THE FICHTELGEBIRGE BEAD AND BUTTON INDUSTRY OF BAVARIA

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Venice and Bohemia are generally considered to be the principal bead manufacturers of Europe. Yet Germany, especially the Fichtelgebirge region of northeastern Bavaria, produced large quantities of glass beads for the world market beginning in the 15th century, if not even earlier, and continued to do so well into the 20th century. The Fichtelgebirge industry is especially notable for two things: 1) the utilization of furnace-winding technology which, based on our current knowledge, was not employed to a significant degree elsewhere in Europe during the post-medieval period, and 2) the localized use of Proterobas, a greenish igneous rock, to produce opaque black beads and buttons without any additives until the early 19th century. This article presents a history of the industry and describes the products and the technology involved. It also provides a preliminary assessment of the chemical composition of the various products.

INTRODUCTION

The Fichtelgebirge is a small forested mountain range in the northeastern corner of Bavaria, itself in the southeast portion of Germany. Located between Bayreuth and the Czech border, it encompasses the former beadmaking villages and towns of Bischofsgrün, Steinachthal, Birnstengel, Fröbershammer, Hütten, Fichtelberg, Mehlmeisel, Mittellind, Unterlind, Warmensteinach, and Oberwarmensteinach, all of which are situated in the western end of the region (Figure 1).

This region was ideal for glassmaking due to the presence of vast forests that not only provided wood for the furnaces but the ashes were a source of potash necessary for the manufacture of *Waldglas* (forest glass). Another major asset was the presence of large amounts of such materials as Proterobas and quartz for glassmaking. The former material is an igneous rock, a greenish lamprophyre (Figure 2), that occurred in a dike some 8 km long and 5-30 m wide that ran through the Oschenkopf, a granite mountain that rises to a height of 1,024 m between the towns of Bischofsgrün and Fichtelberg. It melts readily and produces an opaque black glass without the need of any additives. The glass is truly black unlike traditional black glass which appears either deep purple, green, or blue when a sliver of it is held up to a strong light.

Another advantage of the remote Fichtelgebirge region was that during the Middle Ages the craftsmen there were not as closely regulated as those in the cities who were organized into guilds where every action was supervised and recorded. Furthermore, the guilds fixed selling prices and also limited the number of workshops. The Fichtelgebirge glassmakers could thus carry on business relatively unhindered by guilds and price restrictions.

HISTORICAL BACKGROUND

When exactly the production of beads and buttons began in the Fichtelgebirge is not known as very few documents have survived from the period preceding the 15th century. It might have been as early as the 12th or 13th century when rosary beads came into great demand. Rosaries were not only mnemonic religious devices promoted by the church but were also the only "ornaments" common folk could own. The demand caused a change in terminology. Whereas in former times the designations *Krallen* and *Perlen*, deriving from coral beads and oriental pearls, were equally applied to glass beads, there now appeared the designation *Paternosteri* (rosary beads) throughout Europe. The pilgrims and crusaders who started in or passed through Nuremberg and other cities on their way to the Holy Land would have been a ready market for beads and rosaries, making the Fichtelgebirge an ideal spot for a thriving beadmaking industry.

While a glassworks was already operating in the area of Bischofsgrün in 1340 (Weiss 1971:337), the earliest documented bead- and button-making hut is not recorded there until around 1450 (Goldfuss and Bischof 1817) (Table 1). Hans Röthel owned a glassworks for the production of buttons in the vicinity of Warmensteinach in 1584 (Kühnert 1924) and, in 1615, Christoph Hock is listed in the Bischofsgrün parish register as a beadmaker and glass enameler (Bucher 1893). In 1692, Johann Willen

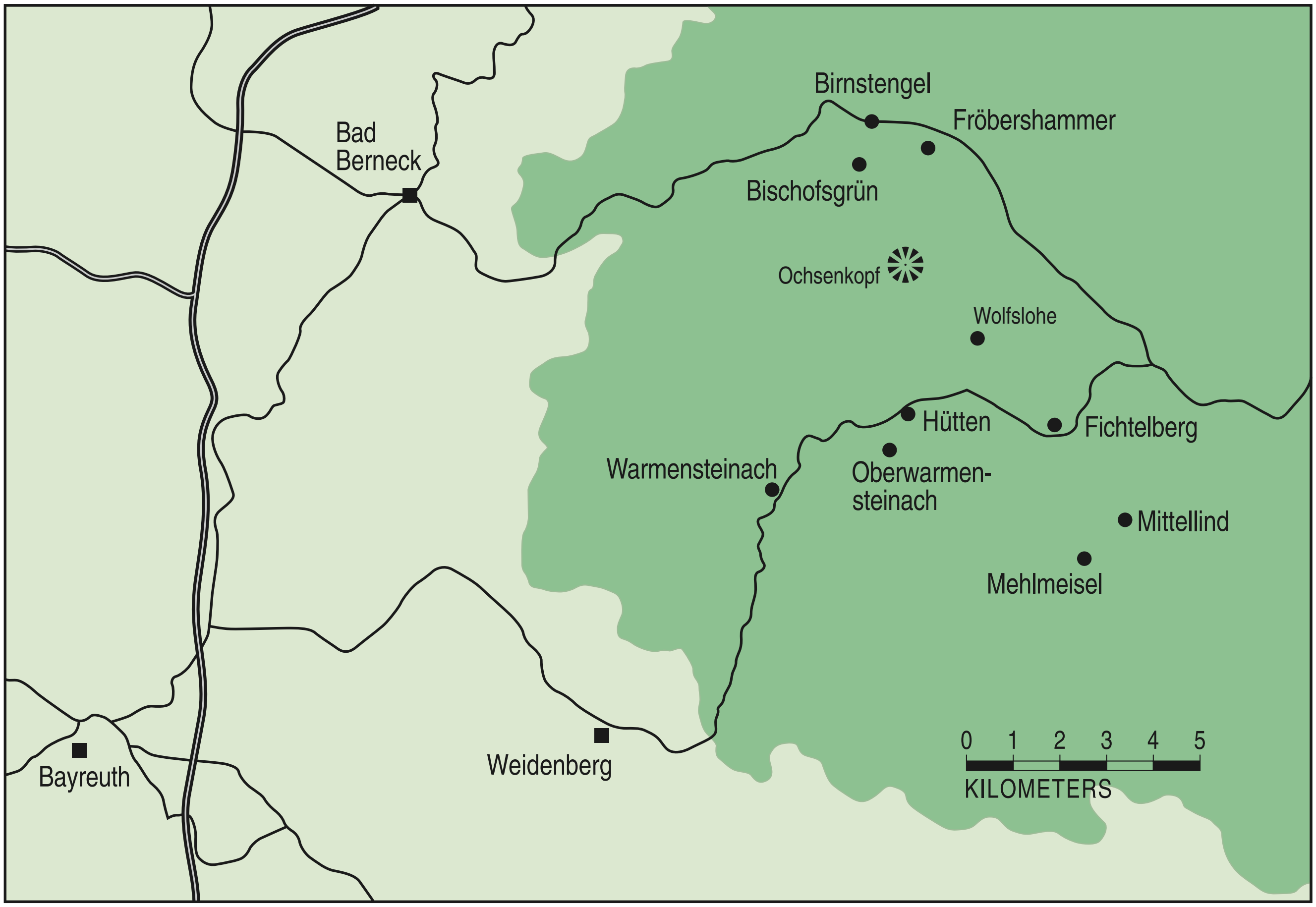

Figure 1. The western portion of the Fichtelgebirge region of northeastern Bavaria showing the locations of former bead-producing centers (●) and nearby towns (■) (drawing: David Weisel).

Figure 2. Proterobas specimen from the Oschenkopf mines (all photos by K. Karklins unless otherwise noted).

(1881) admired the beautiful buttons and beads in many different colors as well as all the beaded ornaments in the two glassworks at Warmensteinach. He also noted the perfect crystal and the beautiful enameling of the local glass products, making reference to the glass dynasties of the Greiner, Glaser, and Wanderer families. Apparently, glassmaking in the Fichtelgebirge at this period was of such outstanding economic importance that members of these famous families – whose names are traditionally linked to Thuringian glassmaking – emigrated to the Fichtelgebirge.

The two Warmensteinach glassworks are again mentioned in 1716 as producers of buttons and entire neck ornaments in many colors of which many hundred quintals were exported each year through Leipzig, Hamburg, and Amsterdam to Moscow, Turkey, and the West Indies (Pachelbel-Gehag 1932). In 1792, Matthias von Flurl (1792:469f) mentions two *Paterlhütten* (bead huts) operated by wire-drawing master Ludwig Haider and armourer Pirzner in Warmensteinach, revealing the close ties between beadmaking and the iron-working industry at this time. That same year, noted geographer and explorer Alexander von Humboldt (1792) named Kommerzienrat Loewel as the owner of a beadmaking hut in Bischofsgrün.

