A Study of Scythian Gold Jewellery Manufacturing Technology and its Comparison to Greek Techniques from the 7th to 5th Centuries BC

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Introduction

"At best we have made some inroads into the petrified forest of artefact studies and may have found a path leading back to the real world. If that path leads archaeologists to study the most obtrusive of all their evidence, something may have been achieved. The study of finds from hoards and votive deposits is far too important to be left to period specialists, when it could take its place near the centre of a revitalised social archaeology. Too often we seem to despair at the limitations of our evidence but, for once, suitable material is available in abundance; those irreducible objects that will outlast the boldest attempts to explain them."

Bradley 1990, 203

This manuscript is based on a new technique that has been developed over a number of years by myself to produce high-quality images of marks from tools used in the production of metallic artefacts. The macro-laser-imaging-technique was developed to overcome the limitations that were encountered when using a binocular microscope for the study of Anglo-Saxon jewellery from two cemeteries in the north of Britain that were only 13 miles apart[1]. In this study of the Anglo-Saxon material it was found that the depth of field was not adequate to achieve a sharp photograph when dealing with the high magnification that is required to see the macro marks which is needed for the identification of a tool and to produce a relative chronology from these tool marks. There are problems due to vibration caused by traffic, lifts and people walking in adjacent rooms which resulted in the photographs sometimes not being the desired quality.

Whilst I was working in Cologne in 1993, a scanning electron microscope was used to study a Merovingian brooch. Although the scanning electron microscope produced much better results, it was not possible to use the original artefacts within the vacuum chamber; therefore a silicon copy of the original had to be produced. This meant that the costs involved in the studying of this brooch were very high: a conservator was required to produce the copy and to clean the artefacts from the aggressive corrosive remnants of silicon rubber which took a whole day, and as a scanning electron microscope is an exceedingly complex piece of equipment a specialist was required to operate it. As this specialist is usually not an archaeologist, he does not understand exactly what is required and a great deal of time is spent trying to achieve the required results. A scanning electron microscope is not rented in order to produce a photograph but rather for the time that it is in use, and so experimentation with this equipment is very expensive. Another disadvantage of using a binocular microscope or a scanning electron microscope is the lack of portability: the artefacts have to travel to the equipment and not vice versa, as not all museums have direct access to these valuable pieces of equipment and the insurance costs of transportation of any artefact to where this equipment is available are often too high to make this type of study valid.

The macro-laser-imaging-technique works on a similar principle as a scanning electron microscope but uses a coherent light source to illuminate the sample and not an electron beam. The resulting grid is dependent on the wavelength of the light source, in this case a red helium neon laser which produces a light with a wavelength of 632.8 nm. This single light source is then divided into two by the use of a 50/50% splitter mirror; this reduces the effect of angles and produces a more uniform illumination of the tool mark. The two light sources are directed to the required position on the artefact by the use of silver coated mirrors. A standard single lens reflex camera is used to take the photograph of the required tool mark. This results in more of the "dark light" being collected in the aperture of the camera and because the light source is parallel and in phase there are also less random reflections. As the camera aperture is larger than that of a binocular microscope, the image is sharper because much of the information that is required to produce a sharp image is within the dark light area from which there is a larger sample. The advantages over a scanning electron microscope are the costs and the portability; the equipment that I use can be carried to the artefacts as it only weighs 32 kg. and can be taken on an aeroplane, which means that artefacts in more inaccessible regions of the earth can be studied: all that is required is a 12 volt power supply for the laser.

For this comparative study of Greek and Scythian jewellery manufacturing in the North Pontic region, material from 3 sources was used: the Ashmolean Museum, Oxford[2], the Staatliche Museen zu Berlin Preussischer Kulturbesitz Antikensammlung, Berlin[3] and a private collection which consists of the necklace studied and paintings from the 20th century[4]. I would like to thank each for their support of this thesis in allowing myself access to the material. Although this study was limited to 146 individual artefacts which can be sub-grouped into 27 types because of the replication of the plaques and other artefacts that could be studied, research in Russia and the Ukraine would have been highly desirable. This was not possible due to my personal situation which could not support the cost.

[1] Redfern, 1993.

