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AN ARCHAEOLOGICAL EXPERIMENT WITH EARLY MEDIEVAL GLASS BEAD PRODUCTION IN AN OPEN HEARTH – THE RESULTS

EKSPERYMENT ARCHEOLOGICZNY Z PRODUKCJĄ W OTWARTYM PALENISKU WCZESNOŚREDNIOWIECZNYCH SZKLANYCH PACIORKÓW – REZULTATY

Abstract: The aim of the experimental research was to verify the hypothesis of glass bead production in an open hearth. In this case, data from archeological excavations in Ribe, where the remains of "glass" hearths were discovered, was utilised. The experiment involved the forming of the hearth, where a clay nozzle in the shape of a loom weight was placed in the centre. The air was pumped into the hearth using bellows equipped with a separate air circulation system. The results of the research indicate that, thanks to such a construction and thanks to the process of charcoal sieving, the manufacturing of simple and more complex glass beads is simple and the hearths themselves are quite effective.

Keywords: Experimental archaeology, bead making, glass beads, Ribe.

INITIAL ISSUES

Researchers dealing with the area of early medieval glass bead production in Scandinavia sooner or later come across experimental research conducted within the field. In most cases they are based on the premise that glasswork in those times was conducted using tiny, clay kilns. Reconstructions of open hearths, where the bottom of the hearth is laid with stones and then coated with clay, can also be found (G r i m b e 2010, G a m 1990).

In her article, T. Gam advances the thesis that in the case of open hearths it was really difficult to avoid pollution of the glass with floating ashes and particles of charcoal. It was also claimed that the process of vitrifying the hearth's surface near the bellows would occur – yet in Ribe such textures on the surface of hearth were not observed. That is why the researcher claims that the air intake was lo-

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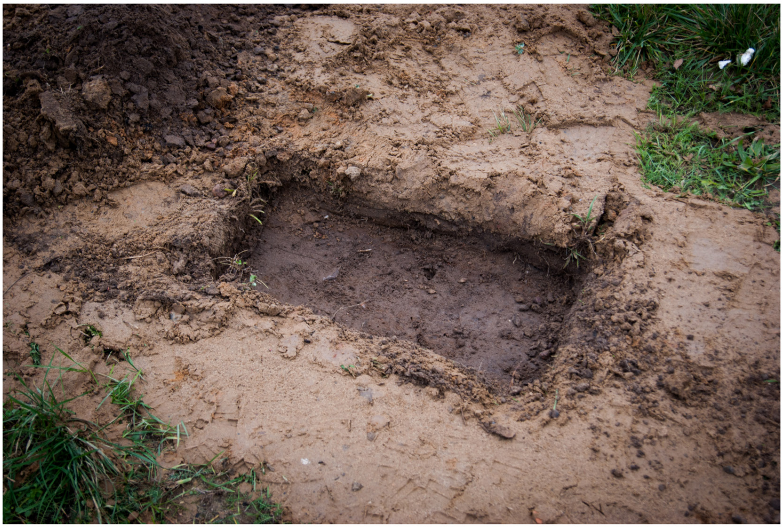

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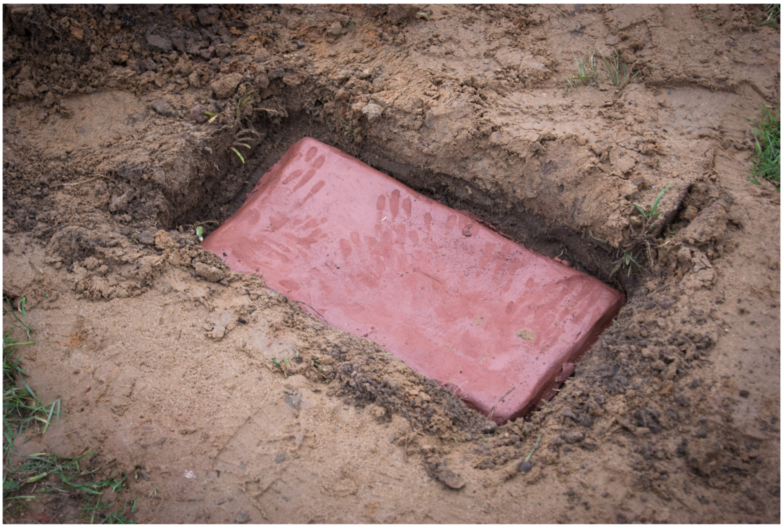

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Fig. 1. Hearth preparation (phot. M. Rutkowski)