Table 1. Chronology of Registered *Paterlhütten* in the Fichtelgebirge, 1450-1800.

Date	Owner	Location	Source
1450/1493	?	Bischofsgrün	Local archives; Goldfuss and Bischof (1817)
1572-1640	?	Bischofsgrün	Church registers
1584	Hans Röthel	Warmensteinach	Local archives
1611	?	Bischofsgrün	Local archives
1615	Christoph Hock	Bischofsgrün	Church registers
1616-1630	?	Wolfslohe, Fichtelberg	Local archives
1622	?	Bischofsgrün; 2 glassworks	Local archives
1692	?	Warmensteinach	Willen (1881)
1716	?	Warmensteinach; 2 glassworks	Pachelbel-Gehag (1932)
1792-1860s	Loewel, later Scharrer	Bischofsgrün	von Humboldt (1792); Vierke (2006:354)
1792	Ludwig Haider	Warmensteinach	Flurl (1792)
1792	Pirzner	Warmensteinach	Flurl (1792)
1793	?	Bischofsgrün	Tieck and Wackenroder (1970:58)

The bead industry thrived throughout the 19th century (Vierke 2006:351) (Table 2). In 1817, there were four *Paterlhütten* in Steinachthal southwest of the Ochsenkopf and one in Fröbershammer adjacent to Bischofsgrün (Goldfuss and Bischof 1817:319). Each hut could produce at least 1,440,000 buttons or 5,400,000 beads per month. The colored beads were sold by the pound for 20 Kronen, although if the *Masche* (1,000 beads) weighed less than a pound, it cost 12-18 Kronen. Black beads were a bit cheaper. A *Schnur* (a string of 20 dozen) of colored buttons cost 18-20 Kronen; the black ones, 10-12 Kronen. These products went to Poland, Silesia, Switzerland, and Austria, and to Leipzig, Frankfurt, and Hamburg from whence they were shipped to Africa and America (Goldfuss and Bischof 1817:323-324).

At mid century, the four huts in Steinachthal are still in operation with another four in the eastern Fichtelgebirge (Vierke 2006:356). Sackur (1861) mentions 12 glass houses in the Fichtelgebirge region that produce 6,000,000 beads a week! Amthor (1881:11) notes six *Paterlhütten* in Bischofsgrün and Fichtelberg alone whose beads were sent to all parts of the world, especially India and into the interior of Africa, by way of the Bayreuth companies Scharrer and Koch, and Bettmann and Kupfer. A French directory of beadmakers and dealers from that same year shows one *Paterlhütte* in Bischofsgrün, but six in Warmensteinach, two in Oberwarmensteinach, and one in Unterlind (Jargstorf 1995:88).

The Fichtelgebirge bead industry experienced a very strong economy during the late 19th and early 20th centuries. Although trade agreements between the Austro-Hungarian Empire and Russia cut off trade to the latter and much of Asia and profitable sales to Persia dropped off, trade increased elsewhere. This included the Middle and Near East, East Asia, India, but above all, the German colonies in Africa. The Fichtelgebirge exported 30,000 Zentner (1,500,00 kg) of glass beads in 1899. At that time there were 10 *Paterlhütten* in the region: five in Warmensteinach, one in Oberwarmensteinach, one in Hütten near Oberwarmensteinach, one in Bischofsgrün, and one in Mittellind near Fichtelberg (Vierke 2006:352).

Despite the relative prosperity, there was ever-increasing competition from Bohemia during the second half of the 19th century. Compared to the 10 beadmaking establishments in the Fichtelgebirge in 1881, there were 98 beadmakers and dealers in Austria (which incorporated Bohemia at the time), 60 of which were in Gablonz, now Jablonec nad Nisou, Czech Republic (Jargstorf 1995:94). To better deal with this, the beadmakers in Warmensteinach formed a cooperative in 1899. In the early 20th century, Japan also became a stiff competitor (Vierke 2006:352). Then came World War I.

The Fichtelgebirge bead industry attempted to recover following the war but was initially plagued by hyperinflation and then suffered during the Great Depression. By 1925, there were only seven functioning

Table 2. Chronology of *Paterlhütten* in the Fichtelgebirge, 1800-1960 (after Vierke 2006:354).

Date	Name	Location
1800s-1920s	August Pscherer	Unterlind
1800-1860s	Loewel, later Scharrer	Bischofsgrün
1850s-1860s	Adam Greiner	Bischofsgrün
1850s-1870s	C. Bunte	Schönbrunn
1850s-1890s	Johann Schinner	Grünberg (Brand)
1860s	Ludwig Haider	Warmensteinach
1860s	Pirzner	Warmensteinach
1860s-1960s	Josef Trassl	Oberwarmensteinach
1870s-1940s	Christian Herrmann	Birnstengel
1880s	Heinrich Herrmann	Warmensteinach
1880s	S. Lindner	Warmensteinach
1880s	Rabenstein Perlenfabrik	Oberwarmensteinach
1880s	Schott & Herrmann	Warmensteinach
1890s-1960s	Genossenschaft	Warmensteinach
1900s-1920s	Hans Herrmann	Warmensteinach
1920s	Alfons Trassl	Warmensteinach
1920s-1969	Michael Trassl (Trasslhütte)	Oberwarmensteinach

Paterlhütten in the Fichtelgebirge: four in Warmensteinach, one in Oberwarmensteinach, one in Bischofsgrün, and one in Unterlind (Vierke 2006:359-360). The industry deteriorated over the next few years with a number of bead huts closing and the work force being seriously reduced. The remaining huts had to cut production for weeks and months on end. Although the huts continued to produce beads until 1942, World War II essentially brought an end to the *Paterlhütten* (Vierke 2006:417). The *Paterlmachers* were unable to compete with the technology of the Sudeten German beadmakers who were expelled from Bohemia after the war and came to the Fichtelgebirge and other regions of Bavaria to start new businesses. The last *Paterlhütte* in Bischofsgrün ceased production in 1957, followed in 1969 by the Trasslhütte in Oberwarmensteinach, thus ending a beadmaking tradition that spanned a remarkable 500 years and sent countless millions of beads and buttons to practically every part of the world.

FICHTELGEBIRGE *PATERLHÜTTEN*

The production of *Paterln* (from Pater Noster), as the beads were called locally, was performed in so-called *Paterlhütten* (bead huts). These were modest wooden buildings with one or more furnaces in a large working space adjacent to which was a restroom where workers could sleep and take meals. Next to this was a shed where clean white sand was stored for working into glass (Vierke 2006:363).

In smaller huts, a single furnace was located in the center of the work area. Round or oval in outline with a domed top, it was, on average, about 2 m in diameter and 1.6 m high (Vierke 2006:363). A fire channel extended down the center of the furnace with the working crucibles on either side. The melting crucibles were at the front and rear of the furnace. The working crucibles were long, rectangular, earthenware vessels of low height, which were divided approximately in the middle by partitions into two units connected by an opening at the bottom of the partition. The melting crucibles were also earthenware vessels with a rectangular cross-section but had approximately four times the capacity of the working crucibles. The furnaces were fueled with wood for the most part, 1/4 to 1-1/2 fathoms (cords) being consumed daily (Sackur 1861). Coal was also used beginning in the 20th century (Vierke 2006:32).

There was a work hole at every working crucible and each hole was enclosed by short side walls which delineated each work space (Figure 3). On the floor of every work station was a small, thin-walled, earthenware vessel which was kept warm by the furnace. Newly formed beads were placed in these to allow them to cool gradually (Sackur 1861). In some furnaces, there was a heated recess in the furnace wall which contained an earthenware pot for the same purpose. Furnaces could have up to 14 work stations (Vierke 2006:364).

Figure 3. Beadmakers at the furnace in the Marquardhütte, Warmensteinach, 1930s (Herrmann 2008:22).

FURNACE-WOUND TECHNOLOGY

The production of furnace-wound glass ball buttons with iron loop shanks is a fairly simple process. A small piece of bent iron wire held in a pair of pliers (*Zange*)[1] is dipped into a crucible of molten glass in a furnace and rotated back and forth until the required size is achieved. The button is removed from the furnace, smoothed with a knife, and then dropped into a covered earthen annealing pot which is situated in the oven in front of the worker (Flurl 1792:471). While the glass is still viscid, the buttons could be pressed in open-face molds to impart a design. The buttons could also have enamel designs painted on them or ground facets applied when they had hardened.

