

Gary C. Grassl

Who Were the First Continental Craftsmen at Jamestown, Virginia?

In 1607, Englishmen established at Jamestown, Virginia, the first permanent English colony in what is today the United States. It has been described as “the birthplace of the United States of America.”¹ Continental European craftsmen arrived at Jamestown one year later. Capt. John Smith wrote that “eight Dutch-men and Poles”² arrived ca. Oct. 1, 1608, with the Second Supply under Capt. Christopher Newport. Smith said that these eight were sent by the parent Virginia Company of London “to make Pitch, Tar, Glasse, Milles, and Sope ashes.”³ *Nova Britannica*, published in 1609, reiterates most of this information: “And for the making of Pitch, Tarre, Turpentine, Sope-ashes, Deale, Wainscott, and such like, wee have alreadie provided and sent thither skillfull workemen from forraine parts.”

Smith did not reveal who among the eight foreigners was to make which product; therefore, we have to take a closer look at each. Pitch and tar refer to “naval stores.” Soap ashes are for making lye used in making soap. Glass is self evident, but what is “milles,” and who was to make it? According to the *Oxford English Dictionary*, milles refers to the products of a mill. Wainscot refers to wooden paneling for rooms. Deal is planks. Capt. Newport’s returning ship is said to have carried clapboard and wainscot.⁴ I believe that milles, the product of a mill (such as a saw mill), referred to such related wood products as wainscot, clapboard and planks. But who among the eight Continental Europeans at Jamestown made these wood products?

Who were Samuel, Francis and Adam?

The settlers at Jamestown were perennially short of food. The Indians grew tired of feeding them when they were short themselves. When Smith demanded provisions once again, Chief Powhatan held him off by asking for things he knew Smith wouldn’t want to trade, such as guns and swords. But Smith decided that he could meet one of the Indian’s demands—a European-style house: “The President [Smith] . . . sent three Dutchmen and two English, having no victuals to employ them, all for want thereof being idle, knowing there needed no better castle than that house, to surprise Powhatan.”⁵ Smith wanted to use this building to trap Powhatan and then defend himself from the enraged tribesmen. The three “Dutchmen” are called Samuel, Francis and Adam, but were they really from Holland? We know that the English called all Germanic speakers on the Continent “Dutch.” But Smith identified the “Dutchmen” as Germans when he criticized the parent London Company for having prematurely sent “into Germany or Poleland for glass-men & the rest” of the craftsmen.⁶

Some historians have identified Samuel, Francis and Adam as the glassmakers mentioned by Smith,⁷ but that is unlikely. While glassblowers could have put up



Fig. 2. Photo of the simulated 1609 Glasshouse at Jamestown, VA. Here glassblowers may be observed using ancient techniques. The original Glasshouse would have had window-like openings in its roof to carry off smoke; these openings would have been covered by partially closed lids to keep out the rain.
Courtesy of U.S. National Park Service



Fig. 3. Sketch of an earlier version of the simulated Jamestown Glasshouse before it fell victim to flames when its wooden shingles caught on fire.
Courtesy of U.S. National Park Service

workers—the makers of milles or wainscot (which, incidentally, was imported into England mainly from the Black Forest at that time).

Who were the Poles and did they make glass?

“The glassmakers have long been thought to be from Poland or individuals from both Poland and Germany,” stated William M. Kelso and Beverly Straube. “Scholars now believe that the Germans were the glassmakers and the Poles were the producers of “*the rest*”—the pitch, tar and soapashes.”⁹ However, guides, films and displays at Jamestown still claim the Poles as glassmakers.¹⁰

There was a small Polish glass industry around 1600, but it was largely for local consumption. While Poland exported little glass to England at this time, it did export large quantities of pitch, tar and soap ashes.¹¹ For this reason, one of the men planning the English colonizing effort urged, “Men skillfull in burning of Sope ashes, and in making of Pitch, and Tarre, and Rozen [resin]” be brought to Virginia “out of Prussia and Poland, which are thence to be had for small wages, being there in the manner of slaves.”¹²

The English followed this advice and sent for Polish pitch, tar and soap-ash makers, because they knew that Poland had a thriving industry in these products. The same thing could not be said for its glass industry at that time.¹³ The German one, on the other hand, was thriving in comparison, because it was a continuation of the Roman glass industry:

The Romans . . . did much to spread glassmaking technology. With its conquests, trade relations, road building, and effective political and economical administration, the Roman Empire created the conditions for the flourishing of glassworks across western Europe and the Mediterranean . . . In Rome’s Western empire, the city of Köln in the Rhineland developed as the hub of the glassmaking industry, adopting, however, mainly eastern techniques.¹⁴

Around 1600, the English imported most of their glass from France and Hesse. Would the English really have been looking for glass men from the comparatively minor Polish industry in preference to the extensive and ancient industry of Germany? There is no indication that they ever tried to hire Polish glassmakers. But we do know that in 1569, a London merchant named Anthony Becku tried—unsuccessfully—to bring German glassmakers to England.¹⁵ The Abbot of Jarrow had tried to bring German glassmakers to England as early as 758.¹⁶

According to the *Encyclopaedia Britannica*, “about 1350 considerable quantities of colourless flat glass were supplied by John Alemayn of Chiddingfold for glazing the windows in St George’s chapel, Windsor, and in the chapel of St Stephen, Westminster. The name Alemayn (Aleman) suggests a foreign origin.”¹⁷

“Flat” or “broad glass” was first developed by German craftsmen, according to “A Brief History of Glass”:

The 11th century . . . saw the development by German glass craftsmen of a technique—then further developed by Venetian craftsmen in the 13th century—for the production of glass sheets. By blowing a hollow glass sphere and swinging it vertically, gravity would pull the glass into a cylindrical ‘pod’ measuring as much as 3 metres long [118.11 inches], with a width of up to 45

cm [17.72 inches]. While still hot, the ends of the pod were cut off and the resulting cylinder cut lengthways and laid flat.

The cylinder was then flattened out with iron instruments on an iron plate or on a stone or ceramic slab.¹⁸

In describing the manufacture of “broad” or “Lorraine glass,” the French encyclopedist Denis Diderot wrote, “This was the method of the glass industry of Bohemia and Germany, of which Alsace and Lorraine were, in certain ways, technological outposts. For this reason broad glass was also called ‘German sheet.’”¹⁹

Broad-glass makers speaking a German dialect were brought from Lorraine/Lothringen to England for the local market several decades before other German-speaking glassmakers were brought to England for the Virginia colony.

“In 1567 James Carré of Antwerp stated that he had erected two glass-houses at ‘Fernefol’ (Fernfold Wood in Sussex) for Normandy and Lorraine glass for windows, and had brought over workmen.” Two families were from Normandy and made crown glass, and four were from Lorraine and made broad glass.²⁰

An English chronicle describes the Lorraine glassmakers as Germans, apparently because they spoke the German dialect of Lorraine (*Lothringisch*):

There is reason to believe . . . that Germans had settled in this part of the country [North Country] long before the Revolution of 1688. Henzells, Tyttores [Dietrich], and Tyzacks, it is certain, came over to England from Lorraine, as Protestant refugees, in the reign of Queen Elizabeth . . . They were under the direction of one of their number, who wrote his name Henzole [Henzell], and who left descendents.²¹

Records of the Virginia Company of London show that Poles were hired to make pitch, tar and soap ashes at Jamestown. In 1619, this company ordered that “some young men shall be” apprenticed to “the Polonians resident in Virginia,” so that “their skill in making pitch and tar and soapashes shall not die with them.”²²

Kelso and Straube wrote, “references to glass production at Jamestown ceases after 1610, by which time the Germans are dead, whereas pitch, tar, and soap ashes continue to be exported to England.”²³ In other words, if Poles were glassmakers, why was no glass made at Jamestown when the Poles survived into the 1620s? (One of them, Matthew, was killed during the native uprising of 1622.)²⁴ And when they had a perfectly good glasshouse at their disposal? William Strachey, the secretary of the Jamestown Colony, described it in 1612 as “a goodlie howse . . . with all offices and furnaces thereto belonging.”²⁵ Also, why would the Virginia Company have shipped over Italian glassmakers in 1621 if there were Polish glass men still at Jamestown? Therefore, we can assume that the Poles were not glassmakers.