A – a hole for hearth, B – plastered hearth

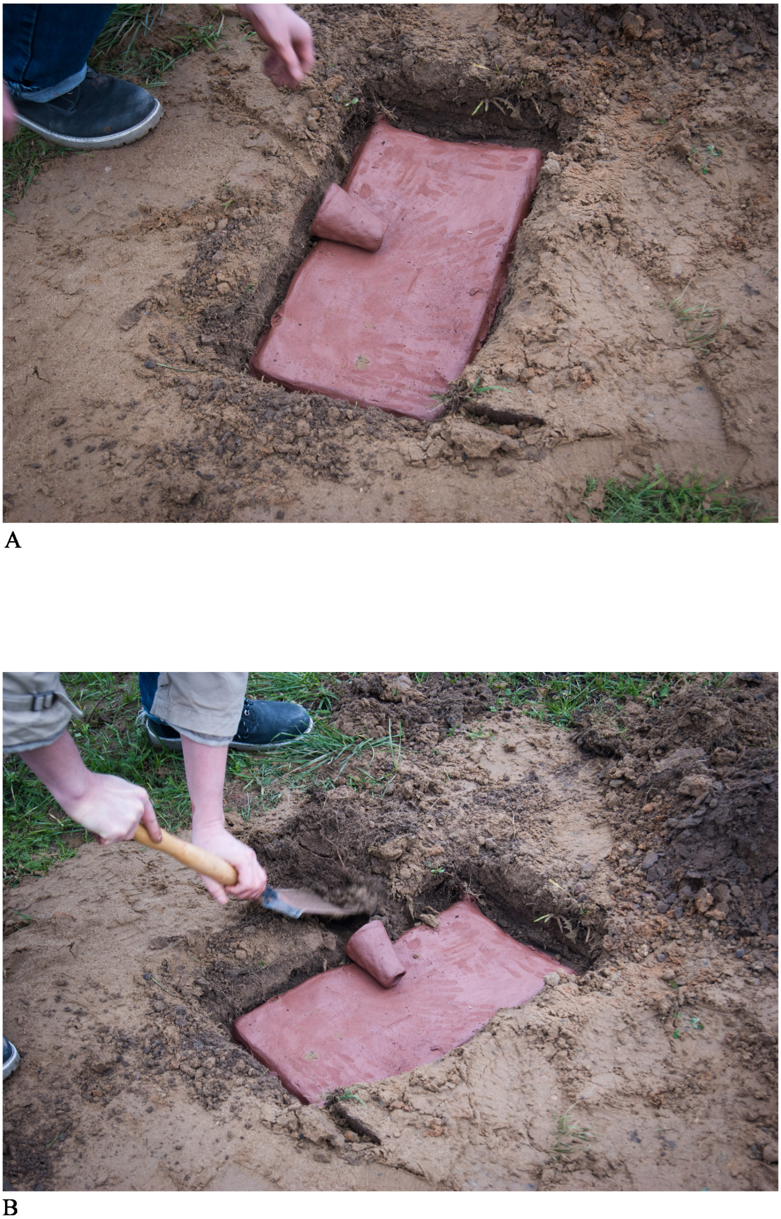
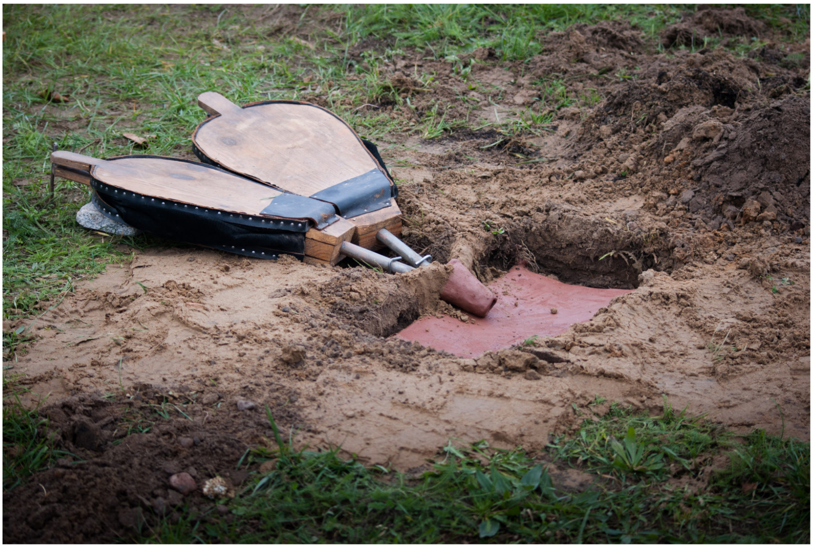


Fig. 2. Placing of nozzle (phot. M. Rutkowski)



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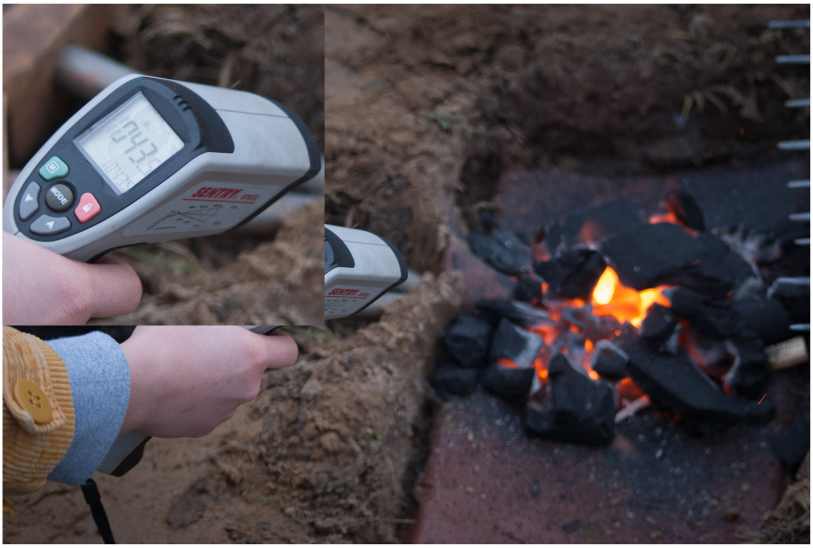

