Revised Upper Devonian and Lower Mississippian Stratigraphic Nomenclature in Kansas

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Abstract

As revised here, the Chattanooga Shale of Kansas includes the basal Misener Sandstone Member overlain by informal lower, middle, and upper shale members. Present only in the subsurface, this formation underlies most of the eastern two-thirds of the state. Most of the Chattanooga Shale is Devonian in age, although the uppermost part may be Early Mississippian. The Misener Sandstone Member has an erratic distribution and is usually less than 1 m (3.3 ft) in thickness. The lower shale member is present only in south-central Kansas and is less than 15 m (49.5 ft) thick. The middle and upper shale members can be traced throughout much of the area of Chattanooga subcrop, and their combined thickness can be more than 76 m (250.8 ft). A lenticular limestone bed is present near the base of the upper shale member in central Kansas, and limestone and dolomite beds occur within the upper parts of both the middle and upper shale members in northeastern Kansas. Ferruginous oolites are present in the upper shale member in northeastern Kansas, near the contact with the overlying Mississippian carbonates. Sometimes called the Kinderhook Shale, the Chattanooga Shale of Kansas is equivalent to the Woodford Shale of Oklahoma, Texas, and New Mexico.

Introduction

The Chattanooga Shale and its equivalents are widely distributed in the eastern part of North America. With its type locality in Tennessee (Hayes, 1891), the Chattanooga Shale also is found in Alabama, Kentucky, Arkansas, and eastern Oklahoma (Cooper, 1931; Conant and Swanson, 1961). Many stratigraphically equivalent formations exist, such as the Woodford Shale of Taff (1902) in western and central Oklahoma, western Texas, and southeastern New Mexico (Cooper, 1931; Amsden, 1980; Ellison, 1950).

The Chattanooga Shale of north-central and northeastern Oklahoma has been traced into adjacent parts of Kansas (McClellan, 1930; Leatherock and Bass, 1936), and Hilpman (1967) commented on the similarity of lithology and fauna in the Woodford Shale of Oklahoma and the Chattanooga Shale of eastern Kansas. The Chattanooga Shale and Woodford Shale are obviously the same formation and will be called the Chattanooga Shale in this report. In Kansas, the Chattanooga Shale is present only in the subsurface and underlies the eastern two-thirds of the state (Goebel, 1968).

This predominantly shaly formation comprises the Upper Devonian and possibly part of the Lower Mississippian section in Kansas, but over the years a lack of precision has characterized the use of stratigraphic nomenclature applied to it. It is proposed here that outmoded names such as Kinderhook Shale be retired and that useful, informal new names such as the lower, middle, and upper shale members be introduced (fig. 1).

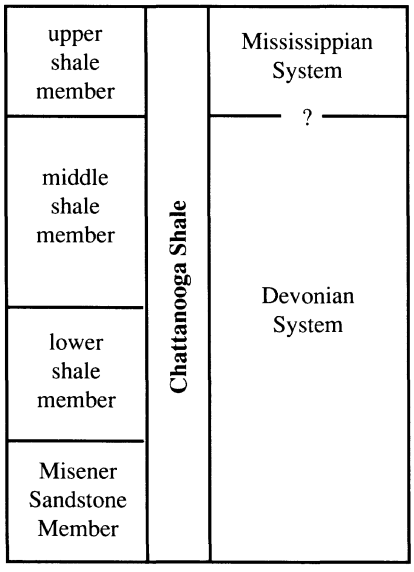

FIGURE 1—PROPOSED SUBDIVISIONS OF THE CHATTANOOGA SHALE.

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Age of the Chattanooga Shale

Early workers (White, 1929; Cooper, 1931; Moore, 1935) believed that the Chattanooga Shale of Kansas and Oklahoma was entirely Mississippian in age, based upon stratigraphic relationships and conodont biostratigraphy. Lee (1940, 1956) classified it as Devonian or Mississippian, because the Chattanooga was present below limestones of definite Mississippian age and above limestones and dolomites of definite Devonian age. More recently, a conodont study by Hass and Huddle (1965) suggested an age range from Late Devonian to Early Mississippian (Kinderhookian) for the formation in south-central Oklahoma. Over and Barrick (1990), working with conodonts from the formation in the same location as Hass and Huddle (1965), found that only the top 0.6 m (1.8 ft) was Mississippian (Kinderhookian), with the rest being Devonian. Carlson (1963) believed the Chattanooga Shale of Nebraska to be mainly Devonian on the basis of stratigraphic considerations. Therefore, most of the Chattanooga Shale of Kansas is probably Late Devonian in age, although the uppermost part may be earliest Mississippian.