However, the Poles, no doubt, assisted in the glassmaking operation by producing essential catalysts. We note that the Poles were brought to Virginia to make pot ash, among other things. Without adding either pot ash or soda ash to the glass melting pot (*Glassschmelzhafen*), the temperature needed to melt the sand would have been unobtainable with wood fire.

I do not believe that the Poles assisted in the glassmaking operation other than in making pot ash or soda ash. They were brought from Poland to Virginia to make specific

products that could be sold in England. High on that list were pitch, tar and resin, known as naval stores. These were essential for keeping the English merchant fleet and war ships afloat. Before the discovery of tobacco as a cash crop, these were among the few products from Virginia that would fetch a prize in England and help satisfy the investors. Had the Poles been diverted from this high-priority work to helping out at the Glasshouse, the management of the Jamestown colony would have been derelict in its duty.

What did a forest glass house or a *Waldglashütte* look like?



Fig. 4. A wooden model of Agricola's furnace.

J. Carl Harrington, the archaeologist who dug up the Glasshouse ruins, wrote, "considerable glass was melted and fabricated . . . all of it was 'common green' glass."²⁶ This green glass was called forest glass or *Waldglas* in German.²⁷ It was produced between the fourteenth and seventeenth centuries in so-called *Waldglashütten* or forest glass huts located mostly in heavily wooded areas of the German Empire. Alkali in potash or sand—the raw materials—gave it a color that ranged from light to dark green, but it could also come in shades of blue, brown or yellow.²⁸

The German mineralogist Georg Bauer (Georgius Agricola) reproduced "a woodcut showing the interior of a German glass factory, and glass vessels both finished and unfinished." It appeared in the edition of 1581 of the *De re metallica*.²⁹ The fire was in the lower chamber. The

smelting pots were set on a shelf or siege above this fire. The top floor was used to anneal or slowly cool off the finished glass products. This is, however, more sophisticated than the average German *Waldglashütte*.

The oldest glass ovens were simple structures of stone and loam with a round ground plan. The top portion was domed. They were made of good-quality, fire-proof loam that had been thoroughly pounded . . . In the fourteenth century, the ground plan of the ovens took a horse-shoe form . . . [This is the form of the smelting furnace in the Jamestown Glasshouse.]³⁰

Next to the smelting furnace was the cooling oven. The finished glass products were slowly cooled here to prevent strain in the glass from cracking it . . . The floor of the hut consisted of loam. The hut itself was fabricated of wood, and when there was lots of snow it could happen that the roof caved in. Typical for the glass hut was the so-called smoke roof or *Rauchdach*. Since the furnace was heated from below and had no chimney, the biting smoke escaped from the furnace openings and rose up to the smoke roof. The glassmakers' faces were covered with soot. The so-called smoke roof had small, window-like openings with partially closed lids that permitted the smoke to escape but

no rain to enter. [If rain water penetrated the heated furnaces, they would explode.]³¹

Two locational factors were necessary for establishing a glass-furnace: firstly, close proximity to woodlands where there was an abundant supply of fuel and ash from the burning process; secondly, a convenient source of sand, e.g. an esker ridge. The furnaces themselves were simple rubble-stone structures consisting of a barrel-vaulted firing chamber with a central fire-trench. The fire was fed from either one or both sides of the chamber via a stoking tunnel. The crucibles were placed in pairs on top of the sieges, which were located on either side of the fire-trench. Work holes were built into the side of the vault to allow the glass-makers to remove impurities which rise to the surface of the molten glass and also to check when the glass was ready for working. An iron pole was inserted into the crucible via the work hole, if the molten glass was ready a thread of glass would hang from the rod³²

The Jamestown furnace was constructed of river boulders and had only one stoking tunnel. Otherwise, the similarities are startling. Two German *Waldglashütten* uncovered not long ago are described in the endnote.³³

How was glass made in a forest glass house?

Glass was made in five steps:

1. Pre-smelting of the raw materials; this was known as fritting.
2. Refining in the main furnace.
3. Cooling of the finished glass to make it workable.
4. Blowing the glass into appropriate shapes.
5. Slowly cooling the finished product in a cooling oven.

The German Benedictine monk Theophilus Presbyter, probable the pseudonym of Roger of Helmarshausen, described the art of glassmaking in *De diversis artibus*. He wrote between 1100 and 1120, but glassmaking had not changed substantially by 1608:³⁴

If you have the intention of making glass, first cut many beechwood logs and dry them out. Then burn them all together in a clean place and carefully collect the ashes, taking care that you do not mix any earth or stones with them. After this build a furnace of stones and clay, fifteen feet long and ten feet wide

When you have arranged all this, take beechwood logs completely dried out in smoke, and light large fires in [the main] furnace. Then take two parts of the ashes of which we have spoken before, and a third part of sand, collected out of water, and carefully cleaned of earth and stones. Mix them in a clean place, and when they have been long and well mixed together lift them up with the long-handled iron ladle and put them [in the fritting] furnace so that they may be fritted. When they begin to get hot, stir at once with the

same iron ladle to prevent them from melting from the heat of the fire and agglomerating. Continue doing this for a night and a day. [Then set the pots] in the [main] furnace through the holes made for this purpose. Pick up the fritted mixture of ashes and sand with the ladle and fill all the pots [with it] in the evening. Add dry wood all through the night, so that the glass, formed by the fusion of the ashes and sand, may be fully melted.

Pot ashes or soda ashes were mixed with quartz sand, because sand required 1,713° Celsius to smelt, but wood-fired ovens could attain a temperature of only 1,200° C. The ashes reduced the temperature needed to melt the sand.³⁵

The raw materials were pre-smelted at high temperature in a fritting oven but not perfectly blended. The resulting frit was placed in the smelting pots in the main furnace and then completely smelted. The reason for the pre-smelting was that large quantities of ashes, sand and other ingredients were required to produce a relatively small amount of glass; in other words, the raw materials shrank considerably. Had the smelting begun in the smelting pots, they would have had to be filled again and again with raw materials as each portion melted down. Much easier to smelt all the raw materials together, and when they have shrunk place them in the pots. One other reason for the pre-heating was the fact that a lot of gas was given off during the first smelting. If the material was all pre-heated, the glassblowers at the main furnace would not have had to endure these gases.³⁶

The material was fused until no part of the sand or other individual components of the mixture were distinguishable. It was tested by sticking an iron into the melt, holding it up and examining the threads of glass that hung from the iron. If they showed no sign of sand or other raw material, a new load of mixed, raw materials was placed into the smelting pot. This went on until the pot was full. During this smelting, which lasted from 12 to 18 hours, glassgall—insoluble particles floating on the surface—was regularly skimmed off. When all the ingredients in the melted glass were completely fused, the temperature was reduced to a glass working temperature and maintained there. The melted glass was allowed to sit for 12 to 16 hours until the expectoration of the gases and the movement of the smelt had reached an equilibrium. Then the glass was ready to be blown into shapes. This work could last up to 12 hours.

What kind of glass products were made in the Jamestown Glasshouse?

Although, Harrington could not locate a single shard of the green *Waldglas* in the Jamestown Glasshouse big enough to provide a clue as to the nature of the final product, experts agree that it was most likely window glass. Eleanor S. Godfrey believes that the Jamestown glasshouse was established to supply flat or window glass for the London market.³⁷

“There were two kinds of flat glass, known respectively as ‘brode-glas’ and ‘Normandy’ glass. The former was made, as described by Theophilus, from cylinders, which were split, reheated and flattened into square sheets. It was known as Lorraine glass, and subsequently as ‘German sheet’ or sheet-glass.”³⁸

1. Sheet or cylinder glass (*Walzenglas*).

“A breakthrough in windows . . . came in the 11th century, with the production of

the first sheet glass. German glassmakers discovered that by blowing a glass sphere and swinging it vertically, gravity would pull the glass outward into a long, relatively thin cylindrical pod. While the glass was still hot, they cut off the ends of the pod, sliced the resulting cylinder lengthwise.³⁹ "The split cylinder is passed to the flattening furnace (*Streckoven*), where it is exposed to red heat, sufficient to soften the glass; when soft the cylinder is laid upon a smooth flat slab (*Strecktisch*)."⁴⁰ The split cylinder is then bent apart with iron instruments; then smoothed with ironing or polishing wood until it is completely flat. It is then pushed into the cooling oven. However, it is unlikely that *Walzenglas* was made at the Jamestown glasshouse, because its annealing or cooling oven was too small to hold it.