The furnace-winding of beads differs from winding beads at the lamp in that in the former process, beads are wound directly from a crucible of molten glass in a furnace rather than melting the end of a glass rod over a flame and winding a strand around a mandrel. While Sackur (1861) attributes the invention of furnace winding to the Fichtelgebirge beadmakers, it was a process already described by Theophilus to make rings in Europe during the 12th century and likely used well before that. He prescribed the use of a mandrel composed of a wooden handle about a finger thick and a span (23 cm) long which is fitted into a socketed, tapered iron spit about a foot long with a sharp tip. A wooden disk a palm (7.5-10 cm) in diameter is situated about a third of the way down the handle. The tip of the tool is dipped into a pot of molten glass in the furnace and a glob of glass is taken up on it. The tip is then driven into a wooden post next to the worker to produce the hole. The perforated glob is then immediately reheated in the furnace and the mandrel struck against the post two times to loosen and stretch the glass. The mandrel is then rotated rapidly and by this action the ring is worked down to the disk and rendered uniform and smooth in the process. The ring is then dropped into a little trough (Hawthorne and Smith 1979:73-74).

The Fichtelgebirge beadmaker's principal tools were two iron mandrels (*Perleneisen* or *Paterleisen*) and a blade-like iron tool or hammer to aid in removing beads from the mandrel. The mandrels may originally have been simple iron wires with pointed tips but by the 19th century they were iron rods 0.8-1.6 m in length and up to 1.0 cm in diameter at the handle end. The working end narrowed to whatever diameter was required for a specific bead size and was tapered slightly to aid in removing beads from the mandrel (Sackur 1861; Vierke 2006:370-372).

In the production process, the beadmaker sat on a stool in front of the work hole (Figure 4). To protect his eyes he wore a pair of metal-rimmed goggles. A two-pronged iron fork was driven into the ground on his left side and served to hold his mandrels. These had to be handled carefully because if the working end became bent or misaligned, it would throw the tool out of balance and hamper bead formation. Two mandrels were generally used so that as the beads on one mandrel cooled in the fork, new beads could be formed on the other one, thereby increasing production (Vierke 2006:370-371).

To begin, the working end of the mandrel is generally dipped in a kaolin bath to serve as a separator to facilitate bead removal. To make a single large bead, the worker dips

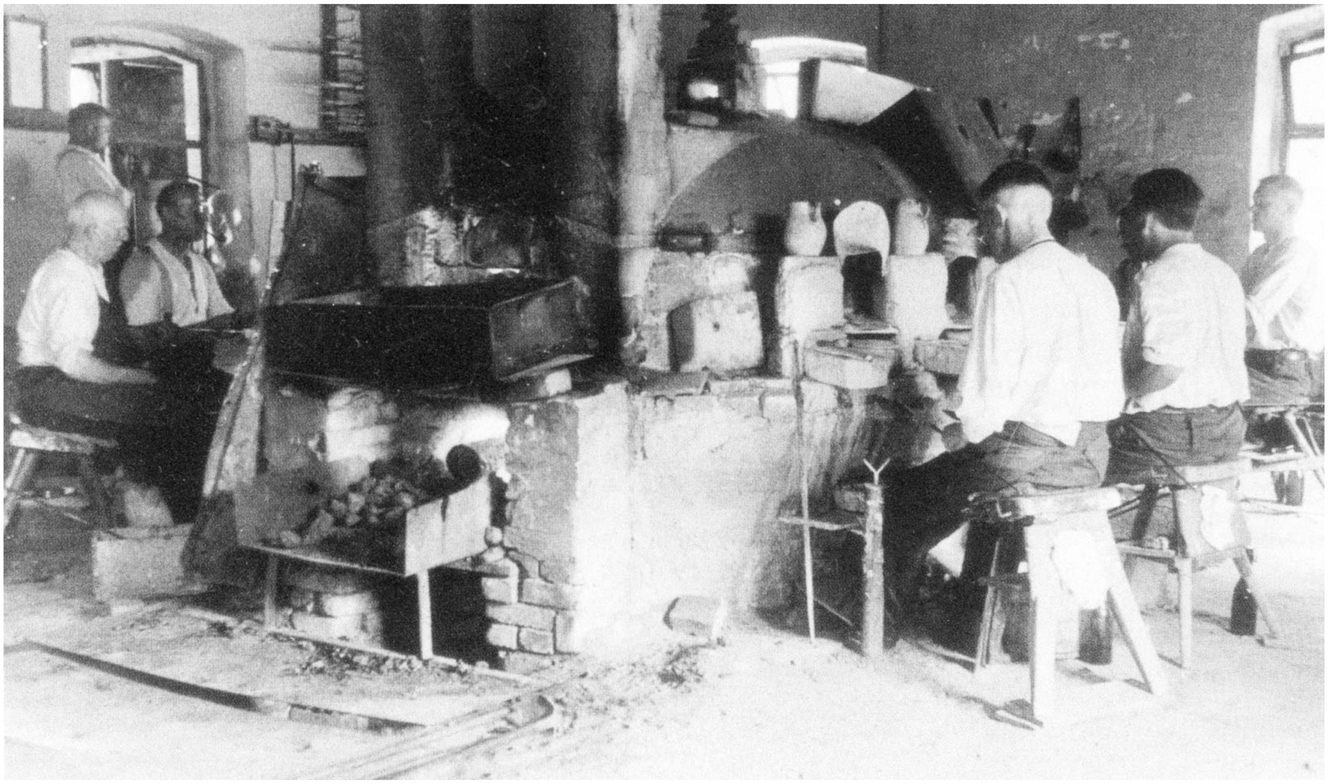

Figure 4. Beadmakers at work in a Warmensteinach *Paterlhütte*, 1930s (Herrmann 2008:21).

the tip of the mandrel into the molten glass in the crucible and removes a small gather which is quickly wound around the mandrel. It is then removed from the furnace and rotated in a wooden mold to impart the final desired shape. Shaping could also be performed by striking the viscid bead with a hammer which imparted flat facet-like features (Vierke 2006:372).

To produce a series of smaller beads, a strand of glass is raised from the crucible and wrapped around the mandrel to form a bead. Without breaking the strand, the mandrel is rapidly moved slightly upward, anchoring the thread next to the first bead and wrapping it around the mandrel to form another bead. The process is continued until the end of the mandrel is reached (Figure 5), each bead in the series being connected to the next one by a thin strand of glass. When the beads are sufficiently cool, the mandrel is struck smartly with a hammer or the blade-like tool to separate the beads from the mandrel and they fall into the annealing box. This process must be done carefully so as not to crack or shatter the newly formed beads. This beadmaking process obviously requires a great deal of skill and an experienced worker takes pride in seeing how close to each other he can place the beads (Vierke 2006:371-372).

In an alternative method for producing multiple beads, the mandrel is not coated with clay. A bead is formed at the tip of the mandrel which is then struck and raised so that the bead is loosened and slips down to the base of the working end. Successive beads are formed in a like manner. In this case the beads are not connected to each other by a thread of glass as in the previous method, thereby producing beads without small broken projections at the ends (Vierke 2006:371).

Once the beads have been properly cooled, those made in a connected series must be separated. This is sometimes done by placing the beads in a sieve and shaking them. The projections break off and fall through the sieve. Another method involves placing the beads in a sack or cloth and agitating it to break them apart followed by sieving. In either case, the beads are then washed and polished by shaking them in bags of bran for 20 minutes or so (Vierke 2006:376-377). The beads are subsequently strung and packed in bundles for shipment worldwide.

BEAD PRODUCTION

The beadmakers worked in 12-hour shifts, one from noon to midnight and the next from midnight to noon, seven days a week. This did not change until the late 19th century when some huts initiated a 6- or 8-hour shift. In the

Figure 5. Beadmaker at the Lindner Trasslhütte in Warmensteinach, ca. 1960, with a series of beads on his mandrel (Herrmann 2008:28).

1920s, the standard shift became six hours with Sundays off (Vierke 2006:381).

According to Flurl (1792:473) the *Paterlhütten* operated from August to Easter. This gave the workers, many of whom were small-scale farmers, part of the spring and summer to undertake agricultural activities. It also allowed woodcutters to cut the large amounts of wood required to fuel the furnaces for the following season.

Sackur (1861) noted that a good beadmaker in the Fichtelgebirge produced about 5,000 of the smaller beads in a workday (12 hours). In a week, a glass house could produce about 500,000 beads of all sizes, which is about 8 to 12 centner (400-600 kg) of glass. Since these products were manufactured in 12 glass houses in that neighborhood, this amounted to a weekly production of 6 million beads.

Veh (1965:100) reports that in the 1930s, a worker could produce 20-36 beads per minute, depending on their size, which reflects a substantial increase in productivity over that mentioned by Sackur 70 years earlier. Unfortunately, increased productivity generally resulted in decreased quality. Beads fashioned in the 19th century were well formed while those made in the 20th century are generally less uniform in shape.