[2] The Scythian treasures from Nymphaeum.

[3] The Maikop treasure and Vettersfelde.

[4] Private collection of P. Feinstein Berlin . *Add: 'More details of the provenance of the necklace are given on p.5 below and at the beginning of Ch.2.5, pp.114.*

The studied artefacts that were from Vettersfelde/ Witaszkowo proved that it is possible to reconstruct the order in which the four of the artefacts were produced and from the tool marks themselves it is possible to reconstruct the number of tools that the craftsman had at his disposal. The wear of the circular tool that was used to decorate these four artefacts and which was not replaced by another tool indicates that there was a degree of specialization that has not previously been proposed for the Scythian culture. The goldsmith did not decide to reproduce or obtain a new tool for completion of this series of objects but used the broken tool to produce the decorative features.

The results from the material studied from the Maikop hoard show that it is also possible to discern potential modern forgeries by considering the technology that was used to produce the artefacts. The limited number of tools which were used by the craftsmen who produced these artefacts when compared with the number of tools that were used to produce the decorative motifs on the Vettersfelde/Witaszkowo material indicates that the craftsmen had better quality tools than those used by the Scythians or the Greeks. These tools were also used in the production of artefacts which have been thought to have been manufactured in different areas, e.g. sea-eagle-hunting-fish plaques (which were linked by Rostovtzeff to the Seven Brothers Kurgans and thus provenanced the Maikop Hoard to the Maikop region) and the double ended lotus-blossoms, which are thought to be Ionic.

The material that has been studied from Nymphaeum indicates that there are differences between the ancient Greek and Scythian craftsmen. The ancient Greek craftsmen used more labour intensive methods to produce the artefacts, perhaps because they had easier access to slave labour although not all craftsmen were slaves.

The unprovenanced gold strap necklace with seed-like pendants in the Feinstein collection, which was originally bought by the collector's family in 1916 as a reproduction of an ancient Greek necklace, was found upon examination to be an original ancient Greek necklace. Although artefacts from recent private collections should not be studied for ethical reasons, in this case due to the fact that it was purchased in 1916 when the Russian government allowed artefacts from excavations that had been conducted on private land to be sold to private collectors or even to be melted down as gold bullion, it was decided that this necklace was too important not to be included in this study. Its acquisition was indisputably before the 1970 Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property, the UNESCO threshold after which it is illegal under

article 1c to deal in the products of archaeological excavations (including regular and clandestine) or of archaeological discoveries.[5]

It may be possible, through the study of more artefacts, that this necklace could be provenanced or it could be linked to the great "Blizniza" master. The construction techniques that were used by the craftsmen to produce this artefact indicate a technological level that has not been previously thought to have been used before the 8th century AD. Although a number of drawing plates have been found in eastern Europe dating from the 4th century BC no drawn wire has yet been discovered from a provenanced artefact and previously it has always been thought that drawn wire is an indication of a forgery. The use of advanced techniques may indicate that the craftsman, while making the artefact in the ancient Greek styles, may have been a Greco-Scythian.

Although there is only a limited database from the excavated material, the potential of studying the tool marks from artefacts from the north Pontic Region has been shown in aiding researchers in their understanding of the cultural interaction. It is potentially possible to discern which culture had produced the artefact by examining the technological techniques used to produce jewellery. The Scythian craftsmen had to develop techniques which would speed up the production of jewellery because, according to their burial customs, they only had a maximum of 40 days to produce grave goods, whilst the Greek craftsmen worked according to different economic criteria; since the production artefacts could have been very largely based on slave labour, it is possible that the time used to produce the artefacts was not of primary importance. The Greco-Scythian craftsmen produced artefacts that are in a Greek style but used different manufacturing techniques from those of the Greek craftsmen.

These observed technical and qualitative differences provide the justification for a further systematic examination of a much larger collection of jewellery. Were Scythian "masterpieces" in jewellery really produced due to the introduction of gold manufacturing techniques by the Greeks or were they the product of a local technological base which differs from the that of the aforementioned culture?

[5] www.un-documents.net/cppiiecp.htm 1-11-2010.

CHAPTER 1.