2. Normandy or crown glass

In the "crown" or "bell" method, the glassblower blows a small glass ball with his blowpipe. He then works it into a small cylinder by rolling it on a low, flat platform.

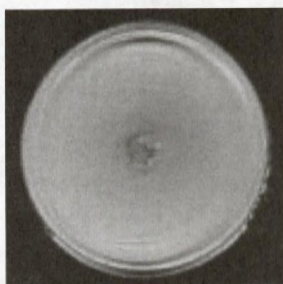


Fig. 5. A *Butzenscheibe*, or bulls-eye glass.

The cylinder is then blown out to resemble the body of a bee. The glass is heated again, and one side is flattened on a tilted platform. A solid iron pole called a *Hefteisen* or punty is then attached to the flattened side, and the blowpipe is knocked off. The opening that has been made by the blow pipe is then widened with a hot iron. The glass ball is softened by re-heating. The opened ball is spun around at the end of the punty until centrifugal forces it open in the form of a "bell" or "crown." Further rapid spinning flattens it into a disk with a diameter of 10 to 15 centimeters or 4 to 6 inches.⁴¹ This procedure has been known since the twelfth century.⁴² The resulting disks are known in Germany as *Butzenscheiben*; the name

comes from the small, navel-like protrusion (the *Butze*) in the center of the *Scheibe* or



Fig. 6. Glassblower in simulated Jamestown Glasshouse blows a glass bubble with his blowpipe, demonstrating the technique used by German glassmakers.
Courtesy of U.S. National Park Service.



Fig. 7. Glory hole in glass oven of a simulated Glasshouse at Jamestown, VA. The glassblower inserts his blowpipe into the furnace to re-heat the glass bubble at its end.
Courtesy of U.S. National Park Service.



Fig. 8. The glassblower gives shape to the gas bubble by rotating it on a flat surface.

disk where the punty had been attached. In English, they are known as bull's-eye glass or glass-roundels. A number of these colorful, small disks are fitted into a window frame and held in place by lead. They are known to have been used to fill windows since the fourteenth century. "These small, round Butzenscheiben were especially popular during

the Renaissance for glazing the windows of the houses of the bourgeoisie, important civic buildings as well as churches.”⁴³

Who were the glassmakers and whence did they come?

When we subtract three German wainscot makers and three Poles from the eight foreigners enumerated by Smith, we get only two, anonymous glassmakers—probably a master and a journeyman. But these would have been sufficient to make glass, provided they had helpers. Where did these glassmakers originate?

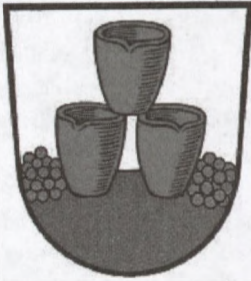


Fig. 9. Coat of arms of the town of Großalmerode.

Eleanor S. Godfrey estimates that about 400 cases of window glass were imported into England from Normandy, Lorraine and Hesse in 1567 to meet the scarcity of window glass.⁴⁴ “In the 16th century, Hesse along with its adjoining forest regions was one of the two top glass-producing regions of Germany. As early as 1406 all glassmakers around the Spessart Mountains [SE of Frankfurt] had organized themselves into a union The glass houses in Hesse appear to have conducted a significant export especially along the Rhine.”⁴⁵ However, later the center of Hessian glassmaking shifted from the

Spessart mountains to the Almerode or Großalmerode area east of Kassel.

“The glass industry of the Großalmerode region was so important in the beginning of the 16th century that in 1537 the seat of the Frankish-

Hessian guild of glass blowers was moved from the Spessart mountains to Großalmerode.”⁴⁶ (Three crucibles are in the coat of arms of this town.) “In 1557, more than 200 glassmakers gathered at the annual session of the court in the town of Almerode in Hesse.”⁴⁷ The sphere of influence of this Hessian glassmakers guild included all of Germany north of the Main River (except Saxony), as well as large parts of Scandinavia.⁴⁸ Between 1500 and 1700, 65 glasshouses were active in the Kaufunger Forest near Großalmerode.⁴⁹ Of these, there were no less than 18 glasshouses in the immediate vicinity of the town.⁵⁰



Fig. 10. Crucible from James Fort with the initials “PTV GER.”

Großalmerode was the major German glassmaking center closest to a German North Sea port. The Weser River connects Großalmerode with Bremen, one of the three German ports open to English merchants.

Because of its accessibility to the English, the Großalmerode area could very well have been the place of origin of the glassmakers at Jamestown.

About a dozen crucibles were found inside James Fort. “Recent research indicates that this ware was made in the Hesse area of Germany.”⁵¹ “Molten glass, remnants of glassmaking,” still adhere to some of these crucibles. One of the crucibles from inside

James Fort bears the initials of a potter from this Hessian glass and pottery center.⁵² The initials inside a circle read:

PTV
GER

They spell out "Peter Töpfer Großalmerode," a prominent potter of the town.⁵³

But why would Großalmerode glassmakers have wished to come all the way to Virginia? Glassmakers were frequently on the move; when they had exhausted one wooded area, they had to move their glass hut to another. The glass huts were called not only *Waldglashütten* (forest glass houses) but also *Wanderglashütten* (wandering glass houses). The German glass men were no exception. In 1510, German glassmakers worked in the Italian cities of Perugia, Florence, Bologna and Arezzo.⁵⁴ The early glassmakers of Jutland, Denmark, were mainly of German origin.⁵⁵ Glassmaking was introduced into Sweden by German glassmakers.⁵⁶

Is there a specific reason why Großalmerode glassmakers would have wanted to emigrate around 1600? It happened that "the majority of glass-houses was closed down by sovereign law for the protection of forests during the last third of the 16th century."⁵⁷

"By 1596, a great number of the glass houses around Almerode had already been shut down, but in that year specifically the houses of the Kaufunger Forest [immediately adjacent to Großalmerode] received the stroke of death. At that time, many masters and journeymen emigrated."⁵⁸

"The great number of glasshouses around Großalmerode resulted in the destruction of the forests and led to a reduction of the houses at the beginning of the 17th century.

An extraordinarily large emigration of Hessian glassmakers followed. Wherever in Germany glass was produced at that time, one soon met masters and journeymen from Großalmerode."⁵⁹ There is documentation of a Hessian glassmaker in the Duchy of Holstein in 1574 and in Sweden in 1591; later we find Hessian names appearing again and again in Dessau, Brandenburg and even in Bohemia.⁶⁰ It may have been in search of work that two glassmakers from the Großalmerode area immigrated first to England and then to Jamestown, Virginia.



Fig. 11. A broken glass-smelting pot found at James Fort.

How did the German glassmakers make glass in James Fort?

The glassmakers have been described as lazy: "In 1608, with the second group of arrivals, came eight Dutch and Polish glassmen. . . . Although there was such abundance of material, the workmen were not an industrious lot."⁶¹

This is wrong on several counts. First, the glassmen were neither Dutch nor Polish. Nor could they by any stretch of the imagination be described as lazy.