All the beadmakers were men although children were also allowed to make beads during the latter part of the 19th century. They readily learned the production process and their nimble fingers deftly worked the mandrels. Women, on the other hand, were never involved in the manufacturing process but did string the beads (Vierke 2006:369).

BUTTONS AND BEADS OF THE FICHTELGEBIRGE

Although a number of glassmaking sites exist in the Fichtelgebirge, only one has thus far been investigated archaeologically. Attributed to ca. 1616-1630, the "Proterobas Glasshütte" is located on the southern slope of the Ochsenkopf in an area known as the "Wolfslohe" near the small town of Neubau. Excavations conducted there during 2004-2006 under the direction of Dr. Peter Steppuhn (2005, 2008) and Dr. Anja Heidenreich (2007) revealed the foundation of a square 3x3 m stone glassworking furnace (Figure 6) with crucible fragments and a great amount of production waste in association. The furnace likely had an arched superstructure with 4-5 crucibles and an equal number of workstations (Steppuhn 2008:107).

The recovered materials reveal that the principal products were black Proterobas buttons, medium- to low-domed ball types with iron loop shanks (Figure 7). Some were quite fancy, having been decorated with various colored enamels. A number of ball buttons composed of blue and green glass were also recovered (Steppuhn 2008:107), as were fragments of like colored *Waldglas* (forest glass) vessels, some decorated with elaborate enameled decoration, and circular window panes with folded edges (Heidenreich 2007).

Spindle whorls were also in evidence. Up to 4 cm in diameter, these were primarily made of Proterobas and ranged from oblates or somewhat dome shaped to doughnut forms, depending on the size of the perforation (Figure 8). A few globular and ovoid Proterobas beads were also present, as were a number of black tube segments which suggest that the drawing of tubes, possibly for beads, was also practiced here. The tubes were 22-28 mm in length and 3.3-3.9 mm in diameter.

Based on the material recovered from the Wolfslohe site and surface collected in the general vicinity, the most distinctive products of the early Fichtelgebirge furnace-

Figure 6. The foundation of the "Proterobas Glashütte" furnace on the Oschenkopf looking southwest (courtesy of Dr. Anja Heidenreich).

wound cottage industry are those made of Proterobas which was utilized nowhere else. The buttons are generally in the form of low domes around 8-18 mm in diameter. The early ones had iron loop shanks but these were eventually replaced by those of brass. Most are plain but there are many examples with molded designs or ground surfaces and facets. Some buttons exhibit colorful flower-like enamel decoration (Figure 9). When exactly Proterobas buttons began to be made and when production ceased has yet to be determined but in North America they seem to be restricted to the 16th and 17th centuries (Cofield 2014; Pratt 1961:10; Beverly A. Straube 2014: pers. comm.), though Heinrich Scherber mentions the production of Proterobas buttons and beads in the Fichtelgebirge in 1811 (Schaller 1989).

Proterobas beads are less common. Those examined range from oblate to globular forms measuring 8-10 mm in diameter to oblong forms 14-16 mm in length and 7-8 mm in diameter. The globular group includes plain specimens as well as those with a lattice pattern in white or yellow enamel around the equator or white squiggles scattered over the surface (Warmensteinach 2013) (Figure 10). Another form consists of a lobed oblate (Figure 11).

A unique fragmentary tabular Proterobas bead about 20 mm long has a star and the likeness of Christ on the cross on one side and the letters [I]HS on the other (Figure 12) which is the monogram of Christ. It was found in the vicinity of Bischofsgrün. Near identical specimens in black (Proterobas?) and transparent ultramarine glass have been found in Amsterdam (Jamey D. Allen 2014: pers. comm.). They are doubtless related to the tabular beads that depict Mary holding the baby Jesus also found in Amsterdam (Jamey D. Allen 2014: pers. comm.) and are morphologically identical to the man-in-the-moon beads found in eastern North America. Assigned to the period 1670-1760, the latter were believed to have been made in Venice and traded through Holland (Lorenzini and Karklins 2000-2001)

Figure 7. Black Proterobas buttons from the Oschenkopf furnace site (photo: W. Ullmann).

Figure 8. Proterobas spindle whorls and possible beads from the Oschenkopf (photo: W. Ullmann).

Figure 9. Decorated Proterobas buttons as well as a glass face button from the Oschenkopf site (photo: Manfred Sieber).

Figure 10. Globular beads decorated with enamel patterns found at the Hüttenhaus, likely 18th century (Warmensteinach 2013).

Figure 11. Lobed Proterobas bead, 17th century, Oschenkopf.

but it now seems that they may all have originated in the Fichtelgebirge.

As for non-Proterobas beads, a form that likely originated in the Fichtelgebirge is the pentagonal-faceted bead which has eight pentagonal facets pressed into it while the glass was still viscid. A dark amber colored specimen 17.5 mm in diameter was surface collected in the vicinity of Bischofsgrün (Figure 13). While a single surface find cannot be taken as proof for local production, the likelihood is there. Beads of this form have been found at North American sites occupied from about 1650 to 1833 but are most common from about 1700 to 1760 (Karklins and Barka 1989:74).

Possibly as early as the latter part of the 17th century and well into the 20th century, the Fichtelgebirge beadmakers also turned out very large globular (Figure 14) and oval (pigeon egg) forms. Another Fichtelgebirge form is the annular or ring bead (Figure 15, upper center). These are "the ringel perle of Germany" that the American explorer

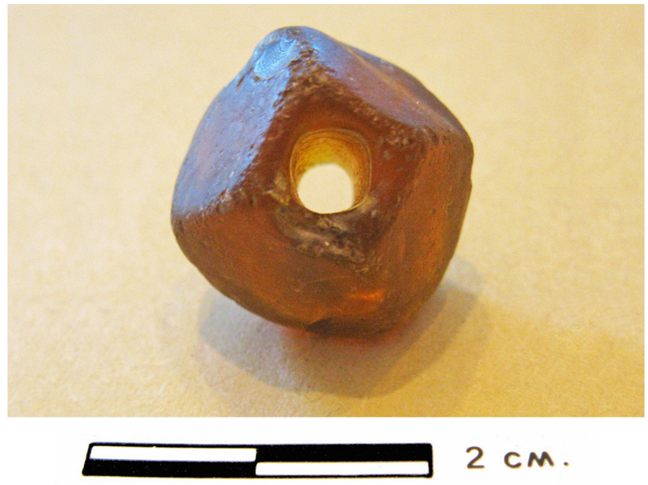

Figure 13. Pentagonal-faceted bead, vicinity of Bischofsgrün.

Richard Burton (1860:393) mentions in the narrative of his travels in Central Africa. They continued to be made in various colors well into the 20th century.

Beadwork made in the Fichtelgebirge during the 19th century incorporates locally made beads. A beaded valence on exhibit at the Fichtelgebirgsmuseum in Wunsiedel is composed primarily of well-formed and uniformly sized doughnut-shaped beads (Figure 16). This piece also incorporates polyhedral bugle beads which were likely obtained from Bohemia so not just local beads were utilized.

Based on surface finds at the Glasperlenhütte Herrmann in Birnstengel (1882-1957) and in Mehlmeisel (1867-1938), the most common beads produced during the late 19th and 20th centuries consist primarily of oblate, round, oval, and ring forms. These came in at least 36 colors and up to 16 sizes (Figure 17). They are generally irregular in form.

Figure 12. Proterobas bead with a star and the likeness of Christ on the cross on one side and the letters [I]HS on the other.

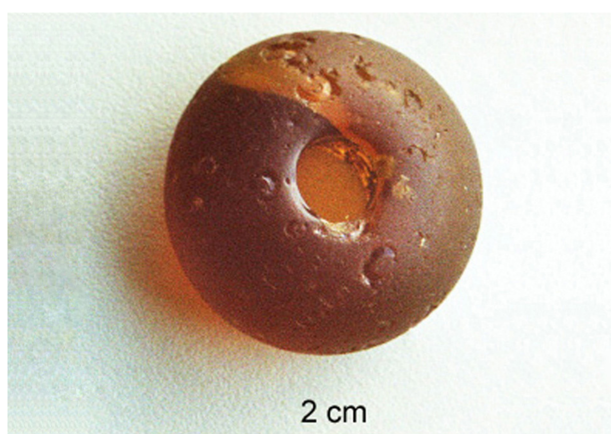

Figure 14. Globular, furnace-wound bead of amber-colored glass surface collected in the Fichtelgebirge (photo: S. Jargstorf).

Figure 15. Group of furnace-wound beads from the Paterlhütte Hermann, Birnstengel, late 19th-20th centuries. The Prosser-molded beads in the upper left are likely imports (photo: Manfred Sieber).

