek in northeastern part of county.

Webb sand

Pennsylvanian (Missourian): southern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 89. Name used for the middle of three productive sandstones that occur in the Lane–Vilas shale (Lansing group) in Elk and Montgomery counties, Kansas; known also as the "Longton sand" and as the "Heck sand."

Weeping Water limestone member (of Oread limestone)
Weeping Water limestone (of Oread limestone)
Weepingwater limestone

Pennsylvanian (Virgilian): eastern Kansas, southeastern Nebraska, and northwestern Missouri.

C. S. Prosser, 1897, Journal of Geology, v. 5, p. 154–172. Massive light-gray limestone, 9 ft (2.7 m) thick, forming top member of Wabaunsee formation in Cass County, Nebraska.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 32, 36. Weepingwater limestone is lowest unit of Oread limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 162, 163. Questionably synonymized with Toronto limestone member of Oread limestone. There is sufficient doubt as to the equivalence of the "lower Oread" limestone of Kansas and the Weeping Water limestone of Nebraska to make use of the latter name undesirable as a subdivision of the Kansas Oread. The Weeping Water limestone occurs in the stratigraphic position of the "lower" Oread, but it is possible that this is really a quite different limestone comparable or perhaps exactly equivalent to the Amazonia limestone in the Lawrence shale.

Type locality: West side of North Branch Weeping Water Valley, about 1 mi (1.6 km) northwest of Nehawka, Cass County, Nebraska.

Weir–Pittsburg coal bed (in Cabaniss Formation, Cherokee Group)
Weir formation
Weir cyclothem

Pennsylvanian (Desmoinesian Series): southeastern Kansas, southwestern Missouri, and northwestern Oklahoma.

G. E. Abernathy, 1937, Kansas Geological Society, Guidebook, 11th Annual Field Conference, p. 18, 20, 22; 1938, Kansas Academy of Science, Transactions, v. 41, p. 193, 195. Cherokee Group is divided into 15-cyclic formational units. The Weir, sixth in sequence (ascending), occurs below the Pilot and above the Knifeton. Thickness about 36 ft (10.8 m). Includes a 3-ft (0.9-m) coal bed known as Weir–Pittsburg.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 98, 101. The Weir cyclothem contains a basal sandstone, very thick underclay, thick coal (Weir-Pittsburg) and overlying shale. Total thickness of the cyclothem is about 30 ft (9 m).

W. V. Searight, W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as Weir formation in Cabaniss group. Underlies Tebo formation; overlies Seville formation of Krebs group.

W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 22 (fig. 5), p. 46–48. Formation in Cabaniss subgroup of Cherokee Group. In Kansas, includes only Weir–Pittsburg coal and its underclay. Thickness averages about 12 ft (3.6 m) in Cherokee and Crawford counties.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 24. The Weir–Pittsburg coal bed has been the most important coal bed commercially in Kansas. The average thickness of the Weir–Pittsburg coal bed is about 3.6 ft (1.1 m).

L. L. Brady, 1990, Geological Society of America, Coal Geology Division guidebook, p. 119, fig. 9.

Named for towns of Weir, Cherokee County, and Pittsburg, Crawford County, Kansas, where the coal was extensively mined.

Weir-Pittsburg lower coal (in Cherokee Group)

A local name for the Weir–Pittsburg coal bed (W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 48).

Weir-Pittsburg upper coal (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

A local coal-bed name for the Mineral coal bed (W. G. Pierce and W. H. Courtier, 1937, Kansas Geological Survey, Bulletin 24, p. 70; W. B. Howe, 1956, Kansas Geological Survey, Bulletin 123, p. 62).

Weiser cap
Weiser lime

Pennsylvanian (Desmoinesian): southern Kansas.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 89. Used to designate the Altamont limestone in southern Kansas.

Weiser sand

Pennsylvanian (Desmoinesian): southern Kansas and northern Oklahoma.

C. W. Boughton, 1920, Kansas Geological Survey, Bulletin, v. 5, p. 15. Named for Mr. Weiser who first encountered the Weiser sand in Montgomery County, Kansas; same as Wiser sand.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 89–90. Used to designate sandstone in southeastern Kansas that occurs in the Bandera shale (below the Altamont limestone and above the Pawnee limestone); occurs about 120 ft (36 m) below the Wayside sand at a depth of about 700 ft (210 m) in the Wayside–Havana oil-producing area, Montgomery County, Kansas; occurs about 70–90 ft (21–27 m) below the Wayside sand in the Elk City gas field; sandstone that occurs in the Bandera is known as the Bandera Quarry sandstone; not the same as Wiser sand (*contra* Wilmarth, 1938).

Wellington marble
Permian: south-central Kansas.
M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 2,300. Popular term for marble quarried from beds in Sumner group of Sumner County, Kansas, that are older than Wellington formation of Sumner group.