Immediately on landing at Jamestown around October 1, 1608, the glassmakers

went to work experimenting with making glass. Capt. Smith wrote, "No sooner were we landed, but the President [Smith] dispersed many as were able, some for glasse."⁶²

Glass samples were sent back to England in December on the ship that had brought the glassmakers to Jamestown. The samples were not made in the Glasshouse, which was not built until the spring of 1609, but in or near James Fort itself. "Evidence of this two-month effort is abundant within the fort's early features in the way of crucibles—some containing molten glass or sand—large melting pots with glass residues, and pounds of cullet, or waste glass."⁶³

Two glass-smelting pots (*Glassschmelzhäfen*) fused together by molten glass were discovered in 1938 near the Fort; they were fused together, because one had been placed on top the other like a lid. In archaeological work began in 1994 under the supervision of Dr. William Kelso, crucibles containing glass were found in the Fort itself; slag from glassmaking was found in the Fort ditch.

"John Smith acknowledged the industriousness of these glassworkers when he declared that most of the 'labourers' in the fort 'never did know what a dayes worke was, except the Dutch-men [Germans] and Poles, and some dozen others.'⁶⁴

In the spring of 1609, the glassmakers with the help of other settlers build the Glasshouse on the mainland about 1 mile from James Fort. ". . . there is reference to a second 'tryal' being produced that spring."⁶⁵ And "Now wee so quietly followed our businesse, that in 3 monthes we made 3 or 4 lasts of pitch and tarre, and sope ashes, produced a triall of glasse."⁶⁶

"It does not appear that they [glassblowers] produced much if any glass in this structure," declared APVA's Jamestown Rediscovery archaeologists.⁶⁷ This evaluation is, however, contradicted by J. Carl Harrington: "Archeological evidence . . . does show,

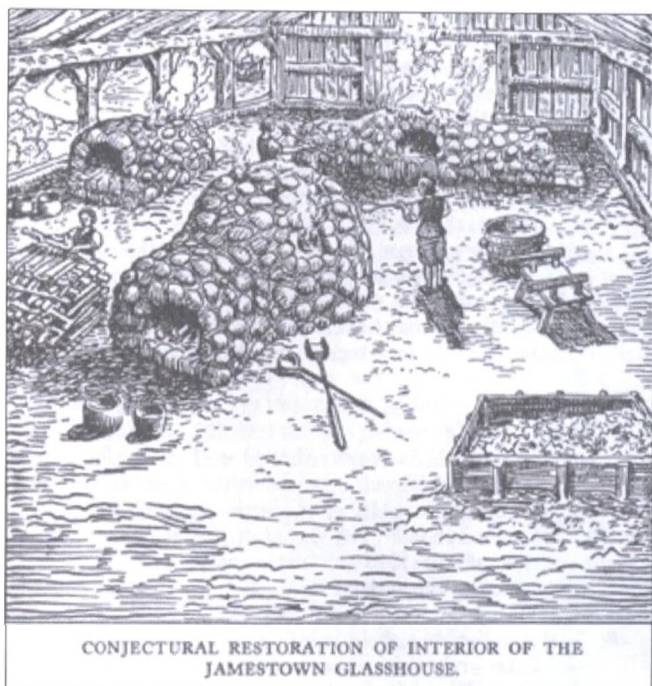


Fig. 12. Ruin of the main furnace (smelting furnace) built by the German glassmakers on the mainland opposite Jamestown Island. The circular portion in the foreground held the glass making pots and the fire. Firewood was fed through the channel in the back.

Courtesy of U.S. National Park Service.

however, that considerable glass was melted and fabricated," declared the archaeologist who uncovered the Glasshouse.⁶⁸

"In a semi-circle around the front of the [main] furnace was found a thick deposit of ashes and fine charcoal."⁶⁹ "Lying on [the] stone paving [in the main furnace] were thick deposits of slag, indicating rather extensive use. Although Mr. Dimmick [the owner of the Glasshouse grounds] had removed everything found within this furnace, except part of the slag, it appears that he found a considerable accumulation of furnace



CONJECTURAL RESTORATION OF INTERIOR OF THE
JAMESTOWN GLASSHOUSE.

Fig. 13. Artistic reconstruction of the interior of the 1609 Glasshouse built by Germans. (The smelting furnace faces in the opposite direction as in the photo above.)

Courtesy of U.S. National Park Service.

refuse, such as ashes, broken crucibles, stone spalls, and glass drippings.⁷⁰ Harrington found a number of broken smelting pots. "These broken pots add considerably to our knowledge of what went on at the Jamestown glass factories. Above all, they show that a serious attempt was made to turn out glass products, and that the first glassmaking effort was much more than just a public relations stunt designed to promote the financing of the Company's colonizing venture."⁷¹

It must also be stated that the original glassmakers at Jamestown were not simply glassmakers. The modern glassblowers at the simulated glasshouse utilize ovens built by engineers. The original glassblowers were their own engineers; they built their own ovens. How were these ovens used?

As we have learned, the raw elements of glass—sand, lime from oyster shells and pot or soda ash—are mixed and melted preliminarily in the fritting oven. This is the right one of the two long furnaces in the background. The resulting "frit" is placed in melting

pots set inside the smelting furnace (*Schmelzofen*) in the center of the Glasshouse. These pots (*Glasschmelzhafen*) have been placed on a stone ledge inside this oven. The pots are below rectangular holes in the sides of the furnace. The furnace is heated with firewood placed through the front opening into the fire trench, which runs down the middle of the furnace. This fire fuses the ingredients. Through one of the rectangular holes, also called work holes, the glass blower dips his blowpipe (*Blasrohr*) into the molten glass in a melting pot. He then blows the molten glass into a ball, according to what the final product is to be. From time to time, he dips the glass ball back into the

furnace to keep it at proper temperature. Then he places the finished object into the left one of the two ovens in the rear. This is the annealing oven (*Ausheizofen*) where the objects are slowly cooled so that they will not break. To the left is a kiln for firing melting pots.

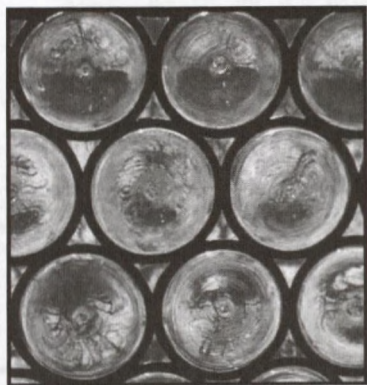


Fig. 14. *Butzenscheiben* fastened together by means of lead strips.

What did the glassmakers make at the Jamestown Glasshouse?

What type of window glass was made at the Jamestown Glasshouse—broad glass or crown glass? Broad or cylinder glass required a wide flattening furnace, which did not exist at the Jamestown Glasshouse. It also required a flat iron plate, stone or ceramic slab on which to flatten the glass. Although the archaeologist J.

C. Harrington found some glassmaking implements and some glass melting pots, he found no plate or slab when he dug up the Glasshouse ruins.

The fact that the cullet the glassmakers brought from Europe came from crown window glass would seem to indicate that they intended to make that sort of glass in Virginia.⁷²

Crown glass could be expanded to a diameter of 23.5 inches or more. But the annealing oven of the Jamestown Glasshouse is only 12 inches wide. They could have made *Butzenscheiben*; these disks 4 to 5 inches in diameter would have fitted comfortably into this cooling oven. Their small, round shape and thick edges would have offered some protection from breakage in the long ocean voyage back to England. Glaziers could have fastened these roundels into window frames by means of lead strips or rods. The glassmakers could have also made various green bottles, which would also have fitted easily into the narrow annealing oven.

“When Captain Argall arrived as governor in 1617, the glasshouse was no longer running and the building had fallen in decay,” stated Lura Woodside Watkins.⁷³

It is true that the glasshouse was no longer operational in 1617, but this was not the glassmakers’ fault. The London Company that had brought them to Virginia could not provide them sufficient food and protection. Despite their best efforts, the glassmakers could not keep working for the simple reason that they—like most of their fellows—probably perished during the horrible winter of 1609-10; this is when the vast majority of the settlers succumbed to disease, starvation and Indian arrows.

“Even though the colony was not ready to support local industries of this type,”

declared Harrington, "we know now that glass was made in Virginia as early as 1608, and in greater quantity than we had assumed from the documentary evidence."⁷⁴ The ruins of the four furnaces discovered by Harrington and preserved by the National Park Service under glass are testimony to the diligence of the German glassmakers.