Another distinctive form is the "waffle" bead which appears to have been made during the 20th century. It generally consists of a slightly drop-shaped bead that has been pressed flat parallel to the perforation with a tool that had either a crosshatched pattern cut into it or just a series of parallel lines (Figure 18). Pendants with similar crosshatched decoration but made using molds have purportedly been produced in the Czech Republic.

In addition to the furnace-wound beads mentioned above, blown beads were also produced by some individuals in their cottages. Goldfuss and Bischof (1817:324) relate that some farming families in Bischofsgrün manufactured round and elongated beads from white and colored glass with the aid of a blowpipe. They dipped the end of the hot bead in molten tin and sucked it into the bead and then immediately blew it out again. This imparted a thin film of tin on the interior surface which displayed a beautiful play of colors. Being more fragile and expensive than furnace-wound beads, they did not sell well and were only made in small quantities during free time. Assigned to the 17th century, a strand of very large globular blown beads (Figure 19) that is attributed to the Fichtelgebirge is on display at the Historisches Museum Bayreuth.

When the Sudeten Germans were expelled from Czechoslovakia following World War II, many moved to the Fichtelgebirge area and began to produce both mold-pressed and lamp-wound beads in various forms.

COMPOSITIONAL ANALYSIS

In order to obtain a chemical profile for the beads and buttons produced in the Fichtelgebirge that may aid in the identification of these products in archaeological or ethnographic collections, samples were obtained of some of the material excavated at the Wolfslohe furnace site and surface collected at former beadmaking sites in and around Bischofsgrün, Mehlmeisel, and Warmensteinach. For comparative purposes, beads and buttons likely of Bavarian origin were obtained from generally well-dated archaeological contexts in North America, Europe, and Africa.

While the Wolfslohe material comes from sealed contexts attributed to ca. 1616-1630, the surface material can only be roughly dated to the 18th-19th centuries and the 20th century. While this is not an ideal situation, the

Figure 16. Detail of a 19th-century beaded valence made in the Fichtelgebirge region incorporating small, locally made furnace-wound beads with pink bugle beads likely imported from Bohemia (Fichtelgebirgsmuseum, Wunsiedel).

material nevertheless provides much useful information regarding the chemical composition of Fichtelgebirge beads and buttons over time.

The 41 samples were analyzed by Laure Dussubieux (2016) of the Elemental Analysis Facility, The Field Museum, Chicago, using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). The lab numbers are designated KAR in the tables below. The specimens fall into five groups: low-soda/low-potash glass (Proterobas) (9 specimens), high-potash glass (13 specimens), high-soda glass (14 specimens), mixed-alkali glass (3 specimens), and lead glass (2 specimens).

Low-Soda/Low-Potash Glass (Proterobas)

A piece of melted Proterobas (KAR 1) and four Proterobas ball button rejects (KAR 2-5) from the Wolfslohe and nearby find sites were found to contain low soda (2.1-3.2%) and potash (1.2-4.1%) but high concentrations of alumina (13.6-16.9%), lime (9.5-13.1%), magnesia (7.0-9.2%), and iron (6.6-11%). The latter is certainly responsible for the color of the glass.

To determine if 17th-century black ball buttons found in eastern North America derived from the Fichtelgebirge, specimens (KAR 23-26) excavated at several sites in Maryland, Virginia, and South Carolina were analyzed as well (Table 3). Their form, dimensions, and composition mesh nicely with those of the Wolfslohe specimens.

High-Potash Glass

Five Fichtelgebirge samples (Table 4) have high concentrations of potash and lime that are characteristic of glass manufactured using forest plant ash in parts of Europe beginning in the medieval period. Two of these are clear *Waldglas* vessel fragments with a slight greenish tint (KAR 6, 7) from the Wolfslohe site which contain 11.6-12.5% potash with 1.5-1.8% soda, 2.4-2.7% alumina, 14.0-15.0% lime, 2.7-3.5% magnesia, 0.87-1.04% iron, 708-1019 ppm titanium, and 1770-2388 ppm barium.

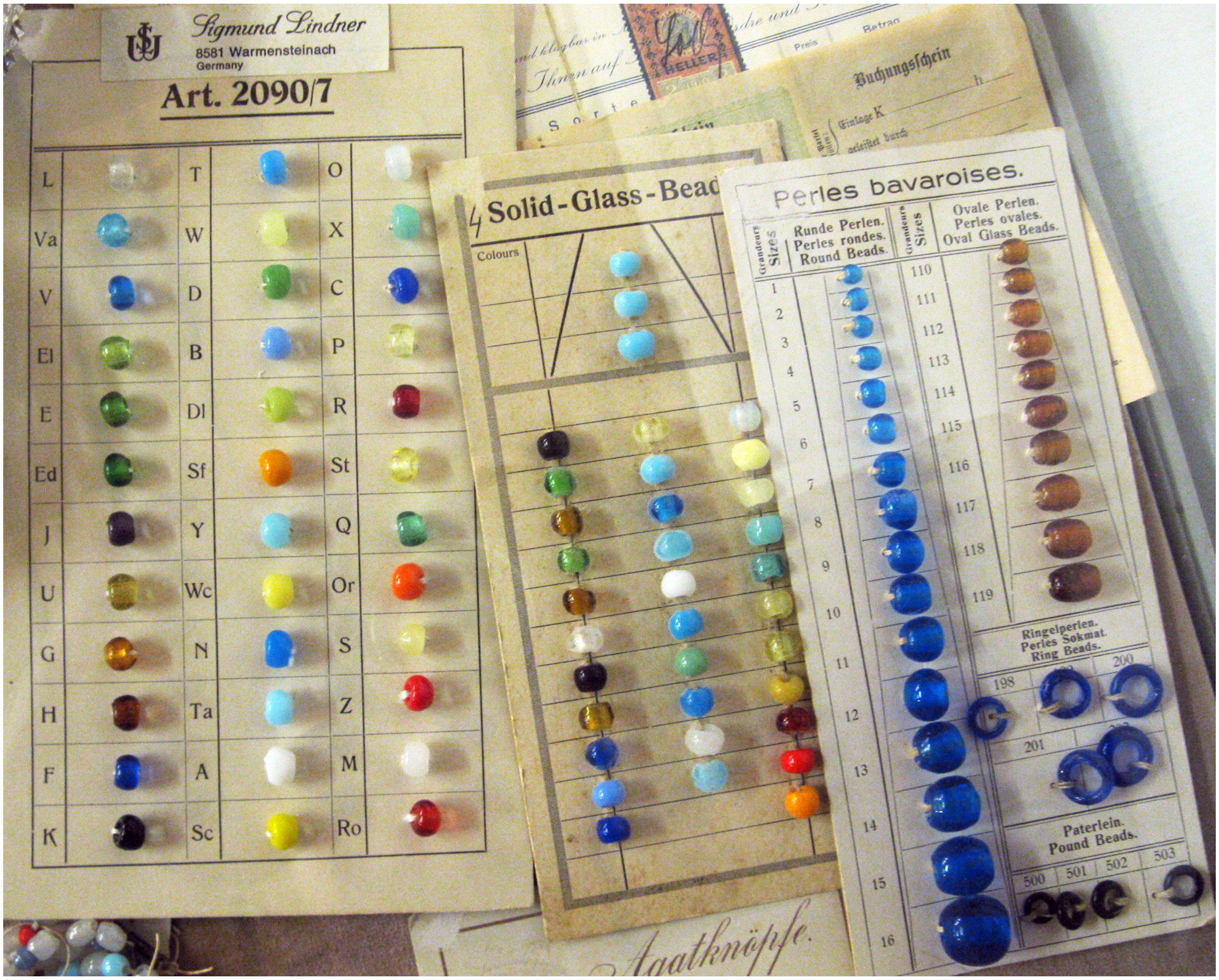

Figure 17. Sample cards of furnace-wound beads produced in the Fichtelgebirge, 20th century (Glasmuseum Warmensteinach). The card on the right is attributed to Paterlhütte Hermann, 1942 (Vierke 2006:131).

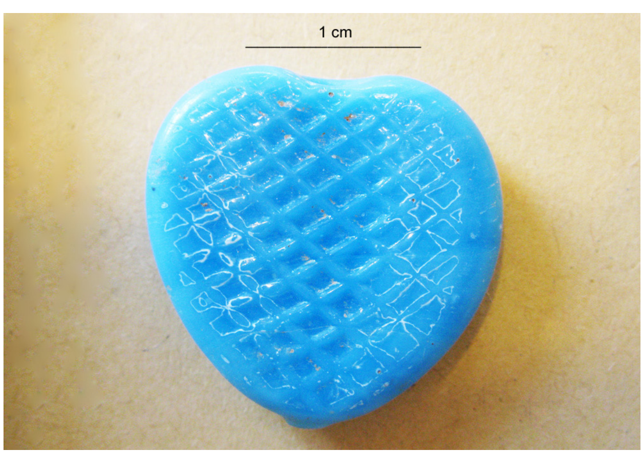

Figure 18. "Waffle" bead from Paterlhütte Herrmann, Birnstengel, 20th century.