Weskan Shale Member (of Pierre Shale)
Cretaceous (Upper): northwestern Kansas.
M. K. Elias, 1931, Kansas Geological Survey, Bulletin 18. Upper 80 ft (24 m) consists of gray clayey shale with a few thin beds of bentonite, large tough limestone concretions, rusty cone-in-cone lenses, and thin streaks of concretionary limonite. Lower 90 ft (27 m) consists of gray clayey shale with comparatively abundant beds of bentonite; large limestone concretions common; some thin streaks of purple-brown limonite. Underlies Lake Creek shale member of Pierre shale; overlies Sharon Springs shale; basal member of Pierre shale.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 23. Clayey, gray shale; bentonite beds more common in lower part; large limestone concretions and some limonite; overlies Sharon Springs shale member of Pierre shale.
Type locality: Five miles (8 km) north of Weskan, Wallace County, Kansas. Type locality of upper Weskan is on a small creek north of Swisegood ranch, in SE sec. 2, T. 13 S., R. 42 W.; best exposure of lower Weskan is on south side of Goose Creek, in SW sec. 4, T. 13 S., R. 40 W.

West Branch Shale Member (of Janesville Shale)
West Branch Shale (of Admire Group)
Pennsylvanian (Virgilian Series): eastern Kansas and southeastern Nebraska.
G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 74, 82, 89, 111, 113. *West Branch shale*—Greenish-blue argillaceous massive and crumbly shale; dark near top; calcareous bladed material above middle, and calcareous lensing material near base. Thickness 26± ft (7.8± m). Top bed of Admire shale member of Wabaunsee formation. Overlies Falls City limestone and underlies Americus limestone.
R. C. Moore and G. E. Condra, 1932 (October 1932 revised classification chart of Pennsylvanian rocks of Nebraska and Kansas), divided Admire shale into (descending): Oaks shale, Houchen Creek limestone, Stine shale, Five Point limestone, West Branch shale, Falls City limestone, Hawxby shale, Aspinwall limestone, and Towle shale. Whether this is a restriction of West Branch shale is unknown. The Stine shale and Houchen Creek limestone were named by Condra in the 1927 publication cited above, where they were defined as belonging to lower part of Elmdale shale, which overlies Americus limestone; but their 1932 chart includes them in Admire shale, which underlies Americus limestone.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22. Transferred all beds above Brownville limestone to Permian.
R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,273, 2,274 (fig. 1). Reallocated to member status in Janesville shale (new). Underlies Five Point limestone member; overlies Falls City limestone. Wolfcampian series.
M. R. Mudge and H. R. Burton, 1959, U.S. Geological Survey, Bulletin 1068, p. 14 (table 2), 48–49. Thickness about 27 ft (8.1 m) in Wabaunsee County, Kansas. Underlies Five Point limestone member; overlies Falls City limestone.
M. R. Mudge and E. L. Yochelson, 1962, U.S. Geological Survey, Professional Paper 323, p. 24–26. Persistent coal bed, few inches to 2 ft (0.6 m) below top of West Branch Shale Member south of Kansas River; argillaceous limestone/calcareous shale bed (few inches to 4 ft [1.2 m] thick) about 10 ft (3 m) above the Falls City Limestone; another thin limestone/very calcareous shale bed 6–8 ft (1.8–2.4 m) beneath the Five Point limestone member. Sandstone bodies also present in member.
D. L. Baars, S. M. Ritter, C. G. Maples, and C. A. Ross, 1994, Kansas Geological Survey, Bulletin 230, p. 11–16. Proposed revision of Virgilian–Wolfcampian boundary stratigraphically upward to base of Neva Limestone to conform to global biostratigraphic usage. Revised Admire Group to include rocks up to base of Neva Limestone to conform, including West Branch Shale Member.
Type locality: Exposures in West Branch Township, Pawnee County, Nebraska.

Westerville Limestone Member (of Cherryvale Shale)
Westerville Limestone (of Kansas City Group)
Pennsylvanian (Missourian Series): southwestern Iowa, southeastern Nebraska, northwestern Missouri, and northeastern Kansas.
H. F. Bain, 1898, American Journal of Science, 4th, v. 5, p. 437–439. Fossiliferous ash-gray, fine-grained, thin-bedded limestone, 10 ft (3 m) thick, occurring some little distance above DeKalb limestone.
H. F. Bain, 1898, Iowa Geological Survey, v. 8, p. 276–277. Important bed of limestone well shown on Sand creek near Westerville.
G. E. Condra and J. E. Upp, 1933, Nebraska Geological Survey, Paper 4, p. 5, 8, 10. Note that Condra, Greene, and Moore traced the so-called Drum Limestone of the Kansas City area to Winterset, Iowa, and found it to be same as the type Westerville Limestone.
N. D. Newell and J. M. Jewett, 1935, Kansas Geological Survey, Bulletin 21, p. 40–43, 172–173. Shows that Westerville is not the same as Drum.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 45 (fig. 8), 100–101. Westerville Limestone included in Kansas City Group. Underlies Quivira Shale; overlies Wea Shale.
R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,030, 2,031 (fig. 4). Rank reduced to member status in Cherryvale Formation. Underlies Quivira Shale Member; overlies Wea Shale Member. This is classification agreed upon by state geological surveys of Iowa, Kansas, Missouri, Nebraska, and Oklahoma, May 1947. Clair (1943, Missouri Geological Survey and Water Resources, 3rd series, v. 27) included the Westerville in Cherryvale Shale.
G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 37–38. In Nebraska classified as uppermost member of Sarpy Formation (new). Overlies Wea Shale Member.
T. L. Welp, L. A. Thomas, and H. R. Dixon, 1957, Iowa Academy of Science, Proceedings, v. 64, p. 418 (fig. 1), 421. In section near Winterset, Iowa, Westerville Member of Cherryvale is about 62 ft (18.6 m) thick; underlies Quivira Shale Member; overlies Wea–Fontana Shale Members.