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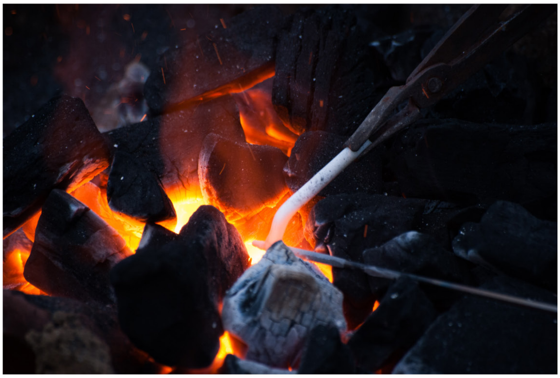
Fig. 3. The prepared hearth (phot. M. Rutkowski)

A – Placing of bellows, B – value of temperature measurement



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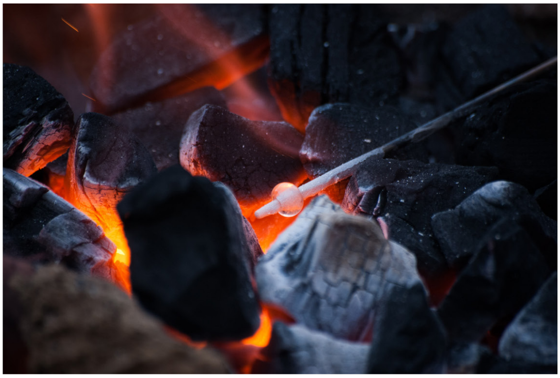

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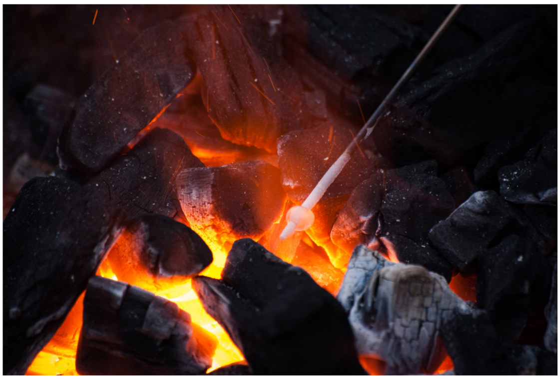

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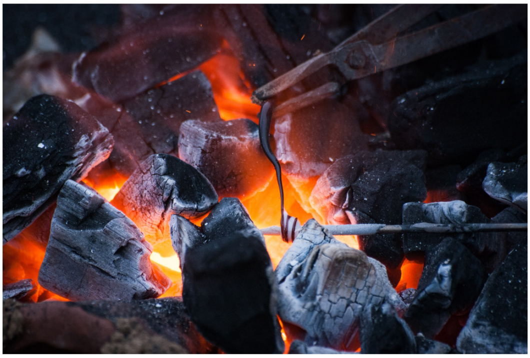
Fig. 4. The making of the base bead (phot. M. Rutkowski)
A – Applying glass on mandrel, B and C – shaping the bead using gravity



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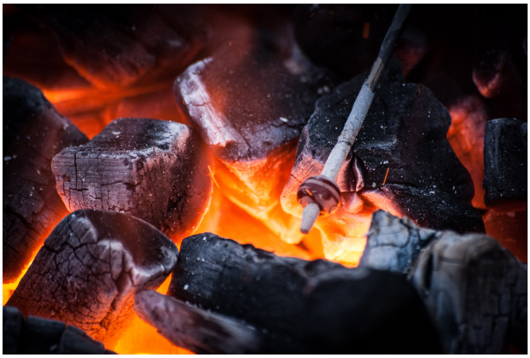

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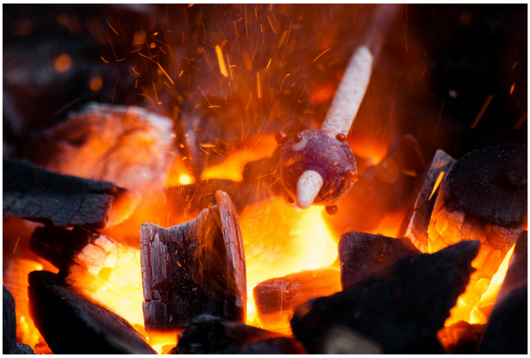

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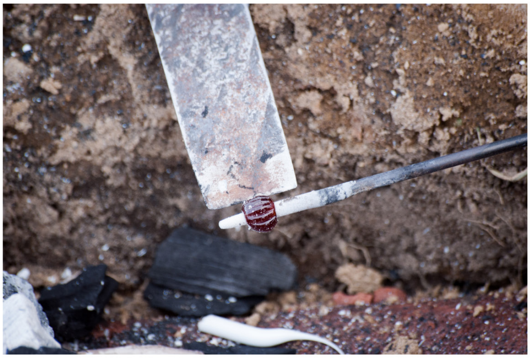
Fig. 5. The making of ornaments (phot. M. Rutkowski)

A – applying lines, B – pattern embedding, C – eye bead

A



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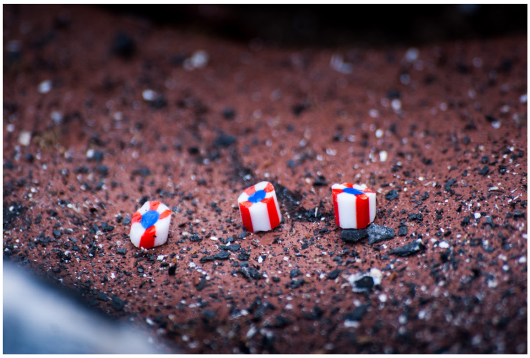

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Fig. 6. The making of beads (phot. M. Rutkowski)
A – base bead, B – chisel cutting, C – preheating mosaic

cated above the clay base – which could indicate the existence of a taller construction, i.e. a kiln (G a m 1990, pp. 209-210).