Figure 19. Strand of very large globular blown beads in whitish glass attributed to the Fichtelgebirge; 17th century (Historisches Museum Bayreuth).

Table 3. Low-Soda/Low-Potash (Proterobas) Glass Samples.

Lab No.	Description	Source	Date
1	Proterobas waster; op. black	Fichtelgebirge: Wolfslohe	1616-1630
2	Ball button; op. black. D: 14.0, H: 9.9.	Fichtelgebirge: Wolfslohe	1616-1630
3	Ball button; op. black. D: 13.3, H: 8.2.	Fichtelgebirge: Wolfslohe	1616-1630
4	Ball button; op. black. D: 17.0+, H: 7.7.	Fichtelgebirge: Bischofsgrün/Birnstengel	1st half 17th C ?
5	Ball button; op. black. D: 14.5, H: 7.5.	Fichtelgebirge: Bischofsgrün	1st half 17th C ?
23	Ball button; op. black. D: 12.4, H: 8.7.	Jamestown, VA	ca. 1610-1640
24	Ball button; op. black. D: 12.8, H: 7.6.	St. Giles Kusso, SC	1674-1682
25	Ball button; op. black. D: 16.0+, H: 8.3.	Mattapany-Sewall, MD	ca. 1666-1740
26	Ball button; op. black. D: 11.3+, H: 7.4.	Posey Site, MD	ca. 1650-1680
Measurements are in mm. D = Diameter, H = Height.			

Three furnace-wound beads (KAR 9, 11, 13) surface collected at an unspecified site in the Fichtelgebirge and attributed to the 18th-19th centuries also have high potash concentrations (14.6-20.7%) with 1.4-2.5% soda, 0.6-0.9% alumina, 8.9-9.6% lime, 0.3-0.4% magnesia, 0.18-0.2% iron, and 270.4-743.0 ppm of arsenic. KAR 9 and 11 have relatively high phosphorus concentrations (5.5-6.6%) while KAR 13 contains only 0.2%. The low phosphorus could be explained by the use of different types of forest plant ash as a flux.

Attributed to the 18th-19th centuries and unearthed in North Holland (KAR 21, 22), the central United States (KAR 29, 31, 32), The Gambia (KAR 39), and general West Africa (KAR 35, 36), eight likely furnace-wound beads in the comparative group have similar compositions. The potash concentration is at 12.9-18.9% with 0.6-1.5% alumina, 8.2-10.9% lime, 0.3-1.3% magnesia, and 0.11-0.56% iron. Soda content is generally 0.5-2.3% but elevated to 5.3% in one of the West African beads (KAR 36). Arsenic content is very variable ranging from a low of 45.4-165.0 ppm in the African specimens to 919.5-2962.5 ppm in the American specimens and one of the Dutch beads (KAR 21). The beads from Holland and the United States – all of which are blue – have cobalt as the colorant and arsenic is often associated with cobalt. Thus, there is the possibility that the variability in the concentration of arsenic is related to the purity of the cobalt used to color the glass or the amount used. Arsenic was, however, also used to clarify glass or as a refining agent so that may be another explanation.

Figure 20. High-potash glass, Fichtelgebirge (KAR 9). This variety was the most expensive, made with the addition of calcined bone ash (Vierke 2006:364 fn.).

As for phosphorus, three beads – one from The Gambia (KAR 39) and two from the United States (KAR 29, 32) – contain only 0.2-0.5%, a match with KAR 13. The phosphorus content of the other beads is 4.0-7.7% which is in keeping with the other two Fichtelgebirge potash-glass beads.

Generally speaking, aside from the variable arsenic concentrations, the beads in the comparative group are very similar in their compositions to the Fichtelgebirge specimens and may well have originated there.

High-Soda Glass

Seven furnace-wound beads surface collected at several beadmaking sites in the Fichtelgebirge are composed of

Table 4. High-Potash Glass Samples.

Lab No.	Description	Source	Date	Figure No.
6	Waldglas; vessel fragment; light green	Fichtelgebirge: Wolfslohe	1616-1630	
7	Waldglas; vessel fragment; light green	Fichtelgebirge: Wolfslohe	1616-1630	
9	WIb*. Globular; tsl. pale blue. D: 21.2, L: 18.0.	Fichtelgebirge: surface	18th or 19th C	20
11	WIb*. Globular; tsp. ultramarine (opaline). D: 10.6, L: 9.0.	Fichtelgebirge: surface	18th or 19th C	21 (LEFT, Lt)
13	WId*. Doughnut; tsp. redwood. D: 10.8, L: 6.5.	Fichtelgebirge: surface	18th or 19th C	21 (LEFT, Rt)
21	WIb*. Globular; tsl. dusk blue (opaline). D: 10.5, L: 8.6.	North Holland	18th or 19th C	21 (CENTER, Lt)
22	WIc*. Oval; tsl. dusk blue (opaline). D: 17.4, L: 22.5.	North Holland	18th or 19th C	21 (CENTER, Rt)
29	WIb16. Oblate; tsp. bright navy. D: 9.4, L: 7.7.	Deapolis Mandan Village, North Dakota	1806-1838	21 (RIGHT, Ct)
31	WIc*. Oval; tsl./op. bright navy. D: 19.0, L: 25.4.	Deapolis Mandan Village, North Dakota	1806-1838	22 (LEFT)
32	WIIf*. Ridged tube; tsp. ultramarine. D: 7.5, L: 7.5.	Deapolis Mandan Village, North Dakota	1806-1838	21 (RIGHT, Rt)
35	WIb*. Barrel-shaped; tsl. pale blue (alabaster). D: 18.5, L: 15.2.	Africa	19th C	22 (CENTER, Lt)
36	WIb*. Barrel-shaped; tsp./tsl. dusk blue (opaline). D: 19.3, L: 17.1.	Africa	19th C	22 (CENTER, Rt)
39	WIb*. Oblate; tsl. wedgewood blue with golden cast. D: 12.7, L: 9.9.	65 Lemain St., Banjul, The Gambia	19th C	22 (RIGHT)

Measurements are in mm: D = Diameter, L = Length. Figures: LEFT, CENTER, and RIGHT designate the frames in the figures. Within each frame: Lt = Left, Ct = Center, Rt = Right.

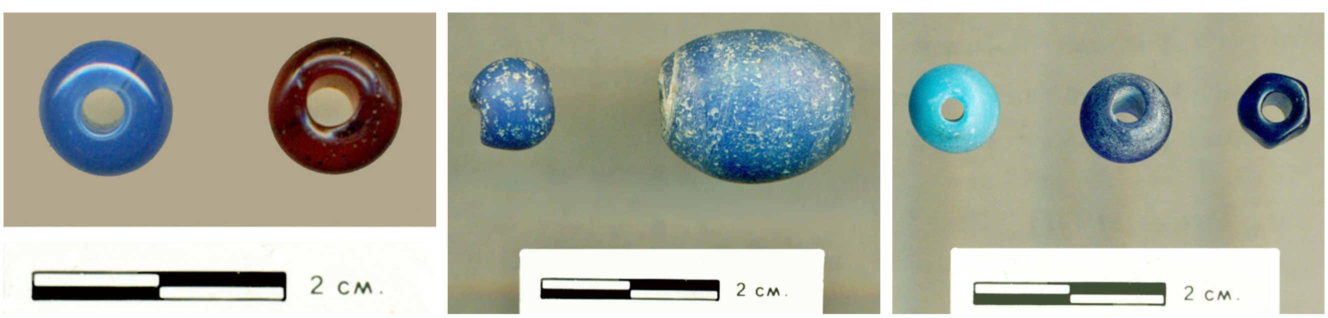

Figure 21. High-potash and mixed-alkali beads. Left: Fichtelgebirge (KAR 11 and 13). Center: North Holland (KAR 21 and 22). Right: Deapolis Village, North Dakota (KAR 28, 29, and 32).