Robbins Shale Member, and a member to be named in the forthcoming report.

J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 34, and pl. 1. Westphalia Limestone Member comprises brown, flaggy-bedded, argillaceous limestone about 1–5 ft (0.3–1.5 m) thick from northern Anderson County southward to northeastern Chautauqua County. Upper part of the member contains fusulinids, *Osagia*, and mollusks. In Anderson County and northward, it is a discontinuous, gray, laminated, carbonaceous limestone 0–1.5 ft (0–0.5 m) thick that directly overlies the upper Sibley coal bed.

Named for Westphalia in western Anderson County. Typical outcrops are in roadside exposures along northern part of sec. 12, T. 21 S., R. 17 E., and at NE corner sec. 20, T. 21 S., R. 18 E. Not definitely recognized in outcrops north of T. 19 S.

West Point shale (of Admire shale)

Pennsylvanian: central Kansas.

R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference, correlation chart. Misprint for West Branch shale.

Wheeler coal bed (in Cherokee Group)

Pennsylvanian (Desmoinesian Series).

An informally named coal bed recognized in Missouri that is considered to correlate with the Bevier coal bed of Kansas (C. R. Wright, 1975, U.S. Geological Survey, Professional Paper 852, pt. 2, p. 74). The Bevier coal bed in Missouri splits in north-central Missouri and the lower coal bed was named the Wheeler coal; the upper coal bed carried the Bevier name.

W. V. Searight; *in*, W. B. Howe and W. V. Searight, 1953, Missouri Geological Survey and Water Resources, Report of Investigations 14, pl. 1. Name appears on generalized stratigraphic section. Underlies Bevier formation; overlies Verdigris formation. Contains Wheeler coal at top. Exposed in northeastern Carroll and southeastern Livingston counties, Missouri.

W. V. Searight , W. B. Howe, R. C. Moore, J. M. Jewett, G. E. Condra, M. C. Oakes, and C. C. Branson, 1953, American Association of Petroleum Geologists, Bulletin, v. 37, p. 2,748. Shown on northern midcontinent composite stratigraphic section as a coal bed in the top part of the Verdigris formation.

W. V. Searight and W. B. Howe, 1961, Missouri Geological Survey and Water Resources, v. 40, 2nd series, p. 85–88. Recognizes the Wheeler coal as the top unit of the Verdigris Formation in Missouri.

C. E. Robertson, 1971, Missouri Geological Survey and Water Resources, Report of Investigations 48, p. 19–20. Describes the Wheeler coal as a split from the Bevier coal. Searight (1953) considers the upper coal bed of the split to be Bevier and the lower coal bed to be Wheeler. Location of Bevier as one bed where mined in north-central Missouri. Split of the Bevier occurs west of the Bevier coal field, with Wheeler coal the lower bed. The Bevier coal is generally absent south of the Missouri River in Missouri, but Wheeler persists southward, and is present in southwestern Missouri.

No type section given, but Wheeler split occurs in northeastern Carrol and southwestern Livingston counties, Missouri.

White Cloud Shale Member (of Scranton Shale)

White Cloud Shale (of Wabaunsee Group)

Pennsylvanian (Virgilian Series): eastern Kansas, southeastern Nebraska, northwestern Missouri, southwestern Iowa, and north-central Oklahoma.

G. E. Condra, 1927, Nebraska Geological Survey, Bulletin 1, 2nd series, p. 40, 41, 58. *White Cloud shale* is here named from exposures west of White Cloud, Kansas, where it is 100± ft (30± m) thick. It underlies Rulo limestone and overlies Howard limestone The salmon-colored limestone in White Cloud shale, about 26 ft (7.8 m) below overlying Rulo limestone, is here called *Happy Hollow limestone*, from exposures in bluffs at mouth of Happy Hollow Creek, located below mouth of Big Nemaha River. [On p. 40, a thickness of 1 ft, 9 inches (52.5 cm) is given for Happy Hollow limestone.]

G. E. Condra, 1930, Nebraska Geological Survey, Bulletin 3, p. 53. The Nebraska Geological Survey now restricts *White Cloud shale* to that part of Scranton shale below Happy Hollow limestone, and applies *Cedar Vale shale* to beds above Happy Hollow limestone and below Rulo limestone.