The article comprises a description of an experiment related to glass bead production in an open hearth on the basis of the remains discovered in Ribe. During the course of the experiment a variety of beads were manufactured, among them single colour, semicircular beads, mellon beads, eye beads, zigzag decorated beads, as well as so-called mosaic beads. These types of beads were selected on the basis of their presence in archeological materials. The experiment was conducted twice; first, on the site of the Archeological Museum in Biskupin during the 20th archeological festival, where the hearth was used every day for 9 days in a row, and second, on the Morasko Campus of Adam Mickiewicz University – photos taken on both sites are included in this article.

ARCHAEOLOGICAL DATA

In the course of archeological research on the site of the craft and trade settlement in Ribe (Denmark), archeologists identified a glass workshop specialising in manufacturing glass beads. Raw materials, production waste, cracked beads and tools used to manufacture glass decorations were all collected. The Ribe discovery, namely of rectangular structures of fired clay from 50 to 60 cm in length and from 20 to 30 cm in width did not display any features indicating the existence of domes or other forms of raised structure which could be taken as a kiln dump. In one the Ribe hearths a clay loom weight in the shape of a cone was discovered, its build and inlet suggesting that it was used as a clay nozzle providing a hearth with oxygen (B e n c a r d 1978).

METHODOLOGY

While planning and conducting the experiment, J. C o l e's (1977; 1997) methodology with later changes by P. R e y n o l d s (1999) was used. The following hypothesis was established – that the manufacture of early medieval glass beads in the workshops situated in Ribe involved the use of specially constructed open hearths. This research hypothesis automatically leads to the rejection of ethnographic analogies from India, Turkey and Africa, which are so often utilised and quoted during such types of experiments. According to us, on grounds of economic and temporal issues it is useless to build a kiln of such small size. Referring to similar constructions from Asia is groundless in relation to medieval Scandinavia, as kilns used to manufacture beads in India are built for up to 10 makers and are therefore much bigger (Jr F r a n c i s 1991). Meanwhile the smaller hearth in Ribe allowed only two craftsmen to manufacture beads at the same time. In the

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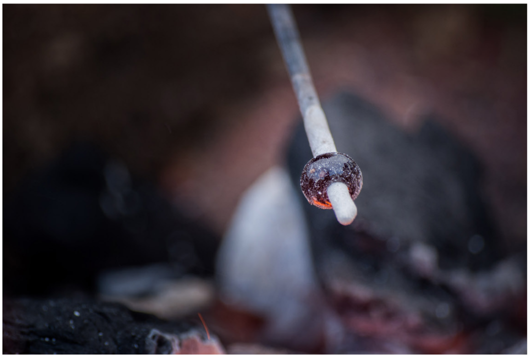

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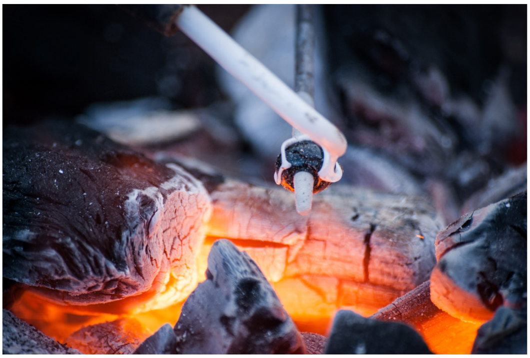

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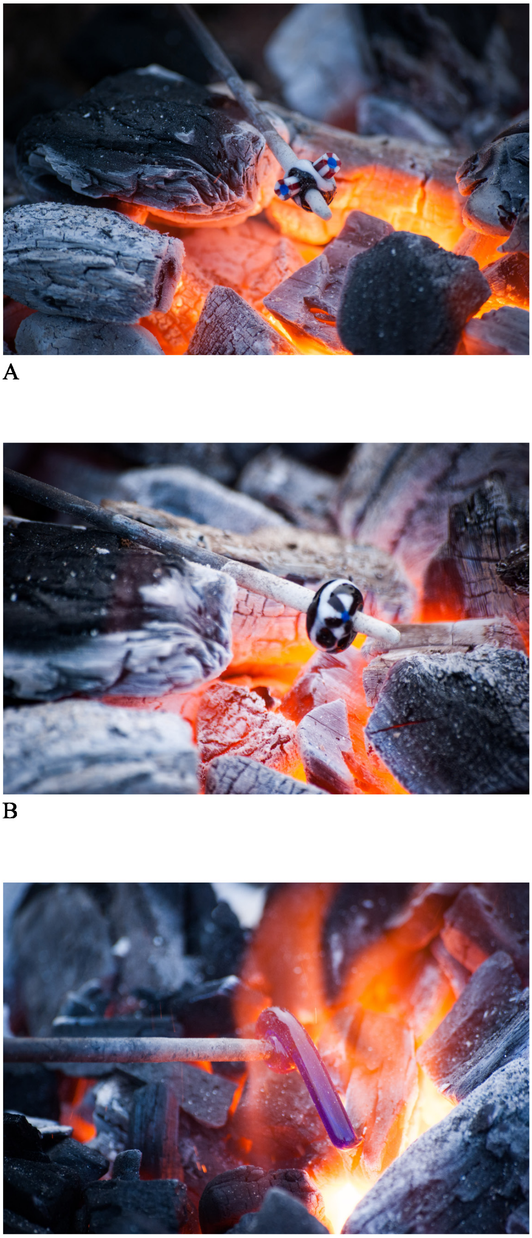
Fig. 7. The making of mosaic bead
(phot. M. Rutkowski)