The original misidentification of the entire formation as being earliest Mississippian in age caused some workers (Imbt and Harper, 1942; Ver Wiebe, 1946) to call it the Kinderhook Shale. Even today, driller's reports in Kansas frequently identify the formation by that name. It should instead be called the Chattanooga Shale.

Misener Sandstone Member

The Misener Sandstone Member was first described in Oklahoma by White and Greene (1924). Williams (1921) had previously suggested that an unnamed quartz sandstone at the base of the Chattanooga Shale in Kansas was equivalent to the Sylamore Sandstone of northeastern Oklahoma and northwestern Arkansas. White (1929) called this sandstone the Sylamore in surface exposures of eastern Oklahoma and Arkansas and the Misener in the subsurface of western Oklahoma, a practice adopted by Amsden and Klapper (1972). In Kansas, Moore (1935) and Moore and others (1951) called this unit the Misener Sandstone Member of the Chattanooga Shale, a practice used here because this name is widely accepted in Kansas and, unlike the name Kinderhook Shale, is not based upon erroneous assumptions as to stratigraphic position.

Amsden and Klapper (1972) used conodont biostratigraphy to date the Misener Sandstone of north-central Oklahoma as Middle to Late Devonian in age (Givetian to early Fammennian). The Misener Sandstone Member in Kansas, which is usually less than 1 m (3.3 ft) in thickness, may not be the same age as it is in Oklahoma because of the erratic distribution of the unit. It apparently developed where lower Paleozoic sandstones subcropped beneath the pre-Chattanooga erosional surface and were reworked in the early stages of Chattanooga deposition (Lee, 1956; Amsden and Klapper, 1972).

Lower, Middle, and Upper Shale Members

Ellison (1950) divided the Woodford Shale of Texas and New Mexico into lower, middle, and upper shale members on the basis of geophysical log response. Hester and others (1990) recognized the same members in the Woodford Shale of western Oklahoma and were able to correlate them in well logs northward across Oklahoma. Hester and others (1990) determined from calculations based on geophysical log readings that the middle shale member has a higher total organic carbon (T.O.C) content than either the lower or upper shale members.

The lower shale member is present only in south-central Kansas, where it has a thickness of less than 15 m (50 ft; Lambert, 1993). The middle and upper shale members are present throughout most of the Chattanooga subcrop, and have a maximum combined thickness of more than 76 m (251 ft).

In central Kansas a lenticular limestone bed as much as 12 m (40 ft) thick is present near the base of the upper shale member (Lambert, 1992), and may be the same limestone that Lee (1956) found within the Chattanooga Shale at this location. In northeastern Kansas, thin limestone and dolomite beds (usually less than 1 m [3.3 ft] thick) are found within the upper part of both the middle and upper shale members, and ferruginous oölites are present in the upper shale member just below the Chattanooga Shale–Mississippian carbonate contact.

Rock-cutting samples from wells drilled through the Chattanooga Shale in Kansas show that the middle shale member is commonly black while the upper shale member is often gray or green (Lambert, 1992). This is another indication that the middle shale member has a higher T.O.C. content than the upper shale member, because in general a shale unit becomes darker with increasing T.O.C. (McBride, 1974; Schmoker, 1980; Hosterman and Whitlow, 1981). Geochemical core analysis confirms these vertical differences and also indicates that the over-all T.O.C. of the formation decreases to the north across Kansas, although in any given locality the middle shale member is the most organic-rich part of the formation (Lambert, 1993).