R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 49 (fig. 11), 210–211. Rank raised to formation in Wabaunsee group. Term Scranton abandoned. Overlies Howard limestone; underlies Happy Hollow limestone. Thickness 30–80 ft (9–24 m).

R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 175. The White Cloud shale is traceable from Iowa and Nebraska entirely across Kansas into Oklahoma.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,277. Rank reduced to member of Scranton shale here reintroduced as formation with stratigraphic span as assigned to it by Haworth and Bennett (1908, Kansas Academy of Science, Transactions, v. 21). Underlies Happy Hollow limestone member; overlies Howard limestone [Utopia member].

H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 14, fig. 5. Thickest formation of Wabaunsee group in area. Gray and green shale; upper half commonly contains many limestone nodules; massive sandstone present at base locally. Full thickness not exposed at surface. Measured at 100 ft (30 m) in coal mines in Adams County. Overlies Howard limestone; underlies Happy Hollow limestone.

Type locality: Exposures west of White Cloud, Doniphan County, Kansas.

Whitehorse Formation

Whitehorse Formation (of Custer Group)

Whitehorse sandstone

Whitehorse sandstone member (of Woodward formation)

Permian (Guadalupian Series): central southern Kansas, Oklahoma, and Texas.

C. N. Gould, 1905, U.S. Geological Survey, Water Supply Paper 148, p. 55. Name proposed to replace Red Bluff sandstone; overlies Dog Creek shale; underlies Day Creek dolomite.

R. W. Sawyer, 1924, American Association of Petroleum Geologists, Bulletin, v. 8. Whitehorse sandstone restricted to upper part of Whitehorse formation; lower part of Whitehorse formation named Marlow formation.

R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of

the Table Creek shale; this combination of shales is called Willard–Table Creek shale in southern Kansas.

Willard–Wamego shale
R. C. Moore, 1949, Kansas Geological Survey, Bulletin 83, p. 186, 189. South of the point in Lyon County where the Tarkio limestone disappears, the Willard is overlain by the Wamego shale and the combined shale unit is designated as the Willard–Wamego shale; about 90 ft (27 m) thick near Emporia.

Williamsburg coal bed (in Lawrence Formation, Douglas Group)
Pennsylvanian (Virgilian Series): in easstern Kansas from Elk County northward to northern Douglas County. Best developed in western Franklin County.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 156–157. Discusses general distribution of the Williamsburg coal.
R. E. Whitla, 1940, Kansas Geological Survey, Bulletin 32, p. 21–22. The Williamsburg coal was previously called the Ransomville coal.
A. L. Bowsher and J. M. Jewett, 1943, Kansas Geological Survey, Bulletin 46, p. 52–69. Two coal beds exist, the Lower Williamsburg coal bed that is best developed in Franklin County, and the Upper Williamsburg coal that is also best developed in Franklin County but has a widespread distribution. The lower coal bed is 20–55 ft (6–16.5 m) below the Oread Limestone and ranges up to approximately 6 inches (15 cm). The better developed upper bed is present from 1 to 30 ft (0.3–9 m) below the Oread Limestone, and the coal ranges up to 26 inches (65 cm) in thickness in western Franklin County.
J. M. Jewett, H. G. O'Connor, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 35. Formally recognized as one coal with upper and lower beds.

Wilson formation
Pennsylvanian: southeastern Kansas and northeastern Oklahoma.
F. C. Schrader and E. Haworth, 1905, U.S. Geological Survey, Bulletin 260, p. 447. Limestones and shales, 280 ft (84 m) thick, underlying Buxton formation and overlying Drum formation; includes Piqua limestone, Vilas shale, Iola–Allen limestone, and Chanute shale.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 103, 108, 112, 124, 130, 131. Synonymized with upper part of Kansas City group and all of Lansing group.
Named for exposures in Wilson County, Kansas.

Windom member (of Belvidere formation)
Cretaceous: central Kansas.
W. H. Twenhofel, 1924, Kansas Geological Survey, Bulletin 9, p. 31, 32. Thin marine limestones near base of Belvidere formation; two 6-inch (15-cm) layers of gray shell limestone separated by gray shale; the limestone consists almost wholly of shells; fossils identical with those of Kiowa shale; thickness 3 ft (0.9 m); underlies Marquette member and overlies Natural Corral member.
Named for extensive occurrence northeast of Windom, McPherson County, Kansas.