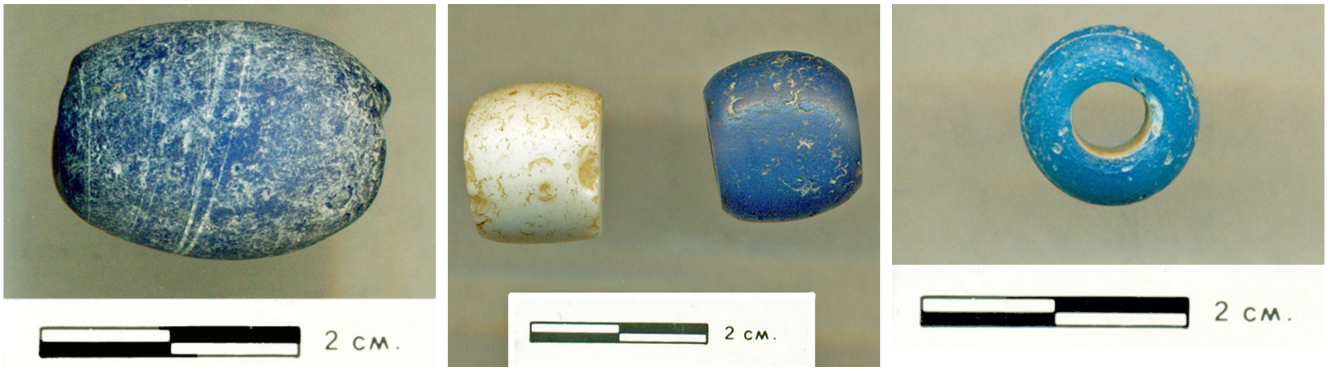

Figure 22. High-potash beads. Left: Deapolis Village (KAR 31). Center: Africa (KAR 35 and 36). Right: The Gambia (KAR 39).

high-soda glass (Table 5). They were likely made during the first half of the 20th century although some may be slightly earlier. The concentration of soda in the glass is 13.4-20.3% with 4.6-15.5% lime and 0.1-0.3% magnesia. Despite the relatively high concentration of potash in all the beads except KAR 20, the low magnesia concentrations (< 1.5%) suggest the use of soda derived from a mineral source. The potash concentration ranging from 2.2 to 5.7 % might be due to the presence of feldspar in the sand. As with the high-potash group, arsenic concentrations are extremely variable, ranging from 5.3 ppm in KAR 18 to 1256.1 ppm in KAR 20. Phosphorus (0.0-0.2%) and chlorine (0.1-0.4%) – which can be impurities in soda – are present in extremely low concentrations, suggesting that the soda used was fairly pure. Antimony is practically non-existent in KAR 15 and 20, but 1116-3557 ppm in the rest. All the beads – with the exception of KAR 17 which is white – are some shade of blue. Half (KAR 15, 19, 20) are colored with cobalt (149.7-374.6 ppm); the others with copper (2228-3378 ppm).

In the comparative group, two high-soda furnace-wound beads (KAR 33-34) from a home-made Native-American-style necklace have compositions that are compatible with those of the Fichtegebirge beads: 18.4-20.3% soda, 3.9-4.0% potash, 6.7-6.9% lime, 0.1% magnesia, with 270.4-743.0 ppm of arsenic and 2955-4818 ppm antimony. Unfortunately, it is presently impossible to determine if they were made before or after World War II.

Three beads (KAR 38, 40, 41) composed of high-soda glass from 18th-19th-centuries contexts in The Gambia also have a high soda content but in this time frame this is not compatible with the composition of contemporary Fichtelgebirge glass. The first two beads are likely lamp wound and quite possibly the products of Venice. From a 19th-century context, KAR 41 is troublesome as it is an annular bead – a staple of the Fichtelgebirge bead industry – with the appearance of being furnace wound. While it is possible that it was lamp wound at another beadmaking center, the likelihood is that it represents the use of soda glass by some of the Fichtelgebirge beadmakers in the 19th century. It is known that soda glass was in use in the Fichtelgebirge by the 1920s but when exactly it was introduced remains to be determined.

Two drawn black beads from 17th-18th-centuries contexts in the United States (KAR 27) and West Africa (KAR 37) were analyzed to see if they were made of Proterobas. Both turned out to be composed of high-soda glass and likely of Venetian origin.

Mixed-Alkali Glass

Two specimens from Bischofsgrün (KAR 8) and Mehlmeisel (KAR 12) and one from a Native American site in North Dakota (KAR 28) are composed of mixed-alkali glass (Table 6) where the concentrations of soda (8.5-11.4%), potash (7.3-10.0%), and lime (9.3-13.8%) are about equal. Phosphorus (an element that is widely present in the high-potash glass) is low (0.0-0.3%), as is antimony (3-57 ppm), and magnesia and iron concentrations are below 1%.

KAR 8 is a black glass "whistle" button attributed to the 1860-1900 period (Janelle Giles 2014: pers. comm.). It was made using ingredients from sources different than for the other two specimens as revealed by trace element concentrations; e.g., U = 19 ppm vs. ~2.7-2.8 ppm in the other two. KAR 12 and 28 are both opaque robin's egg blue and contain ~1% of copper (measured as CuO). They have fairly similar compositions and while not identical, it is likely that KAR 28 originated in the Fichtelgebirge.

It is difficult to explain the composition of these specimens. There are several possibilities, including the use of mixed alkali plant ash or the mixing of high-soda and high-potash glass in equal proportions. Unfortunately, the small sample size precludes an exact determination.

Table 5. High-Soda Glass Samples.

Lab No.	Description	Source	Date	Figure No.
14	WId*. Annular; op. robin's egg blue. D: 12.6, L: 3.0.	Fichtelgebirge: Mehlmeisel	1867-1938	23 (LEFT, 1st)
15	WId*. Annular; tsp. ultramarine. D: 14.0, L: 5.4.	Fichtelgebirge: Mehlmeisel	1867-1938	23 (LEFT, 2nd)
16	WIIdd*. Flattened oblate; tsl./op. light aqua blue. L: 6.3, W: 9.9, T: 5.6.	Fichtelgebirge: Bischofsgrün/Birnstengel	1882-1957	23 (LEFT, 3rd)
17	WIb*. Globular; tsl. white. D: 11.9, L: 9.7.	Fichtelgebirge: Mehlmeisel	1867-1938	23 (LEFT, 4th)
18	WIb*. Oblate; op. light aqua blue. D: 9.3, L: 6.8.	Fichtelgebirge: Warmensteinach	1920s-30s ?	23 (LEFT, 5th)
19	WIb*. Oblate; op. twilight blue. D: 9.2, L: 6.9.	Fichtelgebirge: Bischofsgrün	1920s-30s ?	23 (LEFT, 6th)
20	WII*. Flat "waffle" bead; tsp. ultramarine. L: 19.6, W: ca. 21.0, T: 5.1.	Fichtelgebirge: Mehlmeisel	1867-1938	23 (LEFT, 7th)
27	IIa6/7. Circular/round; op. black. D: 6.1-6.5, L: 4.5-6.3.	Mattapany-Sewall, Maryland	ca. 1666-1740	
33	WIb*. Round; tsl. white. D: 8.8, L: 7.5.	American Indian style hairpipe necklace	20th C	23 (CENTER, Lt)
34	WId*. Donut; op. robin's egg blue. D: 9.8, L: 5.6.	American Indian style hairpipe necklace	20th C	23 (CENTER, Rt)
37	IIa6. Round; op. black. D: 9.8, L: 7.8.	Juffure Factory, The Gambia	18th C	23 (RIGHT, Lt)
38	WIb*. Round; op. black. D: 10.3, L: 8.0.	Juffure Factory, The Gambia	18th C	23 (RIGHT, Rt)
40	WIb16. Round; tsl. bright navy. D: 12.7, L: 12.6.	Juffure Factory, The Gambia	19th C	
41	WId*. Annular; tsp. bright navy. D: 12.7, L: 8.9	Juffure Factory, The Gambia	19th C	

Measurements are in mm: D = Diameter, L = Length, T = Thickness. Figures: LEFT, CENTER, and RIGHT designate the frames in the figures. Within each frame: Lt = Left, Ct = Center, Rt = Right.

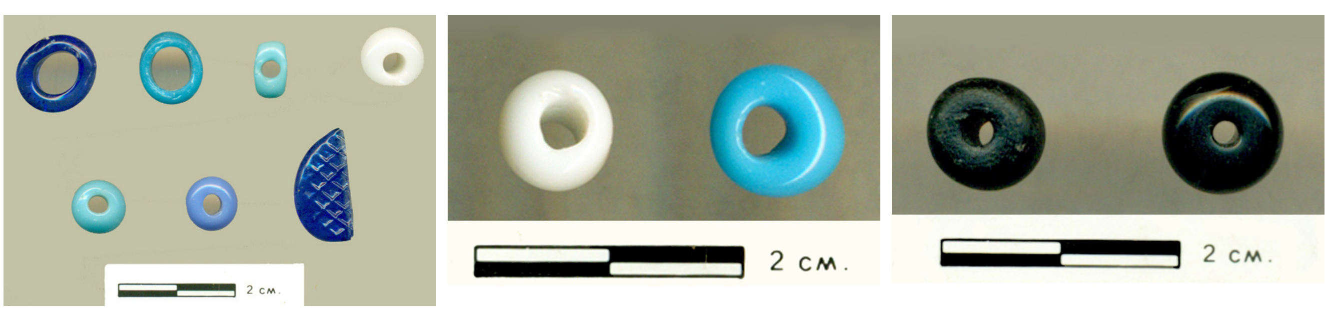

Figure 23. High-soda beads. Left: Fichtelgebirge (KAR 14-20). Center: American Indian style hairpipe necklace components (KAR 33 and 34). Right: The Gambia (KAR 37 and 38).