A – the making of base bead. B – delicate cooling,
C – applying eight shaped pattern



A

B

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Fig. 8. The making of mosaic bead and reticella (phot. M. Rutkowski)

A and B – mosaic embedding, C – applying recitella base

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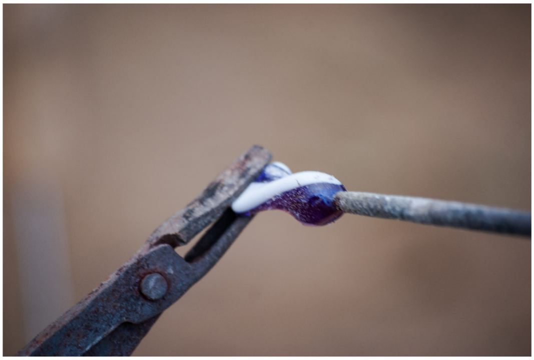

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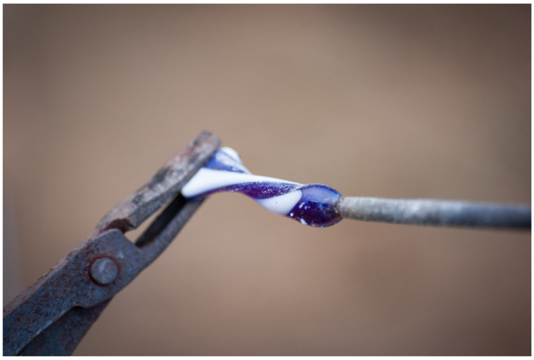

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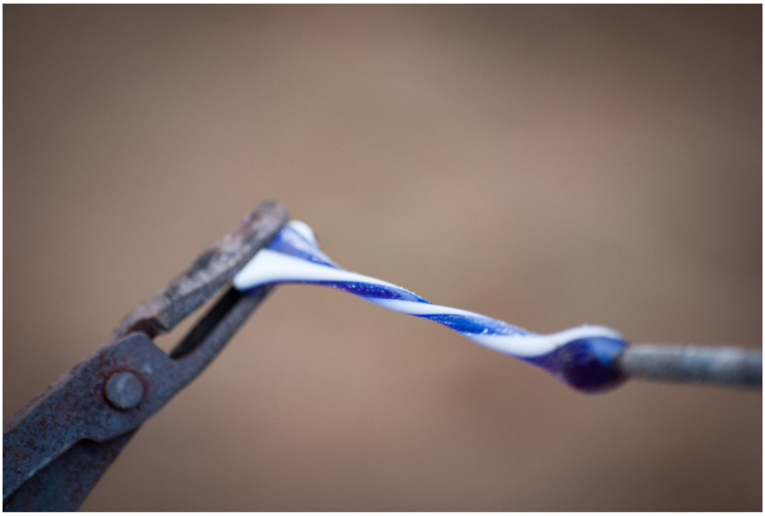
Fig. 9. The making of reticella (phot. M. Rutkowski)

A – cylinder shaping, B – cutting and twisting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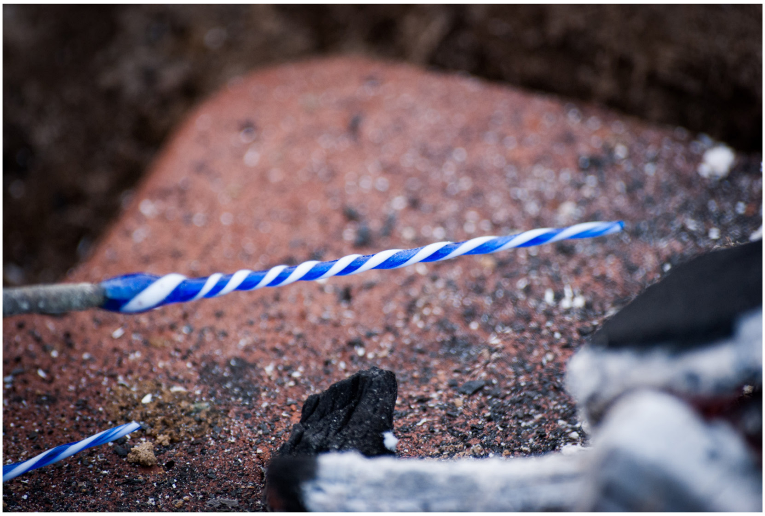
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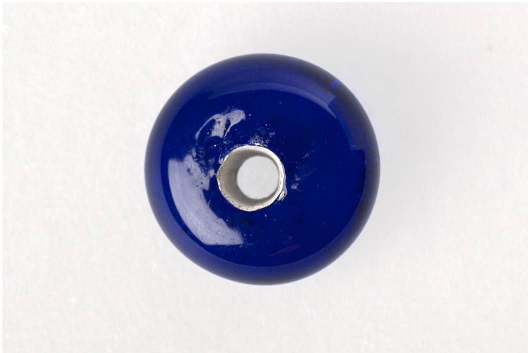
Fig. 10. The making of reticella (phot. M. Rutkowski)
A – taking out and twisting, B – ready-made product