Winfield Limestone (of Chase Group)
Winfield formation
Winfield concretionary limestone member (of Chase formation)
Permian (Wolfcampian Series): eastern Kansas, southeastern Nebraska, and central northern Oklahoma.
C. S. Prosser, 1897, Kansas University Geological Survey, v. 2, p. 64–66. Name proposed to replace Marion concretionary limestone; top member of Chase formation; limestone, 13 ft (3.9 m) thick.
C. S. Prosser, 1902, Journal of Geology, v. 10, p. 715. Expanded to include massive concretionary limestone at top, yellowish shales in middle, and cherty limestone at base; thickness 25 ft (7.5 m); overlies Doyle shales; underlies Marion formation.
N. W. Bass, 1929, Kansas Geological Survey, Bulletin 12, p. 87. The Winfield limestone is a massive limestone (10 or 11 ft [3–3.3 m] thick) that probably corresponds to the massive concretionary limestone of Prosser [1902], which he described as occurring at the top of his Winfield formation. Lower part of Winfield formation put in upper part of Doyle shale.
G. E. Condra and J. E. Upp, 1931, Nebraska Geological Survey, Bulletin 6, 2nd series, Winfield formation divided into three members (top to bottom): Cresswell limestone, Grant shale, and Stovall limestone; thickness 26 ft (7.8 m).
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Top formation in Chase group; divided into four members (top to bottom): Luta limestone, Cresswell limestone, Grant shale, Stovall limestone; thickness 30 ft (9 m); underlies Odell shale; overlies Gage shale.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 29, p. 82–88. Type section should be near Marion, in Marion County. Includes: "Luta limestone member," Cresswell Limestone Member, Grant Shale Member, Stovall Limestone Member. Overlies Doyle Shale; underlies Odell Shale.
R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 41–44. "Luta" limestone included in Cresswell. Thickness about 25 ft (7.5 m).
Named for exposures around Winfield, Cowley County, Kansas.

Winnebago Shale
Pennsylvanian (Virgilian Series): southeastern Nebraska, southwestern Iowa, and northeastern Kansas.
G. E. Condra, 1935, Nebraska Geological Survey, Paper No. 8, p. 5, 10. Burlingame limestone formation divided into (descending): 1) *South Fork limestone* (one massive bed, or two or three beds separated by shale, 2 1/2 ft [0.8 m]); 2) Winnebago shale (bluish, argillaceous, some limy fossiliferous seams, 8–12 ft [2.4–3.6 m]); 3) Taylor Branch limestone (bluish gray, massive, weathering brownish, 2–4 1/2 ft [0.6–1.4 m]). Type section of the Winnebago is in Missouri River bluffs south of mouth of Winnebago Creek, north of Rulo, Richardson County, Nebraska; members have been traced through Kansas to Oklahoma.
E. H. Wenberg, 1942, Iowa Academy of Science, Proceedings, v. 49, p. 343 (fig. 6). Listed as Winnebago shale in insoluble residue correlations of Missouri and Virgil strata in Iowa.

debatable. Provincial classification of post-Sangamonian time into Scandian, Bradyan, and Almenan sub-ages proposed for use in midcontinent region.

M. M. Leighton, 1957, Journal of Geology, v. 65, p. 108, 109. Wisconsin stage divided into six substages (oldest to youngest): Farmdale, Iowan, Tazewell, Cary, Mankato, and Valders.

C. K. Bayne and H. G. O'Connor, 1968, Kansas Geological Survey, Bulletin 189, p. 60, 63–67. The Wisconsinan constitutes the surface material over much of Kansas; discussions of Wisconsinan deposits in Kansas divide Wisconsinan into "Late" and "Early" [named substages not used].

Named for development in eastern part of the state of Wisconsin.

Wiser sand

Pennsylvanian (Desmoinesian): southeastern Kansas and northern Oklahoma.

M. G. Wilmarth, 1938, U.S. Geological Survey, Bulletin 896, p. 2,357–2,358. Wiser sand in north-central Oklahoma is correlated with a part of the Oologah formation; same as Weiser sand.

J. M. Jewett, 1954, Kansas Geological Survey, Bulletin 104, p. 90. Used to designate oil-bearing sandstone in the upper part of the Cherokee section; "Wiser sand" occurs at a depth of about 1,600 ft (480 m) in the Wiggam oil field in Chautauqua County, Kansas (sandstone in that part of the section more commonly is called "Squirrel"). The name as used in Kansas probably is of local derivation and was not a correlation with the "Wiser sand" of northern Oklahoma; not the same as "Weiser sand" (*contra* Wilmarth, 1938).

Wiskanian Series

Cretaceous: northwestern Kansas and eastern Colorado.

C. R. Keyes, 1941, Pan-American Geologist, v. 75, n. 5, p. 369–371. Term proposed for great section of dark shales usually called vaguely and erroneously the Pierre Formation. Thickness about 1,000 ft (300 m). Covers large but indefinite part of median portion of Assiniboine centrum shales, which itself is not really a stratigraphic unit of any rank, but a term applied to great central filling of Cordillera geosyncline.

Name derived from a way-station in Wallace County, Kansas.

Wolf River limestone member (of Topeka limestone)

Pennsylvanian: eastern Kansas, northwestern Missouri, southeastern Nebraska, southwestern Iowa.

G. E. Condra and E. C. Reed, 1937, Nebraska Geological Survey, Bulletin 11, 2nd series, p. 7, 12, 16, 20, 24, 26, 30, 33, 51, 52. Lower member of Topeka limestone formation; where typically developed consists of a thin-bedded, very fossiliferous upper zone, a middle heavy-bedded massive brownish middle zone, and a thin blocky bed at base separated from the middle zone by a few inches of shale; to the north this limestone is a single bed; thickness about 1–5.5 ft (0.3–1.65 m).