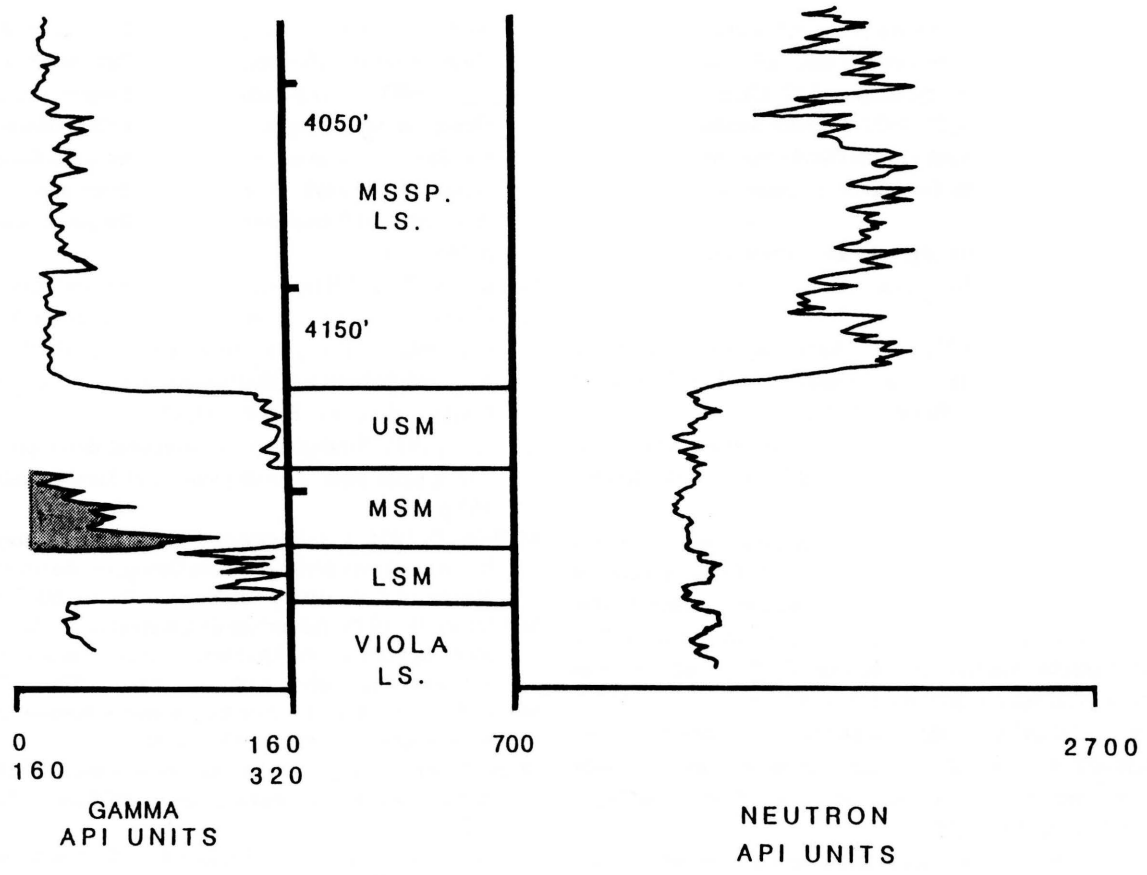

FIGURE 2—GEOPHYSICAL LOG FOR THE PHOENIX #1 ORME WELL, LOCATED IN KINGMAN COUNTY, SOUTH-CENTRAL KANSAS (sec. 4, T. 28 S., R. 6 W.). Depth below surface (feet) is shown in central column. All three shale members of the Chattanooga Shale are present. LSM = lower shale member, MSM = middle shale member, and USM = upper shale member.

Conclusions

The Chattanooga Shale in Kansas consists of the Misener Sandstone Member, overlain by informally defined lower, middle, and upper shale members. Restricted to the subsurface of the eastern two-thirds of the state, the formation is the equivalent of the Woodford Shale in western and central Oklahoma, western Texas, and southeastern New Mexico. It is probably almost entirely Devonian in age, although the uppermost part may be earliest Mississippian. The basal Misener Sandstone Member is equivalent to the Misener Sandstone of western Oklahoma and the Sylamore Sandstone of eastern Oklahoma. The informal shale members can be distinguished in well-cutting samples and on geophysical logs and appear to indicate vertical differences in the total organic carbon (T.O.C.) content of the shales. T.O.C. content of the entire formation decreases to the north in Kansas, although at any given location the middle shale member will be more organic-rich than either the lower or upper shale members.

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