METHODS

1.1 The Principles of the use of Laser Optics in the Study of Tool Marks in Jewellery

As the principles of optics are not commonly applied in archaeology they will be explained in this chapter. The use of a laser to illuminate the sample rather than a white light will be explained along with its advantages. The reduction of the noise in the system through computer enhancement of the photographs will also be explained and clarified. The advantages of using a camera with its larger optics rather than a microscope will be clarified

My initial study of tool marks from two Anglo-Saxon cemeteries Norton and Long Wittenham for my Durham BA dissertation in 1993[1] applied the optical techniques of microscope; the tool marks were illuminated with white light and imaged by a binocular microscope and recorded as a black and white photograph. It was found that the results through this technique failed to produce sharp pictures of the tool marks because of noise produced by the system. See fig 1.1

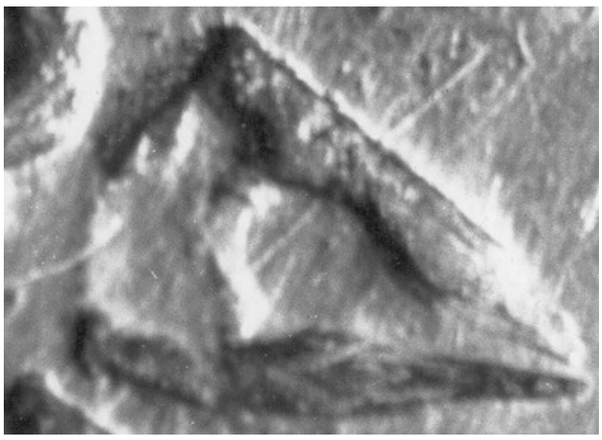


Fig 1.1.1 Tool mark from silver Necklace from Emscote scale 17:1

The noise that was produced by this system did not allow for a sharp photograph to be produced, because the image sharpness and resolution depend upon the size of the aperture. This was discovered by Ernst Abbe in 1873, when he was working in conjunction with Carl Zeiss. It was found that the image sharpness and resolution were dependant on the size of the aperture even though the light reflected from the object only filled a small portion of the objective, the dark space being critical to the quality of the resultant image.[2] This principle, which is now referred to as the Abbe sine condition in Physics, has to be met by any spherically corrected lens if it is to be free from coma in the neighbourhood of the lens axis.

In the following diagram (Fig 1.1.2) of a microscope it can be seen that the microscope objective is not large enough to focus the higher frequency light reflected, resulting in a high quality image being formed over a limited area and depth. In the diagram it can be seen that part of the higher frequency light is not collected in the objective resulting in an uncrisp image at the peripheries.[3] This is the reason why a standard microscope does not produce results that are conducive for the study of tool marks on jewellery, for the objective is not usually large enough to collect the relatively high reflected component of the light which is in the "dark space" to produce an image of high resolution. The smaller the physical dimension, the greater the diffraction angle, which results in the vital information which is required for the identification of tool marks being lost.[4]

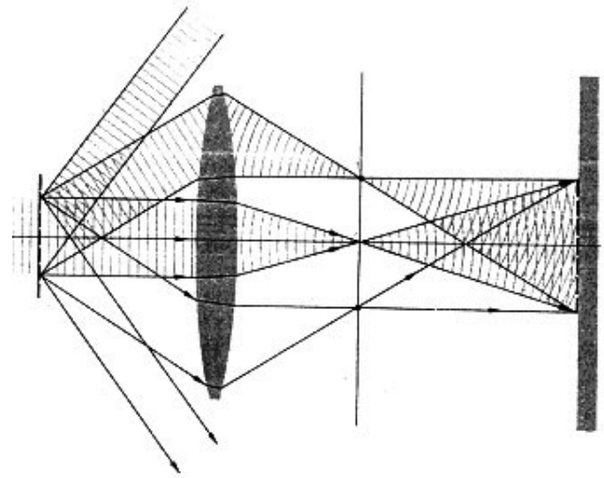


Fig. 1.1.2. A schematic diagram of the collection of light in an optic microscope (adapted from Hecht & Zajac 1974).