The German-American Heritage Society of Greater Washington, D.C.
Washington, D.C.

Appendix

Germans played an important role in the American glass industry after Jamestown: "Wistar is one of the great names of early American glass. The second great American glassmaker was Henry William Stiegel, also known by his nickname, 'Baron' Stiegel. Stiegel made clear and colored glass, engraved and enameled glass, and the first lead glass produced in North America. A third important American glassmaker was John F. Amelung, who became best known for his elegant engraved glass."⁷⁵

Caspar Wistar

"Although other glasshouses were operated in the colonies, especially in New Amsterdam, the first successful and enduring large-scale glasshouse was set up by the German-born manufacturer Caspar Wistar in New Jersey in 1739."⁷⁶ . . . It was founded by Casper Wistar in Salem County, about two and a half miles from Allowaystown, and not far from Philadelphia. Wistar was a German who had migrated to this country in 1717 at the age of twenty-one. He was the forerunner of hundreds of the same nationality who were responsible for the final success of American glassmaking. Indeed, in the eighteenth century, the greater number of glassblowers were of Germanic origin, and it is to Germany that we must look for stylistic influences in much of our good early glass."⁷⁷

Wistar was born in 1696 near Heidelberg. When he arrived in Philadelphia, he had four German glassmakers with him; he took them in as partners. They were Johann Wilhelm Wentzel, Caspar Halter, Johann Martin Halter and Simeon Griessmeyer. Wentzel came from a famous glassmakers family from Bohemia.⁷⁸ "Casper Wistar died in 1752 and was succeeded by his son Richard in both of his manufactures. The Wistarberg works, as it was later known, ran continuously until the Revolution."⁷⁹

The Stangers, a glass making family from Dornhagen, Germany, were brought to America as indentured servants by Casper Wistar. After the closing of the Wistar works in Wistarburg, NJ, they founded or worked at many other glass factories. In 1781, Solomon Stanger started in Gloucester County, NJ, "what was going to be 148 years of continuous glass making in what was to become the town of Glassboro." In 1810, Christian L. Stanger founded the Franklin Glass Works in Malaga, NJ. In 1834, Lewis Stanger opened a new factory known as Lewis Stanger & Son just south of Harmony. "Since the Stangers were teetotalers, the glass works became known as Temperanceville. Window glass and hollow ware were their main out put. No whiskey flasks were made there!"⁸⁰

Heinrich Wilhelm Stiegel

"The most famous American glass was made by Henry William Stiegel, a German who came to America in 1750 [from Cologne] . . . From 1763 to 1770 Stiegel made window glass and various types of bottles and hollow ware at both Elizabeth Furnace and Manheim [Pennsylvania]. In 1769 Stiegel started the manufacture of flint-glass—the first of its type in America—at Manheim, and many experienced apprentices were brought from Bristol, England; Cologne, Germany; and Venice, Italy. In the few years that this factory was in operation, many beautiful pieces were made, following English and Continental prototypes. Quaint, useful, and decorative objects of every kind, in clear glass, opaque white, emerald green, amethyst, brown, and sapphire blue, were produced . . . He also made an interesting enameled glass covered with colorful German peasant patterns of leaves, berries, and parrots. His perfume bottles, sugar bowls, and flower vases were particularly in demand."⁸¹

Stiegel "founded the American Flint Glass Manufactory in Manheim, Pennsylvania, and it was there in about 1771 that the first cut glass was produced in America."⁸²

"Pennsylvania German glassware was best known through the artistry of 'Baron' Heinrich Wilhelm Stiegel. Stiegel was a master craftsman who became a legend in his own time as the flamboyant owner of iron and glassworks. Stiegel glass cannot be definitely identified since his workers took his methods to other factories after his own went bankrupt. However, Stiegel-type flint glass, or crystal, was widely known for its beauty, fragility, and the brilliance of its colors. A wide variety of glassware—from wineglasses, sugar bowls, and cruets to windowpanes and chemists' bottles—was made at the Stiegel furnace . . . Stiegel was the first American glass manufacturer to enamel glass. Pieces made of white, or clear, glass have their decoration of birds, tulips, and scrolls painted on freehand with red, green, and yellow enamel. The motifs used reflect

typical Pennsylvania German traditions of decoration.⁸³

"Stiegel operated his glassworks from 1763 to May, 1774, and employed over 130 foreign workmen."⁸⁴

Johann Friedrich Amelung

"With John Frederick Amelung, another German immigrant dominated American glass production. He established the first really extensive glass manufactory (Maryland, 1784), and he laid the foundations for industrial glass production in the United States."⁸⁵

"Pattern-molded and engraved Stiegel-type glass was also made by [John F.] Amelung at the New Bremen Glass Manufactory in Frederick, Maryland. This factory was established in 1784 and skilled German craftsmen were brought over. They excelled in engraving.... Coat of arms, devices, ciphers, and fancy figures, including sprays of leaves, birds, daisylike flowers, festoons, and names and inscriptions, are typical of the engraving on clear glass.

"After Amelung's glassworks shut down [in 1796], some of the workmen were employed in the Baltimore area and others went to the New Geneva Glass Works in Pennsylvania. Thus glass similar to Amelung was made in these localities."⁸⁶

Johann Martin Greiner

"Previous to 1752, Matthew Earnest [Ernst], Samuel Bayard, Lodewyck [Ludwig] Bamber, and Christian Hertell formed a partnership for the purpose of building a glasshouse [in New York]. They made an agreement with one Johan Martin Greiner of Saxe-Weimar, Germany, to come to America to teach them the 'Art & Mystery of Erecting & Building a Glass House & also in Blowing & Making of Glass.' He was to supervise every step in the construction of ovens and making of pots and he promised to remain in New York for a term of twenty years. The glass company agreed to pay Greiner twenty-four stuyvers for every one hundred quart bottles and three guilders for every fifty half-gallon flasks."⁸⁷ "This New York company continued in operation until 1767."⁸⁸

Notes

¹ Jamestown is called "the birthplace of the United States of America" on a tall obelisk erected in 1907 on Jamestown Island to commemorate the 300th Anniversary of the founding of the colony. It was dedicated by President Theodore Roosevelt.

² Smith, John, *The Generall Historie of Virginia, New-England, and the Summer Isles with the names of the Adventurers, Planters, and Governours from their first beginning An: 1584 to this present 1624* (London: Michael Sparke, 1624), 73.

Two Continental Europeans arrived before the craftsmen. They were the German Swiss prospector, William Volday [Wilhem Waldi?], who arrived with the first English settlers in 1607, and Dr. Johannes Fleischer, the Younger, who arrived in April 1608. (See "Johannes Fleischer, Jr., M.D.: The First Scientist at Jamestown, Virginia," *Yearbook of German-American Studies* 35 [2000]:133-51).

³ Smith, *The Generall Historie of Virginia*, 66.

⁴ "Captain Newport, being dispatched with the trials of pitch, tar, glass, frankincense and soap-ashes, with that clapboard and wainscot which could be provided." (*Travels and Works of Captain John Smith*, Arber and Bradley's Edition 2:242). "Wainscot. . . . A wooden lining for the walls of rooms, usually made of panels." *New Webster's Dictionary of the English Language*.

⁵ *Travels and Works of Captain John Smith*, Arber and Bradley's Edition 2:525.

Explication by Conway Whittle Sams: "That is, that during or after the building of this house for Powhatan, it would afford them a place of safety, 'a castle' for their defence; and an opportunity to kill Powhatan." *The Conquest of Virginia: The Second Attempt* (Norfolk, VA: Keyser-Doherty Printing Co., 1929), 525.

⁶ Smith, *The Generall Historie of Virginia*, 72: "Letter sent to the Treasurer and Councill of Virginia from Captaine Smith, then President in Virginia."

A gloss to this *Historie* by Smith reads, "Two Gentlemen sent to the Germans." The gentlemen in question were sent to the "Dutchmen" Samuel, Francis and Adam, who were helping to build a house for Chief Powhatan (p. 88).

⁷ *Virtual Jamestown: Jamestown Artifacts*. Jamestown Rediscovery, 1994.