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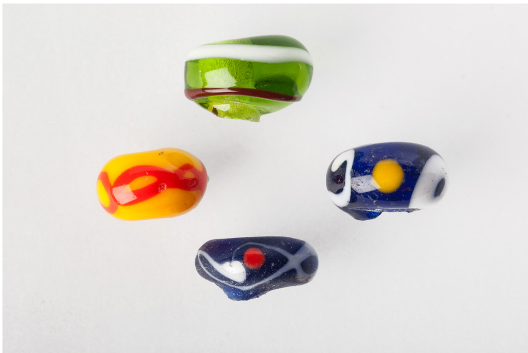

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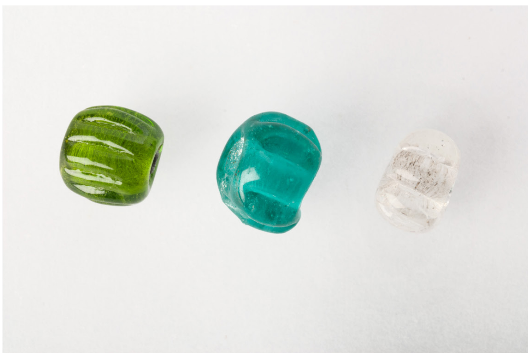

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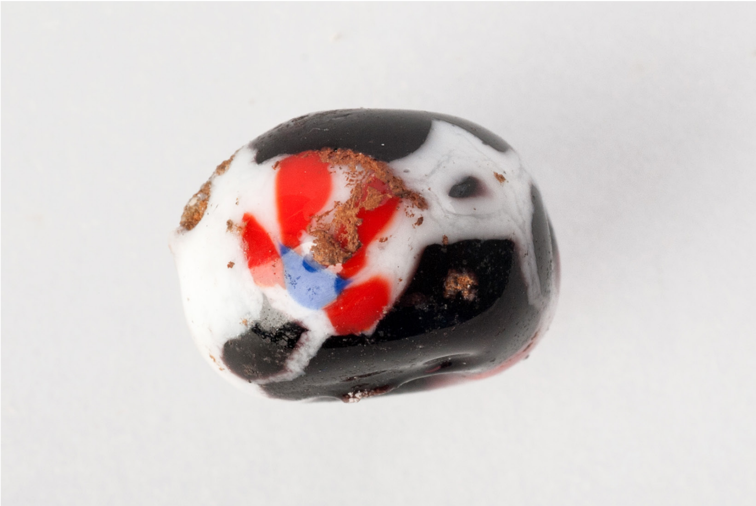
Fig. 11. Ready-made beads (phot. P. Namiota)

A – monochromatic bead, B – ornamented beads, C – melon-shaped beads



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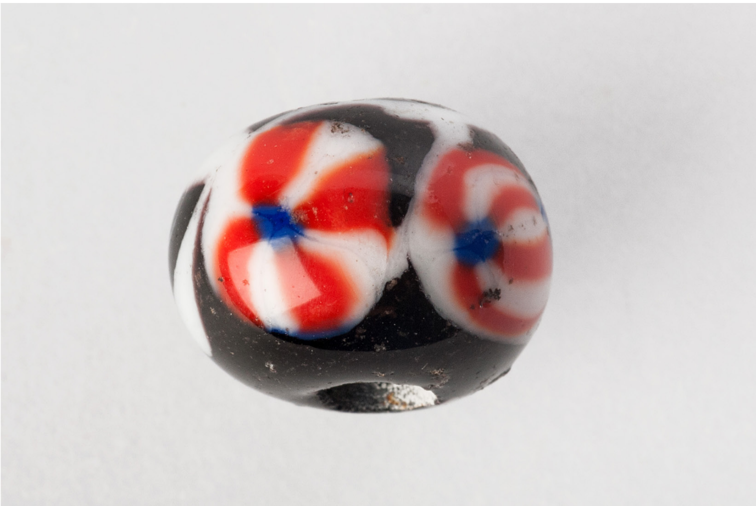

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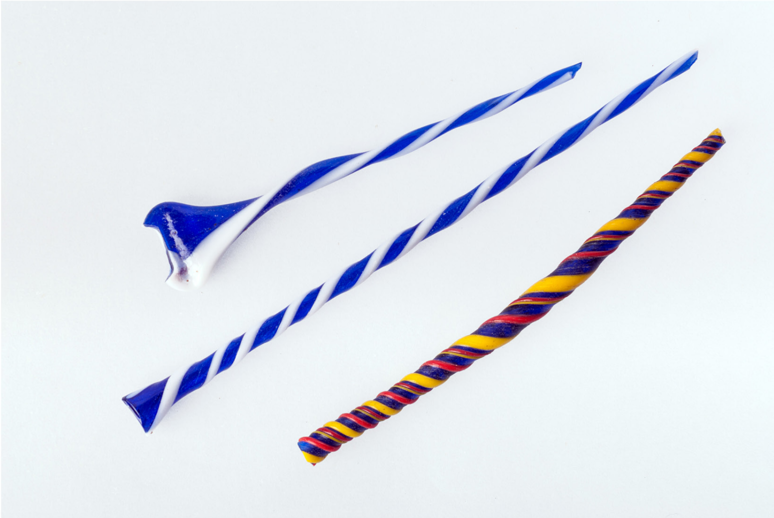
Fig. 12. Mosaic beads (phot. P. Namiota)
A – bead with clay inclusions, B – inclusion free, ready-made bead