The focal plan of a microscope is limited to the area that is being studied and the rest of the object is not in focus when compared with a photograph which has been produced by a camera using micro-lenses. This is because the limitations of camera and depth of field can be overcome using different techniques since some objects that are in front of and behind the sharply focused subjects can still appear sharp. The zone of acceptable sharpness is referred

[1] Redfern, 1993.
[2] Hecht & Zajac 1974, 465.
[3] Hecht & Zajac 1974, 465.
[4] Hecht & Zajac 1974, 466.

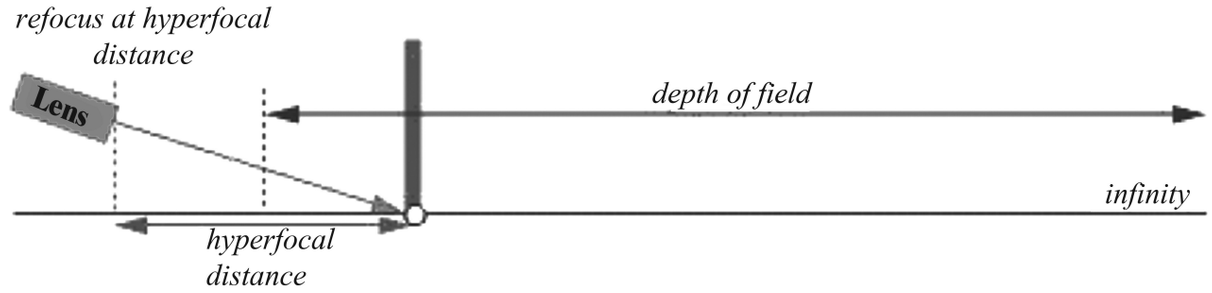


Fig. 1.1.3. Depth of Field

(adapted from www.cs.mtu.edu/~shene/DigiCam/User-Guide/950/depth-of-field.html).11.10.20010

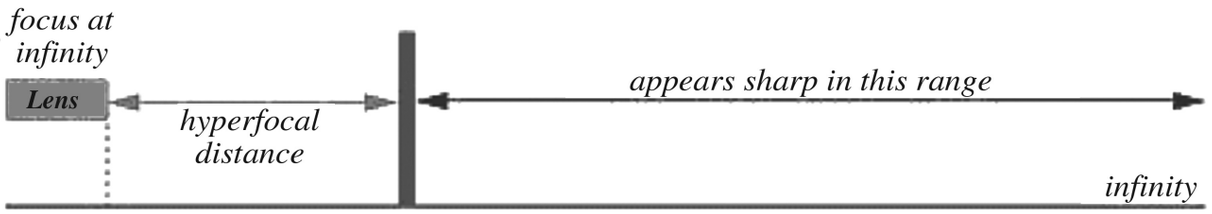


Fig. 1.1.4. Hyperfocal distance

(adapted from www.cs.mtu.edu/~shene/DigiCam/User-Guide/950/depth-of-field.html).11.10.2010

to as the depth of field. Thus, increasing the depth of field increases the sharpness of an image[5] (See fig 1.1.3). The depth of field can be influenced by three factors:

1 Depth of field increases as the lens is closed down (i.e., the F-number increases).[6]
2 Depth of field is greater for short focal lengths than for long ones.[7]
3 Depth of field increases with the object distance.[8]

The distance from the lens to that point is referred to as the hyperfocal distance. (See Fig 1.1.4).

It is possible to focus at the hyperfocal distance. If a lens focuses at infinity, the depth of field starts at somewhere in front of the lens and extends to infinity. More precisely, from that point on, the scene appears sharp, and subjects between that point and the lens are out of focus.