G. E. Condra, 1949, Nebraska Geological Survey, Bulletin 16, p. 21. Nebraska Survey will drop the name Wolf River if it proves to be synonymous with Hartford, which was loosely defined by Kirk (1896) and has priority if it does not include beds of Du Bois, Iowa Point, and Wolf River age.

Type locality: In Missouri River bluffs, just east of mouth of Wolf River, north of Sparks, Doniphan County, Kansas.

Wolfcampian Series

Wolfcamp Formation

Lower Permian: North American Standard Section

J. A. Udden, 1917, Texas University Bulletin 1753, p. 41, pl. 3. Mostly shale, varying from almost black to gray and greenish gray; several cemented shell breccias and conglomeratic limestone interbeds; some layers of calcareous sandstone; thickness at Wolfcamp is 500 ft (150 m); unconformably underlies Hess formation; overlies Gaptank formation.

J. A. Udden, 1917, University of Texas, Bulletin 1762, p. 16. Attributed name to Böse, Baker, and Udden.

P. B. King, 1937, U.S. Geological Survey, Professional Paper 187, p. 94–97. Wolfcamp is oldest formation in Glass Mountains; rests on older Paleozoic rocks with strong unconformity. Top is well-marked unconformity at base of Leonard Formation. Defined as overlying beds containing *Uddenites* fauna (lower Gaptank Formation).

J. E. Adams, M. G. Cheney, R. K. DeFord, R. I. Dickey, C. O. Dunbar, J. M. Hills, R. E. King, E. R. Lloyd, A. K. Miller, and C. E. Needham, 1939, American Association of Petroleum Geologists, Bulletin, v. 23, p. 1,674–1,677. Permian System divided into four divisions of series rank. Wolfcamp is first and lowest of these series. Comprises beds referred to as Wolfcamp Formation (restricted). Rests with angular unconformity on rocks of Precambrian through Upper Pennsylvanian age; unconformably overlain by Leonardian Series. Characterized by fusulinid genera *Schwagerina*, *Pseudoschwagerina*, and *Paraschwagerina*. Wolfcampian equivalents include Hueco Formation of Diablo Plateau, Abo Formation of New Mexico. Series in northern Oklahoma, Kansas, and Nebraska includes beds from disconformity above Brownville Limestone up to horizon near top of Herington Limestone. Recommended that in Oklahoma term Wanette be dropped in favor of Wolfcampian Series.

C. W. Tomlinson, R. C. Moore, R. H. Dott, M. G. Cheney, and J. E. Adams, 1940, American Association of Petroleum Geologists, Bulletin, v. 24, p. 337–358. Subcommittee on the Permian of the American Association of Petroleum Geologists' Committee on Geologic Names and Correlations formally proposed acceptance of the west Texas time-stratigraphic sequence as a North American Standard. Lowermost, or oldest, of the recommended standard series is Wolfcampian Series, named for Wolfcamp Formation that lies with angular unconformity on beds of undisputed Pennsylvanian and older age, and is unconformably overlain by Leonardian Series. Wolfcampian is typified by fusulinids *Schwagerina*, *Pseudoschwagerina*, and *Paraschwagerina*.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 41. Wolfcampian Series, formerly called Big Blue Series, contains older Permian rocks of Kansas. Outcrop thickness in Kansas about 785 ft (235.5 m).

C. A. Ross, 1959, Washington Academy of Sciences, Journal, v. 49, n. 9, p. 299–311. On basis of regional unconformity within Wolfcampian Series in Glass Mountains, Texas, unit redefined to include lower Neal Ranch Formation and upper Lenox Hills Formation (both new). Detailed fusulinid study places Pennsylvanian–Permian boundary above "grey limestone" of King (1931 and 1937) at base of Neal Ranch Formation. Neal Ranch Formation includes rocks of Permian age formerly assigned to the upper Gaptank Formation. This horizon separates *Triticites* faunas below,