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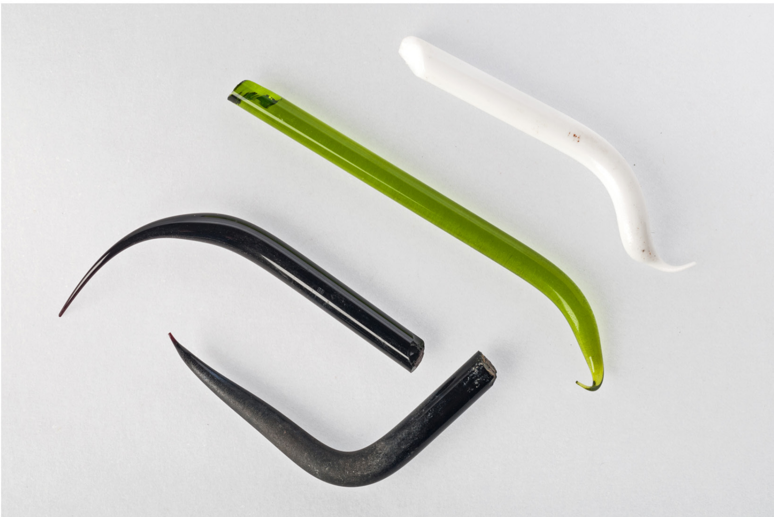

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Fig. 13. Half-finished products (phot. P. Namiota)
A – reticella, B – raw material

course of the experiment the temperature value was checked. A ST672 Pyrometer – 32 + 1300°C, 30:1, 10-MEM SENTRY was used to measure temperature. The raw material took the form of modern, Italian sodium glass as well as a separator used to manufacture beads over glass burners.

THE EXPERIMENT

The first step in creating the workshop was preparing the hearth site. A hole 50 cm in length, 25 cm in width and 10 cm in depth was dug in the ground (Fig. 1A). The longer edge was placed in accordance with the direction of the prevailing wind, so that the wind could support the functioning of the bellows. In order to plaster the hearth, clay with a high content of iron oxide was used, which was then reduced with sand with a low quartz content. A rectangle was made in clay, which was then placed in the previously prepared hole (Fig. 1B). A nozzle like the one found in one the hearths was also made from clay. It was located in the middle of the longer edge of the hearth (Fig. 2A), and then a forked air tunnel was dug (Fig. 2B). The bellows were placed at an angle of 25°, which allowed to direct the stream of air under the charcoal, in order to reach the required temperature faster (Fig. 3A). Charcoal was used as fuel – at the beginning it was not sieved, and later it was sieved and cleaned of any ash.

The mandrels[1] were covered with a modern separator, as the experiment did not aim to check what kind of separator might have been used by the craftsmen in Ribe, but rather the hearth construction, as well as its usefulness in the process of glass bead manufacturing.

It has to be remembered that that working with flames, both nowadays and in the past, required the use of separators. The glass beads were then cooled in fine sand. The tool kit used in the experiment consisted of two pairs of metal tongs, an acute angle chisel, a set of mandrels, a clay nozzle in the shape of loom weight as well as two bellows with a separate intake system.

We used metal tongs in order to hold the chunks of glass. The reason for that was that the metal tongs made it easy to apply glass and glass threads.

In this context, we can note that part of the production waste from the early medieval settlement in Ribe shows signs of "squeezing"/"holding" using some "metal" tool. A second metal mandrel was not used to apply glass.

[1] Mandrel – a metal rod usually covered with a separator, used in lampworking and flameworking, used to wind molten glass and to form glass beads.

THE EXPERIMENT

The hearth was lit gradually. The temperature had to be increased slowly to avoid thermal shock of the clay, which could lead to cracks in the construction. When the hearth was hot enough to use, the temperature was measured, which came to 1043°C in the central position (Fig. 3B). Modern sodium glass can reach temperatures of about 960°C in order to be ready to process.

In manufacturing the beads, we used the winding technique. The initial process of bead manufacturing went as follows: the glass material was heated over the hearth using tongs or placed on one side of the clay part of the hearth (in the case of mosaic beads). When the glass material reached the point of viscosity and became slightly molten, it was transferred to a previously heated mandrel (Fig. 4A) and a rotating movement used to gain the required size, when the glass rod was pulled away from the bead. Glass thread was made, which was cut using the so-called "flame-cut" technique[2] (Fig. 13B). By rotating the mandrels and using gravity it was possible to obtain a regular, spherical shape to the bead (Fig. 4B). Next, the glass was slightly cooled down by placing the mandrel containing the bead on another part of the hearth (Fig. 4C). A bead made this way was ready to be decorated.

A thin glass thread was formed from a glass rod, next it was applied to the base of a bead and was cut off by flame cutting (Fig. 5A). When ornamentation was applied, the mandrel was placed again in the hottest place of the hearth while being constantly rotated, new layers of glass were melted in order to obtain a smooth surface (Fig. 5B).

Eye beads were manufactured in a similar way (Fig. 5C). At first, a so-called base bead was made, which was next cooled down a bit in the flames. The next layer was applied as soon as a drop of molten glass on the glass rod was noticed, and then it was applied to the bead and cut off by flame cutting. Further layers of ornament were embedded one by one until the required pattern was obtained. Then the bead was melted anew in order to obtain a homogenous texture.

In order to manufacture so-called mellon beads, a metal chisel was used. After forming the base spherical bead (Fig. 6A), it was cooled down gently in the flames so that the glass ceases to "shine", a cutting edge of the chisel was applied to the rotating mandrel in order to make series of cuts (Fig. 6B).