⁸ Philip L. Barbour, *The Three Worlds of Captain John Smith* (Cambridge: The Riverside Press, 1964) 1:259-60.

⁹ William M. Kelso and Beverly Straube, *Jamestown Rediscovery, 1994-2004* (Richmond: Association for the Preservation of Virginia Antiquities, 2004), 188. (Kelso is the historical archaeologist who discovered the footprints of James Fort when it was thought to be under the waters of the James River. Straube is the curator of this archaeological project.)

¹⁰ The National Park Service has instructed a "Living History Character" at the Jamestown Glasshouse to say to children: "My name is Lech and I am a glassmaker from Poland. I was recruited by the Virginia Company of London to come to the new colony and make glass to be sold back in England." "Transcript for Living History Characters: Glassblower." Lessonplans/historicjamestowne/elementary.

The National Association of Manufactures repeated this mistake: "Under the auspices of The London Company of Virginia, a group of colonists recruited a handful of Dutch and Polish glassmakers, set sail for

the New World and established a primitive glass factory at Jamestown in 1608—one year after they arrived.” Marissa Gandelman, “NAM Celebrates Jamestown: America’s largest manufacturing association pays homage to America’s oldest industry” in *Expansion Management Online*, 6-1-2004.

Here, the National Association of Manufacturers mistakenly identifies the glassmakers at Jamestown as Dutch and Poles; they were really German. The glassmakers actually arrived in 1608 and established the glasshouse in 1609.

¹¹ Henryk Zins, *England and the Baltic in the Elizabethan Era* (Manchester: Manchester University Press, 1972), 246.

¹² Richard Hakluyt (the lawyer), “Inducements to the liking of the voyage intended towards Virginia” written in 1585 and first published as an appendix to John Brereton’s *A Brief and true Relation* (London, 1602).

¹³ The literature of sixteenth and seventeenth century glassmaking makes virtually no reference to Polish production, while the German glass industry of that period is described at length. Philip L. Barbour, “The Identity of the First Poles in America,” *William & Mary Quarterly*, 3d ser., 21 (January 1964): 90.

The author asked Dr. Gerhard E. Sollbach, head of the faculty of the Historical Institute of the University of Dortmund, Germany, to help with identification of the glassmakers at Jamestown. He, in turn, asked a Polish colleague, who “when he went to Poland for a research visit (University of Oppeln) this summer checked the literature (so far as his time allowed him to do it) for any information of glassmaking in Poland around 1600—but without any success. As he told me, this seems to have been no subject for Polish historians” (personal communication from Prof. Sollbach on November 15, 1995).

¹⁴ Web page: Glass Online. “A Brief History of Glass: The Roman Connection.” Artech Publishing, 1996-2006.

¹⁵ Eleanor S. Godfrey, *The Development of English Glassmaking, 1560-1640* (Chapel Hill, NC: University of North Carolina Press, 1975), 25.

¹⁶ “There are not many sites of ancient glass blowing houses, but there have been partial remains found in Eigelstein, near Cologne, and in Phidius in Greece dating from the 5th century B.C. Pieces of glass from half of a mold, partial remains of a glass furnace and a crucible in which the glass was heated to a molten state, are all artifacts found at these sites” (Web page: Susan Hampton, “Glassmaking in Antiquity: Roman Glass”).

According to the *Encyclopaedia Britannica*, “Glass-making in Germany during the Roman period seems to have been carried on extensively in the neighborhood of Cologne. The Cologne museum contains many specimens of Roman glass, some of which are remarkable for their cut decoration. The craft survived the downfall of the Roman power, and a native industry was developed. This industry must have won some reputation, for in 758 the abbot of Jarrow [England] appealed to the bishop of Mainz to send him a worker in glass.” *Encyclopaedia Britannica*, 11th ed., 102.

H. W. Woodward wrote, “Not a single mention of glassmaking activity appears in English archives until 758, when Cuthbert, the Abbot of Jarrow, sent an urgent request to the Archbishop Lullus of Mainz to assist him in obtaining glassworkers. His plea defines the status of the art throughout northern Europe as clearly as it does of England:

If there be any man in your diocese who can make vessels of glass, pray send him to me; or if by chance he is beyond your bounds, in the power of some other person outside your diocese, I beg you fraternally that you will persuade him to come to us, seeing that we are ignorant and helpless in that art.

“Where the bishop found the ‘foreign glassmakers’ to work at Monkwearmouth is unknown, but traces of furnaces were found on the site in the late 1960’s by Rosemary Cramp.” Rosemary Cramp, “Glass Finds from the Anglo-Saxon monastery of Monkwearmouth and Jarrow,” citing Bede, *Opera Historica* (a late 7th century work) ed. C. Plummer (1896), chap. 5; H. W. Woodward, *Art, Feat, and Mystery: The Story of Thomas Webb and Sons, Glassmakers* (1978).

“It is probable that the glass drinking-vessels, which have been found in pre-Christian Anglo-Saxon tombs, were introduced from Germany. Some are elaborate in design and bear witness to advanced technique of Roman character.” Web page: Online Information, article about GLASS.

¹⁷ *Encyclopaedia Britannica*, 11th ed., 103.

Chiddingfold is a village in Surrey, United Kingdom, on the highway between Milford and Petworth.

¹⁸ Web page: “GlassOline.com – A Brief History of Glass”.

However, this method of making flat glass from a glass cylinder had also been utilized by the ancient Romans. Did Germans re-invent this old Roman process in the eleventh century after knowledge of it had been lost or did they simply continue this old tradition and perhaps improve it?

¹⁹ Denis Diderot, *A Pictorial Encyclopedia of Trades & Industry* 2, plate 249.

²⁰ *Encyclopaedia Britannica*, 11th edition, s.v. “glass.”

²¹ *Monthly Chronicle of North-Country Lore and Legend* 2, no. 15 (May 1888).

The names of at least three of the four Lorraine glassmaker families reveal their German origin. They were originally Hennezell, Dietrich and Tiesack, and they were German-Bohemians:

“Toward the end of the fourteenth century four other families of glassmakers—the de Hennezells, de Thietrys [Dietrich], de Thyacs [Tiesack], and de Bisvals—migrated from the Bohemian border to the forest of Darney in the Vosges mountains of Lorraine. Like their Norman counterparts, they improved the quality and ductility of their glass metal through careful founding, and in addition altered the technique of manipulation in order to increase the size of the cylinders. The resulting sheets were larger, thinner, and flatter

than those made before, so that glass 'in the Lorraine mode,' like Normandy glass, achieved a high reputation. The four families, three of whom later became leaders in the English industry, received from the Duke of Lorraine confirmation of their noble rank of *chevalier* and privileges similar to those enjoyed by the Norman families" Godfrey, *The Development of English Glassmaking*, 6-7.

The first Lorrainer to establish himself in Stourbridge, England, notes D. R. Guttery, the English glass historian, was Paul Tyzack, "Master of the art, feat, and mystery of broad-glass making." "Noble as the Tyzacks were," wryly comments Guttery, "[The] du Thisacks, *gentilhommes verrieres* . . . had been tramps from the early fifteenth century when they left the woods of Bohemia and began their long trek to Darney Forest in the Vosges." They were drawn to the Vosges by the privileges granted them in the famous glassmaking charter, which granted glassmakers quasi-noble (*gentilhommes*) status, but their decision to move into the area was also dictated by the availability of wood. "When their hungry fire had burned through one woods they moved to another. The Vosges forests promised an inexhaustible supply of cleft billets they tossed into their furnaces, not only for themselves, but also for the Henzeys (de Hennezel) and the Titterys (de Thietry), their closest kinsmen and, like them tramps." D. R. Guttery, *From Broadglass to Cut Crystal* (London, 1956), 1.

One of the Thietrys or Dietrichs, Joshua Tittery, a "broad glass man," from Newcastle-on-Tyne, came to America and worked in a Philadelphia glass factory in 1683. Lura Woodside Watkins, *American Glass and Glassmaking* (London: Max Parrish & Co., 1950), 23.