After determining the hyperfocal distance, the resulting depth of field starts from halfway of the hyperfocal distance and extends to infinity. This is, in fact, the maximum depth of field that can be produced. The concept is shown in Fig 1.1.4. The hyperfocal distance is a function of the aperture being used, thus, changing aperture changes the hyperfocal distance.[9]

Following consultation with two physicists,[10] it was decided to use a laser to produce a speckle image of the tool mark. Electronic Speckle Pattern Interferometry is a technique which uses laser light, together with video detection, recording and processing to visualise static and dynamic displacements of components with optically rough surfaces.[11] When a surface is illuminated by a light wave, according to diffraction theory, each point on an illuminated surface acts as a source of secondary spherical waves. The light at any point in the scattered light field is made up of waves which have been scattered from each point on the illuminated surface. If the surface is rough enough to create path length differences exceeding one wavelength, giving rise to phase changes greater than 2π, the amplitude, and hence the intensity, of the resultant light varies randomly.[12]

The advantage of using laser light to illuminate the sample is that it is relatively stable (Wavelength 632.8 nm, Amplitude variations: Mode Sweeping +/- 20%, RMS. Amplitude Noise (30 Hz-30 MHz) < 3%).[13] A single light source could be used, but there would always be shadows on the examined object resulting in a decrease in the measured light intensity from these areas and the quality of the photograph would thus be decreased. To overcome this limitation it was decided to use a half wave splitter mirror to produce two separate illumination sources, but

[5] http://www.cs.mtu.edu/~shene/DigiCam/User-Guide/950/depth-of-field.html
[6] Freir 1985, 40-42; Feininger 1979, 161;
[7] Feininger 1979, 129, 355-358.
[8] Feininger 1979, 129, 355-358.
[9] Lindner 1958,.12-17.

[10] The late Professor Alan Lettington, Reading University and Dr Michael Welch, Reading University.
[11] Jones & Wykes 1989.
[12] McKechnie,. 1976
[13] Melles Griot 1995/1996, 52-54.

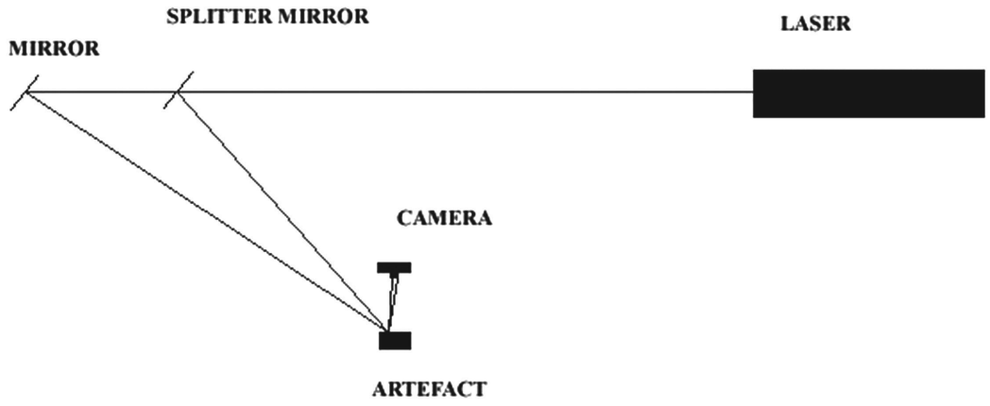


Fig. 1.1.5. Schematic diagram of the Macro-laser-imagining technique.