The last type of glass bead manufactured in the course of the experiments was a bead with an embedded, flowery mosaic. The mosaic was manufactured in advance, before the experiment was conducted, and it was cut into small pieces. In order to heat up the cut pieces, the mosaics were placed on the edge of the hearth in close proximity to the charcoal (Fig. 6C). After forming the base bead (Fig. 7A, B) and after applying ornamentation in the form of white glass thread (Fig. 7C),

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[2] Flame cutting technique – a popular finishing technique for applying glass in mandrels used in modern lampworking.

the bead was placed in the central part of the hearth and after obtaining a smooth surface, while the glass was still malleable and soft, the mosaics were pushed into it (Fig. 8A), which then melted into the bead (Fig. 8B).

The flat surface of the hearth and the nature of temperature spread were ideal for manufacturing decorative glass rods. In order to manufacture them, a mandrel without a separator was used. Cylinders of cobalt glass were applied and used as a base (Fig. 8C). Next, layers of white glass were embedded on opposite sides of the cobalt cylinder. A lump prepared in this way was placed in the central part of the hearth and heated until it reached a light orange colour (Fig. 9A). The edges of the lump were grabbed by the tongs and held above the hearth. A polychromatic glass rod was the stretched out from it, applying a decisive rotating movement (Fig. 9B, C; 10A, B; 13A).

SUMMARY

In order to manufacture glass beads, the presence of two highly skilled craftsmen is needed. One of them makes the glass beads, and the other, crucially, operates the bellows constantly, steadily, without slowing down or speeding up the pumping of air to the hearth, depending on the stage of production.

In the course of the experiment, and after examination of the manufactured beads, no signs of ash inclusion or charcoal was observed inside them where sieved charcoal was used (Fig. 11). The construction of an open hearth enables easy manipulation of the glass material during the process of bead making and decorative elements.

The use of a chisel, in order to make cuts on the surface of the beads, is effective, taking into consideration the fact that the chisel was used to apply identical pressure and an identical angle on the entire surface of bead. At the same time, the chisel made it possible to cut off the completed glass rods while being pulled out of the hearth. In the course of the first experiment, glassiness on the surface of the clay nozzle was observed.

All the inclusions visible in Fig. 12 result from human error; in the case of Fig. 12A this was the embedding of the mosaic on still wet and not fully fired clay.

As the experiment shows, open hearths are effective and make it possible to manufacture glass beads. It can be stated that it was not necessary to build small kilns, and other ethnographic analogies as suggested by other scientists (i.e. Gam 1990) are not necessarily accurate. The sieving of the charcoal comprised one of the key elements. It should be borne in mind that modern charcoal is packed in sacks and because of the friction and pressing resulting from the type of packaging a lot of dust is created. We do not know if such actions had to be taken by medieval glaziers prior to starting work.

It also should be remembered that the above experiment was only a part of the overall technological process. The methods of annealing the ready-made forms were not checked, and this is necessary in order to obtain a completed, uncracked product. The process of annealing itself is much more difficult than erecting a hearth or manufacturing a glass bead.

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Streszczenie

W opisie zagadnienia wytwórczości paciorków szklanych w Skandynawii we wczesnym średniowieczu w literaturze przedmiotu przeważa pogląd o wykonywaniu ich w małych glinianych piecykach. Eksperyment przeprowadzony w otartym palenisku przedstawia nową interpretację sposobu wytwarzania paciorków szklanych we wczesnym średniowieczu na terenie Skandynawii. W trakcie przeprowadzonych badań wykopaliskowych i w serii artykułów poświęconych stanowisku w Ribe nie ma informacji o znalezieniu rumoszu ścian pieca na odkrytych glinianych strukturach. Odnalezione gliniane prostokątne paleniska o wymiarach 50-60 cm długości i 25-30 cm szerokości zostały odkryte w pobliżu odpadów produkcyjnych i zinterpretowano je jako miejsca produkcji paciorków szklanych.

Bazując na pozostałościach odkrytych w osadzie Ribe, a także wykorzystując wiedzę poprzednich badaczy, zaproponowano inne rozwiązanie konstrukcyjne. W trakcie przygotowania do przeprowadzenia eksperymentu zrezygnowano z posiłkowania się analogiami etnograficznymi z terenów Indii, Turcji i Afryki.

Umiejscowienie glinianej dyszy i przesianie węgla drzewnego pozwoliło uzyskać efekt odpowiadający archeologicznym znaleziskom. W eksperymencie wykorzystano metalowe szczypce do trzymania surowca szklanego, metalowe pręty (mandrele), dłuto, miechy o osobnym układzie, a także współczesne włoskie szkło sodowe. Palenisko zostało wylepione z gliny o dużej zawartości tlenku żelaza schudzonej piaskiem, jego umiejscowienie zostało podyktowane kierunkiem wiatru.

W trakcie badań wykonano zarówno podstawowe, jak i bardziej złożone paciorki szklane. Konstrukcja paleniska jest idealna do wykonywania paciorków szklanych, jednobarwnych, zdobionych czy mozaikowych. Dzięki rozłożeniu temperatury na całej powierzchni glinianej podkładki, boczne pola spełniają funkcję miejsca, w którym można surowiec podgrzać i dzięki temu unikać szoku termicznego.

Wszystkie zanieczyszczenia szkła powstałe w trakcie procesu są wynikiem błędu ludzkiego. Eksperyment potwierdził tezę o możliwości wykonywania paciorków szklanych bez widocznych wtrąceń popiołu i fragmentów węgli drzewnych. Pamiętać należy, że samo wykonanie paciorków jest tylko jednym z etapów produkcyjnych, kolejnym trudniejszym jest odprężenie wykonanych produktów. W celu pełniejszego poznania procesu technologicznego należy kontynuować badania eksperymentalne.