Worland Limestone Member (of Altamont Limestone)
Worland limestone
Pennsylvanian (Desmoinesian Series): southeastern Kansas, western Missouri, southern Iowa, northeastern Oklahoma.
F. C. Greene, 1933, Missouri Bureau Geology and Mines, 57th Biennial Report, p. 14, 18, 37, app. 2, pl. 2. A zone of limestones and calcareous shales appears in the Bander shale member of the Pleasanton formation and persists to the north, usually as two thin limestones, here termed upper and lower Worland limestone, and an intervening shale.
R. C. Moore, 1936 (1935), Kansas Geological Survey, Bulletin 22, p. 42, 57, 64. Shown as limestone member of Bandera shale, but only recognized in Missouri.
L. M. Cline, 1941, American Association of Petroleum Geologists, Bulletin, v. 25, no. 1, p. 29. Lower and upper Worland Limestone of Greene (1933) have been traced across southwestern Missouri into southeastern Kansas and are equivalent to lower and upper Altamont Limestones, respectively. Lower limestone of Altamont is herein named Tina, and name Worland retained from upper member of Altamont. Traced into Apponoose County, Iowa.
J. M. Jewett, 1941, Kansas Geological Survey, Bulletin 38, p. 332–334. At type exposure, herein designated, consists of about 4.5 ft (1.35 m) of gray-brown-weathering massive limestone containing large fusulinids. Overlies Lake Neosho Shale Member.
R. D. Alexander, 1954, Oklahoma Geological Survey, Circular 31, p. 14–15, 16 (fig. 5). In this report, Oologah is used for sequence of beds between base of cap rock of Lexington Coal and top of Altamont Limestone in Nowata County and for equivalent sequence of limestone not yet subdivided in vicinity of Tulsa. In Nowata County, upper member of Oologah is Altamont Limestone which is subdivided into Amoret Limestone below and Worland Limestone above, with shale intervals between. The Worland is gray massive cherty limestone about 30 ft (9 m) thick. Occurs below Nowata Shale.
H. G. Hershey, C. N. Brown, D. VanEck, and R. C. Northrup, 1960, Iowa Highway Research Board, Bulletin 15, p. 30–31 (fig. 5). Uppermost member of Altamont Limestone in southwestern Iowa. Consists of thin wavy beds separated by green-gray fossiliferous shale seams and occasional pockets of green shale. Thickness 2.5 ft (0.75 m) in Madison County; 6 ft (1.8 m) in Apponoose County. Overlies Lake Neosho Shale Member; underlies Nowata shale.
Type exposure: Along Kansas City Southern Railway just north of grade crossing northeast of Worland, Bates County, Missouri.

Wreford Limestone (of Chase Group)
Permian (Wolfcampian Series): eastern Kansas, central Oklahoma, and southeastern Nebraska.
R. Hay, 1893, Kansas State Board Agriculture, 8th Biennial Report, p. 104. Limestones containing numerous flint nodules and separated by definite layers of flints; forms lower flint beds of Kansas section; underlain and overlain by shales; 25 ft (7.5 m) thick.
C. S. Prosser, 1902, Journal of Geology, v. 10, p. 713. Buff limestone and chert or flint; cherty limestone at top, heavy limestone in middle, and cherty limestone at base; basal formation of Chase stage; underlies Matfield shales; overlies Garrison formation; 35–50 ft (10.5–15 m) thick.
R. C. Moore, 1935, Rock formations of Kansas; *in*, Kansas Geological Society, Wichita [American Association of Petroleum Geologists, 20th Annual Meeting, March 21–23]. Basal formation of Chase group; in Big Blue series; underlies Wymore shale; overlies Speiser shale; 40 ft (12 m) thick; includes three members (top to bottom): Schroyer limestone (gray cherty limestone, 9 ft [2.7 m] thick), Havensville shale (olive and gray calcareous shale, 20 ft [6 m] thick), and Threemile limestone (gray to bluish massive, chert-bearing limestone, 11 ft [3.3 m] thick).
R. C. Moore, J. C. Frye, and J. M. Jewett, 1944, Kansas Geological Survey, Bulletin 52, pt. 4, p. 104. Includes: Schroyer Limestone Member, Havensville Shale Member, Threemile Limestone Member. Average thickness 35 ft (10.5 m). Underlies Matfield Shale; overlies Speiser Shale. Wolfcampian Series.
H. G. O'Connor, D. E. Zeller, C. K. Bayne, J. M. Jewett, and A. Swineford, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 48. Limestone members characterized by abundance of chert. Thickness 30–40 ft (9–12 m).
Named from exposures near Wreford, Geary County, Kansas.

Wreford Megacyclothem
D. E. Hattin, 1957, Kansas Geological Survey, Bulletin 124, 150 p., 3 pl. The Wreford Megacyclothem consists of two "nearly complete cycles of deposition" from the middle of the Speiser Shale to the middle of the Wymore shale. The Wreford Megacyclothem consists of the lower Threemile Cyclothem, and the overlying Schroyer Cyclothem. The Threemile Cyclothem begins with the middle of the Speiser Shale, and includes the Threemile limestone and the lower portion of the Havensville shale. The Schroyer Cyclothem includes the upper Havensville shale, the Schroyer limestone, and the lower Wymore shale.
A. B. Lutz–Garihan and R. J. Cuffey, 1979, Kansas Geological Survey, Bulletin 216, 19 p., 2 pl. The Wreford Megacyclothem is defined as from the middle of the Speiser Shale to the middle of the Wymore shale. Extends correlations into northern Oklahoma.

Wyandotte group
Pennsylvanian: eastern Kansas.
R. C. Moore, 1931, Kansas Geological Society, 5th Annual Field Conference Guidebook, correlation chart. Includes (top to bottom): Lane shale, Iola limestone, Chanute shale, Drum limestone, Quivira shale, Dekalb limestone, and Cherryvale shale.
R. C. Moore, 1932, Kansas Geological Society, 6th Annual Field Conference, Guidebook. Discarded Wyandotte group and replaced it with Kansas City group.
Presumably named for exposures in Wyandotte County, Kansas.