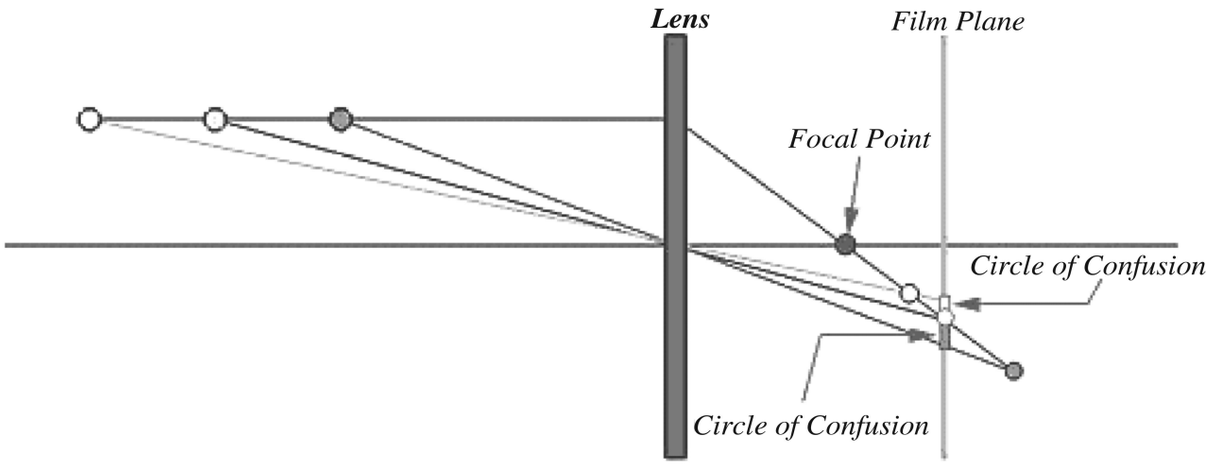


Fig. 1.1.6. Circle of Confusion (www.cs.mtu.edu/~shene/DigiCam/User-Guide/950/depth-of-field.html).11.10.2010

linked in phase and amplitude. The double beam means that the production of shadows is limited and therefore the positioning of the artefact is not so critical. (See Fig 1.1.5)

The use of a laser to illuminate the tool marks would mean that it would be possible to overcome some of the noise produced by the system. When the illumination of the object that is being studied is by a white light source which is made up of an unknown combination of red, yellow, green, blue and violet light, it is not possible to work out the point spread function (psf) for this type of light source because each light frequency would have a different psf since the angles of reflection would be different and thus it is virtually impossible to correct this noise from the resultant image (See Fig 1.1.6.).[14] However when a laser is used the psf can be theoretically reproduced and thus removed from the resultant image because the angle of reflection from a single coherent light source would be influenced by the surface that the laser light is being reflected by which decreases the illumination on the photographic plate.

The original photograph was produced by the use of a Minolta SR T01 with a Pentax bellows, to increase the magnification of the resulting photograph, fitted with a 1:2/55 mm lens produced by the Asahi optical company. The resulting colour slide was then scanned into a computer using an Epson Filmscan 200 which was saved as a jpeg file. Varying amounts of noise were reproduced in the original data resulting in a blurring of the picture. E.g. fig 1.1.7 (Scy 66)

[14] Personal communications Dr. M.A. Welch, Reading University.

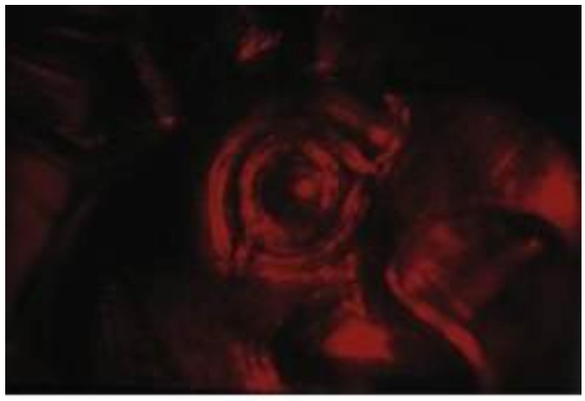


Fig. 1.1.7. Original scanned picture

In the photograph Fig 1.1.7 in its original format without any modification the features are difficult to discern as each is represented in the original red light from the laser with variations in the intensity. Each image was modified to produce the required effects for the finished photograph by using the image enhancement programme ImageJ.[15] ImageJ is a public domain Java image processing program inspired by NIH Image for the Macintosh. It runs either as an online applet or as a downloadable application on any computer with a Java 1.4 or later virtual machine. Downloadable distributions are available for Windows, Mac OS, Mac OS X and Linux.

ImageJ can display, edit, analyze, process, save and print 8-bit, 16-bit and 32-bit images. It can read many image formats including TIFF, GIF, JPEG, BMP, DICOM, FITS and "raw". It supports "stacks", a series of images that share a single window. It is multithreaded, so time-consuming operations such as image file reading can be performed in parallel with other operations.