²² Susan Myra Kingsbury, *Records of the Virginia Company of London 1* (Washington, D.C.: U.S. Government Printing Office, 1935): 251 (pertaining to 21 July 1619).

Poles are referred to as makers of pitch and tar as well as soap ashes and potashes also under entries of May 17 and June 22, 1620.

²³ Kelso and Straube, *Jamestown Rediscovery, 1994-2004*, n. 157.

²⁴ The Virginia Company of London lists among the settlers killed in the Indian uprising of March 22, 1622, "Matthew, a Polander who died at Martin Brandon's."

²⁵ William Strachey's *The Historie of Travell into Virginia Britania* (1612), 78.

Strachey's complete statement about the Glasshouse reads as follows:

a litle without the Island where Jamestown stands, . . . where . . . though the Country wants not for Salsodiack [soda ash] enough to make glasse off, and of which we have made some store in a goodlie howse, sett up for the same purpose, with all offices and furnaces thereto belonging, a litle without the Island where James Towne standes.

Kelso declared in *Jamestown Rediscovery II*:

Crucibles were used for many purposes, including glassmaking . . . Most of the crucibles located at the [James Fort] site are triangular and are believed to have been made in Hesse, Germany. Two of the crucibles contain molten glass on the interior. These are of a larger beaker size and were probably used by the German glassmakers to produce trials of glass before construction of their work space on Glasshouse Point in 1609. Kelso, *Jamestown Rediscovery II: Search for 1607 James Fort* (Richmond: Association for the Preservation of Virginia Antiquities, 1996), 40.

He also wrote in the web page "Jamestown Rediscovery:"

"Glassmen from Germany attempted to make window glass, workers from Poland made soap ash and potash...." www.apva.org/ngex/xwrkplay.html.

²⁶ J. Carl Harrington, *A Tryal of Glasse: The Story of Glassmaking at Jamestown* (Richmond, VA: Dietz Press, 1972).

²⁷ "In [Germany] there had been a continuous survival, probably from late Roman times, of a local type of green glass, a product of forest glasshouses, made with potash obtained by burning forest vegetation and called therefore *Waldglas* ('forest glass')." *The New Encyclopaedia Britannica, Macropaedia 17* (1994), s.v. "decorative arts & furnishings—the history of glass design."

²⁸ "The German glassworkers were . . . known for a particular type of glass, *Waldglas* ('forest glass'). *Waldglas* is green in color, implying the use of a raw material containing iron compounds. It was so named because, beginning in the thirteenth century, the Germans had migratory forest glass houses. These used the nearby wood as fuel and, when it is exhausted, move on. There were *Waldglasbutten* in the imperial forest near Nuremberg, the Fichtelgebirge, the Thuringian forest, Silesia and Sollingen in the fourteenth century, and in Bohemia, Hesse and Lorraine in the fifteenth . . . Unlike the more exalted glass workers of Venice and France, the Teutonic *waldglas* makers had a relatively low social status. They tended to intermarry, and hence there were certain families which made a name for themselves as glass craftsmen: Gundelach and Kunkel in Hesse, Wenzel and Schurer in Bohemia, Preussler in Silesia [and] Greiner in Thuringia." Web page: Iver P. Cooper, "FAQ on Glassmaking in 1632," (2004).

"German glassmakers settled in the forested middle mountain ranges. In the Spessart, in the Thüringer Forest, in the Black Forest, in the Bavarian Forest, in the Fichtelgebirge, Bohemian Forest, Ore Mountains and the Riesengebirge. They found there sufficient fire wood for their smelting ovens. The glass was mostly greenish, not colored. This was caused by the raw materials, the sand and the potash. The trunks of beech and oak trees were burned, their ash was placed in pots and the lye was washed out with hot water. This resulted in the so called pot ash (calcium carbonate). When the surrounding forests had been denuded, the glassmaker moved his glass hut elsewhere. The glassmakers didn't become permanently settled until the

17th and 18th centuries... Web page: Bärbel Heidenreich, "Wanderglashütten und Pottasche, Planet Wissen – Glastradition: Wann, wie und wo wurde Glas gemacht?," trans. by the author.

²⁹ *Encyclopaedia Britannica*, 11th ed., 102.

³⁰ Web page: "Geschichte und Entwicklung des Glases: Wurzeln des europäischen Glashüttenwesens," trans. by the author.

³¹ Web page: "Aus der Glashüttengeschichte: Wie hat eine Glashütte in der Gründerzeit ausgesehen?" Hans Schopf and Will Steger, Sankt-Oswald, Riedelhütte.

³² Web page: "Forest Glass Furnaces in County Offaly, Archaeology, Glass Furnaces."

³³ Two German glasshouses were uncovered near the end of the twentieth century:

The glasshouse in Schönbuch near Tübingen, SW Germany, operated from about 1450 to 1480. The ruins of three ovens were unearthed in 1992. The largest was a smelting oven, the others a *Streckofen* (flattening oven) and *Kühlofen* (cooling oven). It produced hollow glass and mostly green window glass (broad glass) plus some white *Butzenscheiben* in whose production soda ash was used. An unusual find was *Glasfritten*. (Frit is a calcined, partly fused material ready for complete fusion to form glass.)

In 1984/85, the late medieval glass hut Salzriesen was uncovered in the Valley of the Nassach near Göppingen. This glasshouse was productive for almost all of the fifteenth century. Four ovens were utilized: A main furnace and two auxiliary ovens, probably a *Streckofen* (flattening oven), which was heated to a maximum of 550° C, and a cooling oven heated not above 300° C. The fourth oven was probably used for making smelting pots (*Hafen*) and for producing frit. Some frit was also found. This glasshouse produced *Waldglas* ware for everyday use. But much more flat glass (broad glass) in hues of green, yellow, blue, violet and red for Gothic church windows. Plus some clear *Butzenscheiben* in whose production soda ash was used (Web page: U. Schüssler and B. Brinker, "Die Spätmittelalterliche Glasproduktion im Schönbuch bei Tübingen und im Nassachtal bei Göppingen," Institut für Mineralogie, Am Hubland, 97074 Würzburg).

³⁴ Since the end of the 14th century there were glass huts in [Austria's] Steiermark / Styria. The traditional glass hut measured 20 meters by 11 meters. It included a *Schmelzofen* or smelting oven, a *Kühlofen* or cooling oven, two small *Aschofen* or ash ovens for making potash and a *Temperofen* or tempering oven" (Web page: Echolat, "Die Glasmacher, Erster Teil," trans. by the author).

³⁴ "The oldest handwritten copies of the work are found in Vienna (Austrian National Library, Codex 2527) and in Wolfenbüttel (Herzog-August-Bibliothek, Codex Guelf 69). Gotthold Ephraim Lessing rediscovered the document when he worked as librarian in Wolfenbüttel" (Web page: "Theophilus Presbyter" in Wikipedia, the free encyclopedia, trans. by the author).

³⁵ Web page: "Echolat, Die Glasmacher, Erster Teil," trans. by the author.

³⁶ Web page: U. Schüssler and B. Brinker, "Die Spätmittelalterliche Glasproduktion im Schönbuch bei Tübingen und im Nassachtal bei Göppingen," Institut für Mineralogie, Am Hubland, 97074 Würzburg.

³⁷ "At a time when the scarcity of window glass in London was most acute, there was a daring attempt to supply the market from a new source. London merchants in the newly formed Virginia Company decided to establish a glasshouse in the struggling settlement at Jamestown, Virginia," Godfrey, *The Development of English Glassmaking*, 58.

³⁸ *Encyclopaedia Britannica*, 11th ed., s.v. "glass."

³⁹ Web page: "Attache Archive."

⁴⁰ *Encyclopaedia Britannica*, 11th ed., s.v. "glass."

⁴¹ Otto Völckers, *Glas und Fenster; Ihr Wesen; Ihre Geschichte und Ihre Bedeutung in der Gegenwart*. (Berlin: Bauweltverlag, 1939), 80.

⁴² Web page: Rainer Trumpf, "Glas im Bauwesen," PaX Classic GmbH Fachtagung Herbst 2002.