Wyandotte Limestone (of Kansas City Group)
Wyandotte Limestone (of Lansing Group)
Pennsylvanian (Missourian Series): eastern Kansas, northwestern Missouri, southwestern Iowa, and southeastern Nebraska.
R. C. Moore, 1932, Kansas Geological Society, Guidebook, 6th Annual Field Conference, p. 85, 91, 92, 97. Basal formation of Lansing group; includes (bottom to top): Argentine limestone of Kansas City area, Island Creek shale, and Farley limestone. At base of Argentine at some exposures are a very dark or black fissile shale (Quindaro) and blue dense limestone (Frisbie); Wyandotte limestone is very prominent in Wyandotte County, Kansas, and along the

J. C. Frye and A. B. Leonard, 1952, Kansas Geological Survey, Bulletin 99, p. 24, 31, 35, 38, 52, 55, 104, 118, 156. Lengthy discussion of Yarmouth soil, Yarmouthian age, and Yarmouthian stage; follows Kansan and precedes Illinoian.

C. K. Bayne and H. G. O'Connor, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 60, 63–66. Yarmouth soil poorly developed but generally recognized throughout Kansas; similar to the Afton soil and Sangamon soil.

Name derived from Yarmouth, Des Moines County, Iowa.

Younkin formation

Devonian or ?Silurian: north-central Kansas.

J. S. Barwick, 1928, American Association of Petroleum Geologists, Bulletin, v. 12, p. 184. Unit No. 3 encountered in wells in Salina basin, Kansas; thickness 0–400+ ft (0–120+ m); consists of white to gray dolomitic limestone locally interbedded with thick bodies of rounded quartz sand in lime matrix; underlies Skelton shale (unit No. 2); overlies Engle shale (unit No. 4).

Named for Boggess et al., Younkin No. 1 well, sec. 21, T. 9 S., R. 4 E., Clay County, Kansas, where encountered at 2,194–2,520 ft (658.2–756 m) deep.

Z

Zarah Subgroup (of Kansas City Group)

Pennsylvanian (Missourian Series): eastern Kansas, western Missouri, southwestern Iowa, and southeastern Nebraska.

R. C. Moore, 1948, American Association of Petroleum Geologists, Bulletin, v. 32, no. 11, p. 2,031 (fig. 4), 2,033. Name applied to upper part of Kansas City Group. Includes beds between top of Iola Formation of Linn Subgroup and base of Plattsburg Formation of Lansing Group. Subgroup comprises: Lane Shale, Wyandotte Limestone, and Bonner Springs Shale.

R. C. Moore, J. C. Frye, J. M. Jewett, Wallace Lee, and H. G. O'Connor, 1951, Kansas Geological Survey, Bulletin 89, p. 81. Thickness in Kansas about 100 ft (30 m).

J. M. Jewett, H. G. O'Conner, and D. E. Zeller, 1968; *in*, D. E. Zeller, ed., Kansas Geological Survey, Bulletin 189, p. 31. Includes beds between top of the Iola Limestone and base of the Plattsburg Limestone.

R. L. Ravn, J. W. Swade, M. R. Howes, J. L. Gregory, R. R. Anderson, and P. E. Van Dorpe, 1984, Iowa Geological Survey, Technical Information Series 12, p. 51 (fig. 27). Subgroup retained as defined by Moore (1948).

W. L. Watney and P. H. Heckel, 1994, Kansas Geological Survey, Open-file Report 94-34, p. 14. Revise formation and members of Zarah Subgroup. Subgroup now composed of Lane Shale, Bonner Springs Shale Member, Farley Limestone Member, Island Creek Shale Member, Wyandotte Limestone, Argentine Limestone Member, Quindaro Shale Member, Frisbie Limestone Member, Liberty Memorial Shale, Iola Limestone, Raytown Limestone Member, Muncie Creek Shale Member, Paola Limestone Member. Occurs above Linn Subgroup.

Named for village of Zarah on old K–10 at Santa Fe Railway crossing in western Johnson County, Kansas.

Zeandale Limestone (of Wabaunsee Group)

Pennsylvanian (Virgilian Series): northeastern Kansas.

R. C. Moore and M. R. Mudge, 1956, American Association of Petroleum Geologists, Bulletin, v. 40, no. 9, p. 2,274 (fig. 1), 2,276. Includes strata below Pillsbury Shale and above Willard Shale. Thickness 19–53 ft (5.7–15.9 m). Comprising: Maple Hill Limestone Member, Wamego Shale Member, Tarkio Limestone Member.

Type locality: SE NE NE sec. 28, T. 10 S., R. 9 E., along north-south farm access road south of Deep Creek, about 1 mi (1.6 km) east and 1/4 mi (0.4 km) south of Zeandale, Riley County, Kansas. Name derived from town of Zeandale on south side of Kansas River.