Table 6. Mixed-Alkali Glass Samples.

Lab No.	Description	Source	Date	Figure No.
8	Button (“whistle” type); op. black. D: 19.0, H: 5.3	Fichtelgebirge: Bischofsgrün	1850-1900	
12	WIb*. Oblate; op. robin’s egg blue. D: 13.0, L: 10.6.	Fichtelgebirge: Mehlmeisel	1867-1938	24 (LEFT)
28	WIb11. Oblate; op. robin’s egg blue. D: 9.7, L: 7.1.	Deapolis Mandan Village, North Dakota	1806-1838	21 (RIGHT, Lt)
Measurements are in mm: D = Diameter, L = Length. Figures: LEFT, CENTER, and RIGHT designate the frames in the figures. Within each frame: Lt = Left, Ct = Center, Rt = Right.				

Figure 24. Mixed-alkali and lead glass. Left: Fichtelgebirge (KAR 12). Center: Fichtelgebirge (KAR 10). Right: Deapolis Village (KAR 30).

Lead Glass

Two beads (Table 7), one (KAR 10) from the Glasperlenhütte Herrmann in Birnstengel and one (KAR 30) from the Deapolis Mandan village in North Dakota, are characterized by high lead concentrations (57% and 48%, respectively) but differ in the rest of their compositions. KAR 10 contains significant concentrations of soda (~5%) and potash (~2.5%) with hardly any lime (0.3%), while KAR 30 contains 3.5% soda, ~5% potash, and 3% lime. The latter is opaque white and contains more than 3% arsenic. It is of a size that intimates furnace winding but the composition is problematic.

KAR 10 is translucent yellow and its color is certainly due to the presence of uranium (4000 ppm). This element was used to impart a range of colors to glass, glaze, and enamel principally between 1840 and 1945 (Vierke 2006:). The composition of the bead, including major, minor, and trace elements as well as coloring agents, is fairly similar to the composition of 19th-century beads possibly manufactured in Venice (Burgess and Dussubieux 2008). On the other hand, Vierke (2006:26) feels that beads containing uranium were likely produced in Bohemia. As the Birnstengel uranium bead is not the only one in the surface collection from that site, it is also possible that uranium beads were produced there as well.

Table 7. Lead Glass Samples.

Lab No.	Description	Source	Date	Figure No.
10	WIb*. Globular; tsl. sunlight yellow. D: 13.6, L: 12.6.	Fichtelgebirge: Bischofsgrün/Birnstengel	1882-1957	24 (CENTER)
30	WIc1. Oval; op. white. D: 14.3, L: 25.5.	Deapolis Mandan Village, North Dakota	1806-1838	24 (RIGHT)
Measurements are in mm: D = Diameter, L = Length. Figures: LEFT, CENTER, and RIGHT designate the frames in the figures.				

DISCUSSION

Over a span of 500 years, the Fichtelgebirge region of Bavaria produced countless tons of furnace-wound buttons and beads which were transported all over the world.[2] Yet very little is known about the exact products of this rather remote region. Archaeological research has so far been restricted to the Wolfslohe furnace site on the Oschenkopf. The finds at this site, which operated ca. 1640, reveal that black ball buttons, several forms of beads, and spindle whorls were the principal products made from Proterobas. Some of these were decorated with various designs which were painted on rather than applied as viscid glass. The distinctive chemical composition of this material makes the identification of Proterobas products relatively simple. Additionally, unlike most black glasses that are translucent on thin edges when held up to a strong light, Proterobas glass is totally opaque. The use of Proterobas to make buttons (and possibly beads) continued until at least 1811 (Schaller 1989).

Glass beads surface collected in the Fichtelgebirge that may be attributed to the 18th-19th centuries based on their similarity to specimens recovered from archaeological sites in the United States include very large round, oblate, donut-shaped, and pentagonal-faceted forms. These forms are commonly found associated at archaeological sites (e.g., Davis 1972; Good 1972; Karklins and Schrire 1991; Mason 1986) with other very large beads that were doubtless furnace wound including oval (pigeon egg), raspberry (clamped in a mold to impart a series of nodes), ridged tube (five-sided cylinder), and disc or tabular specimens, the latter often decorated with a crescent moon, stars, and comets (man-in-the-moon) (Figure 25). All of these forms, excluding the disc beads, are commonly referred to as "Dutch" because many have been found in Amsterdam and other centers in the Netherlands (Karklins 1983) as well as in Dutch contexts around the world (e.g., Karklins and Schrire 1991; van der Sleen 1967). There is, however, no historical nor archaeological evidence for their manufacture in Holland and, considering that they are furnace-wound, they are almost certainly the products of the Fichtelgebirge which were exported from various European ports, including Amsterdam. Based on the three Fichtelgebirge specimens that were analyzed (KAR 9, 11, 13), the beads produced during the 18th and 19th centuries were made using potash glass. Examples of like forms and compositions are present at 18th-19th-centuries sites in Europe, the United States, and Africa (Table 4).

The beads found in the wasters of beadmakers at Birnstengel and Mehlmeisel likely all date to the late 19th and/or early 20th centuries. They are generally made of soda glass though one robin's egg blue specimen from Mehlmeisel and a yellow bead colored with uranium from Birnstengel are composed of mixed-alkali and lead glass, respectively.

While their composition is similar to lampworked Venetian beads, furnace-wound beads do exhibit certain features that may allow them to be distinguished. They are often irregular in form and, since the smaller forms were often made in a series with a thread of glass extending from one bead to the next, may exhibit a small broken projection at either end. The perforations are also generally larger than those of lampworked beads because the mandrels used were thicker, having to withstand the heat of the furnace and the weight of large and heavy or multiple beads.

CONCLUSION

While much is known about the history of the Fichtelgebirge beadmakers and their technology, we still know very little about their products. The excavation of the Wolfslohe furnace site has provided a glimpse at what was made during the mid-17th century, but the 18th and 19th centuries are represented by only a handful of beads and buttons from scattered surface sites in the Fichtelgebirge region. Quite a bit of material has been surface collected at several late 19th-20th-century sites such as Birnstengel and Mehlmeisel, but even here it is not certain which specimens relate to the 19th and early 20th centuries, which to the interwar period, and which to postwar times. It is the fervent hope of the authors that additional sites will be excavated in the region which will help to fill the numerous gaps in our knowledge about what was produced in the Fichtelgebirge *Paterlhütten*, when, and using what ingredients.

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Figure 25. Various forms of furnace-wound beads from the Potawatomi Indian occupation of the Rock Island site (ca. 1670-1730), Wisconsin. Most, if not all, of the beads were likely produced in the Fichtelgebirge (Mason 1986: Color Plate 4, detail; reprinted with permission by The Kent State University Press).

Washburn, ND, for beads from Deapolis Mandan Village; Liza Gijanto, Department of Anthropology, St. Mary's College of Maryland, St. Mary's City, MD, for beads from several sites in The Gambia; and Irmintraut Jasorka, Industrie- und Glasmuseum, Bischofsgrün, Germany, for samples of locally produced beads. Thanks also to Gudrun und Helmut Hempel of the Glasmuseum Warmensteinach, Germany, for not only providing samples of local products but also permitting the photography of museum specimens. Rosemarie Herrmann is thanked for allowing the reproduction of several images of Warmensteinach beadmakers that appear in the book *Warmensteinacher Glass* by her late husband, Harald Herrmann.

ENDNOTES

1. Preiss (2009:145) proposes that the tool (*Zange*) used consisted of a long metal rod with a split end which

expanded slightly towards the tip. The iron button shank was inserted in the split and held in place with a sliding ring.

2. It should be mentioned that furnace-wound beads were also produced in the Bavarian Forest some 160 km to the southeast of the Fichtelgebirge. A *Paternosterhütte* was already operating in Rabenstein near Zwiesel around 1420, and there were several others in Spiegelau, Bodenmais, and other villages during the 15th and 16th centuries (Vierke 2006:55-56). Unfortunately, it is not known how long this bead industry lasted or what exactly it produced.

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