⁴³ Web page: "Raumausstattung Wohnen: Butzenscheiben."

⁴⁴ Godfrey, 13.

⁴⁵ Robert Schmidt, *Das Glas*. (Berlin: Verlag Georg Reimer, 1912), 131-33.

⁴⁶ Hans-Georg Stephan, *Großalmerode: Ein Zentrum der Herstellung von technischer Keramik, Steinzeug und Irdenerware in Hessen*, Teil I (Großalmerode: Glas- und Keramik-Museum Großalmerode, after 1980), 15:

"Already the early documents of the region link organically the founding and flourishing of Großalmerode east of Kassel with the clay deposits of the region and the genesis of a center of glassmaking in the Forest of Kaufung. . . . The glass industry of the Großalmerode region was so important in the beginning of the 16th century that in 1537 the seat of the Frankish-Hessian guild of glass blowers was moved from the Spessart mountains to Großalmerode" (trans. by the author).

⁴⁷ Schmidt, 131-33.

⁴⁸ Hans-Georg Stephan, *Großalmerode: Ein europäisches Zentrum der Herstellung von technischer Keramik*, Teil II (Großalmerode: Glas- und Keramikmuseum Großalmerode, 1995), 65.

⁴⁹ Web page: Ernst Grage, "Wie war das eigentlich mit dem Waldglas im Kaufunger Wald?" *Trommelstock*.

⁵⁰ Stephan, 96.

⁵¹ J. P. Cotter, "The Mystery of the Hessian Wares: Post-medieval triangular crucibles" in *Everyday and Exotic Pottery from Europe c. 650-1900* (Oxford, England: Oxbon, 1992).

⁵² "Also from Germany are the refractory clay crucibles that were used to melt the raw materials. The clay of the crucibles has quartz sand as main ingredient" and is fired to a near-stoneware consistency that

* "Reiner Quarzsand"; that is, pure quartz sand, and clay were used to make crucibles in Großalmerode. Hans-Georg Stephan, *Großalmerode: Ein europäisches Zentrum der Herstellung von technischer Keramik*, Teil II (Großalmerode: Glas- und Keramikmuseum Großalmerode, 1995), 22.

creates 'industrial strength' vessels able to withstand very high heat without breakage. One of the crucibles is marked twice in the base with a circular stamp bearing the initials PTV GER. Crucibles with this same mark have been recorded from excavations in Großalmerode near Kassel, Germany. Indeed, the GER stands for Großalmerode, a primary center of glass and crucible production for 400 years that peaked in the early seventeenth century. The PTV is believed to represent Peter Topfer, who was listed as a leaseholder in the crucible production monopoly from 1621-1625. He is listed as 'the elder' in 1621, so he was most likely making crucibles prior to the 1608 glassmaking activity at Jamestown." William Kelso and Beverly Straube, *Jamestown Rediscovery VI* (Richmond, VA: The Association for the Preservation of Virginia Antiquities, 2000), 65-66.

See also "Figure 79. Evidence of the glassmakers at work within the fort prior to 1610," p. 63, and "Figure 13. Some of the men at James Fort were clearly conducting experiments in making small trials of glass leaving behind stoneware crucibles still containing sand and melted glass and broken window glass cullet"—William M. Kelso, Nicholas M. Luccketti and Beverly A. Straube, *Jamestown Rediscovery V* (APVA), 13.

The glassmakers brought finished crucibles with them to Virginia, because it took over a year to make new ones. Before firing, the pots, formed of special clay, had to be stored for 1 year. Then they had to be carefully warmed for 14 days in a *Temperofen* (tempering oven) before they could be finally fired.

⁵⁵ "In the year 1621, Landgrave Moritz awarded the privilege of mining clay suitable for crucible production to a Großalmerode consortium consisting of Peter Töpfer the Elder, Hans Töpfer, Georg Töpfer, Christian Zimmer und Georg Ruelberg. This privilege included the sole right to export this clay as well as the sole right to make crucibles from it." Stephan, Teil I, trans. by the author, 51.

⁵⁶ Otto Stöber, *Wundersames Glas* (Linz: Landverlag, 1947), 32.

⁵⁷ Ada Polak, *Glass: Its Makers and Its Public* (London: Weidenfeld and Nicolson, 1975), 40.

⁵⁸ Stöber, 41.

⁵⁹ Stephan, from English summary, 250.

⁶⁰ Adolf Häger, "Foreword to the play: Die Waldgläser. Großalmerode, 21 May 1938," trans. by the author.

Act 5 of this play. Time: Spring 1597. "Young glassmakers from Almerode bid farewell and journey into the world to continue pursuing the glassmaking craft," trans. by the author.

⁶¹ Karl Krück, *Großalmerode: Bergstadt zwischen Meißner, Hirschberg und Kaufungerwald*, trans. by the author (Horb am Neckar: Geiger-Verlag, 1988), 52.

⁶² Schmidt, 133.

⁶³ Lura Woodside Watkins, *American Glass and Glassmaking* (London: Max Parrish, 1950), 21.

⁶⁴ Philip L. Barbour, *The Three Worlds of Captain John Smith* 1 (Cambridge: The Riverside Press, 1964), 238.

⁶⁵ Kelso and Straube, *Jamestown Rediscovery VI*, 62.

"A layer of frothy slag-like material...was excavated in the north end of the bulwark earthwork trench [SE bulwark of James Fort]. Thought to be the waste from melting the raw materials to make glass, samples of the solidified froth were petrologically examined and found to contain more than 90% silica, confirming that this material is glass gall [insoluble material in the melted glass]." Nicholas Luccketti and Beverly Straube, *1997 Interim Report on the APVA Excavations at Jamestown, Virginia*.

⁶⁶ Barbour, *The Three Worlds of Captain John Smith*, 238.

⁶⁷ Harrington, *A Tryal of Glasse*, 8.

⁶⁸ Barbour, *The Three Worlds of Captain John Smith*, 263.

⁶⁹ Virtual Jamestown, "Jamestown Artifacts," 1994 Jamestown Rediscovery.

⁷⁰ Harrington, *A Tryal of Glasse*, 30.

⁷¹ Harrington, *A Tryal of Glasse*, 15.

⁷² Harrington, *A Tryal of Glasse*, 15.

⁷³ Harrington, *A Tryal of Glasse*, 41.

⁷⁴ William Kelso and Beverly Straube, *Jamestown Rediscovery VI* (Richmond: The Association for the Preservation of Virginia Antiquities, 2000), 64.

⁷⁵ Lura Woodside Watkins, *American Glass and Glassmaking* (London: Max Parrish, 1950), 21.

⁷⁶ Harrington, *A Tryal of Glasse*, 47.

⁷⁷ Web page: Steve W. Martin, Iowa State University, "Glass Facts: History of Glass."

⁷⁸ Columbia Encyclopedia, the free dictionary, s.v. "glassmaking in colonial America."

⁷⁹ Watkins, *American Glass and Glassmaking*, 24.

⁸⁰ Web page: Iver P. Cooper, "FAQ on Glassmaking in 1632" (2004).

⁸¹ Watkins, *American Glass and Glassmaking*, 24.

⁸² Web page: William H. Flowers, "Old South Jersey Glass and Antiques."

⁸³ Web page: "American glasses represented by Stiegel glasses," Easterncorner Library, Cambridge, Mass.

⁸⁴ Web page: "Early Cut Glass in America," American Cut Glass Association.

⁸⁵ Web page: "Pennsylvania German Folk Art from the Index of American Design," National Gallery of Art, The Collection.

⁸⁶ Web page: "Stiegel Glass," Old and Sold Antiques Auction and Marketplace.

⁸⁷ Web page: "Waldglas in the USA," based on *A Short History of Glass* by Chloe Zerwick, the Corning Museum of Glass, New York, 1980.

⁸⁸ Web page: "Stiegel Glass," Old and Sold Antiques Auction and Marketplace.

⁸⁹ Watkins, *American Glass and Glassmaking*, 23.

⁹⁰ Watkins, *American Glass and Glassmaking*, 23-24.