The advantage of this program is that it is able to use Fourier transforms of the original photograph and compare them with a theoretical model of the noise produced by the equipment and thus it is possible to remove the noise. Since its development in 1807 by Baron Jean-Baptiste-Joseph Fourier, the Fourier transform has been used in many applications ranging from Fourier's photo studies in heat conduction to molecular modelling. Whilst it provided a powerful analytical tool it was not until 1965 that an efficient algorithm was developed by James Cooley and John Tukey which is known as the fast Fourier transform or FFT which offers fast savings in execution time over that of direct Fourier transform calculations.[16]

While the FFT calculations expedite tour transform calculations they still remain an intensive computing task. Two dimensional FFT which are often used in image processing applications require so much computation that they are most often run on powerful mainframes or specialized hardware.[17]

ImageJ is one of the few programs that is available that is able to produce Fourier transfers of an image on a personal PC, while the majority of the commercially available programs for image enhancement do not use Fourier transfer for the reduction of noise in a photograph because of the computation time.

The image is first converted into a grey scale picture (Fig 1.1.8) in which the features can not be easily discerned. The best method to examine the amount of noise that is being produced by the system is the examination of the Fourier function of the picture. (See Fig 1.1.9) All of the information that is required to reconstruct the original picture is held in the above which also includes the blurring caused by the point spread function, this being a product of all the noise produced by the system. In order to produce the most accurate results from the deconvolution (deblurring) the psf has to be known. In the case of this equipment this is not the case and so the effect had to be achieved through experimentation. The Fourier transformation of a single dot was theoretically reproduced by transforming a single point (See Fig 1.10). This was then subjected to the Fourier transformation of the black and white picture (See Fig 1.1.11). The resulting transform was then reversed to reconstruct the photograph (See Fig 1.1.12) In this photograph the features of the tool marks can be seen because the contrast is improved and the depth of the photograph can be readily discerned. The ear of the Griffin is about 1 mm below that of the eye but it is still in focus.

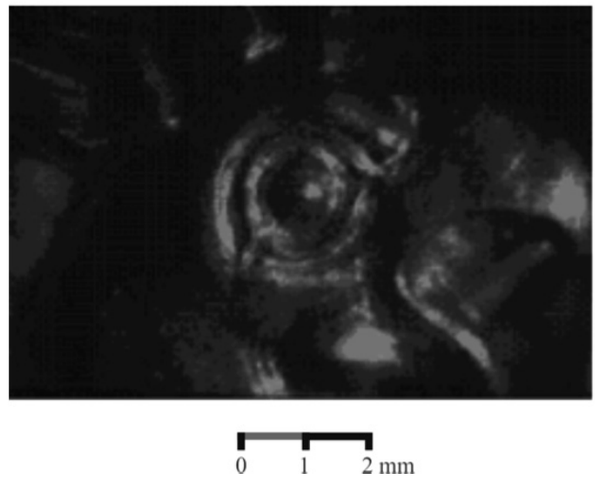


Fig. 1.1.8. Photograph converted to a grey scale image

[15] http://rsb.info.nih.gov/ij/
[16] Reeves 1990, 1.
[17] Reeves 1990, 1.

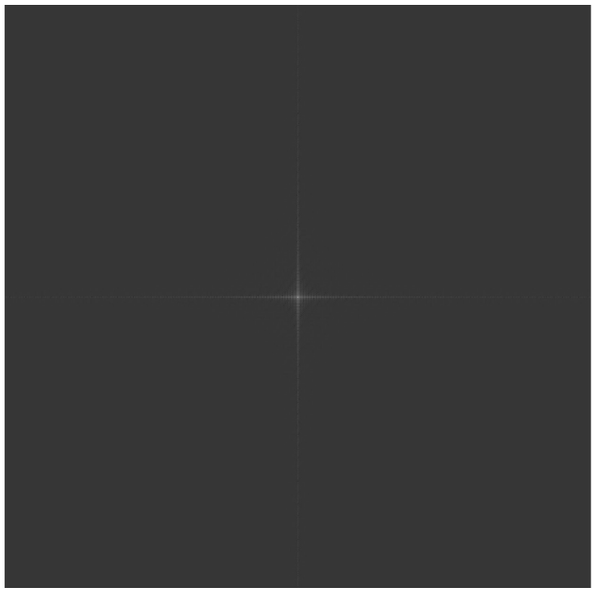


Fig. 1.1.9. Fourier image of the tool mark

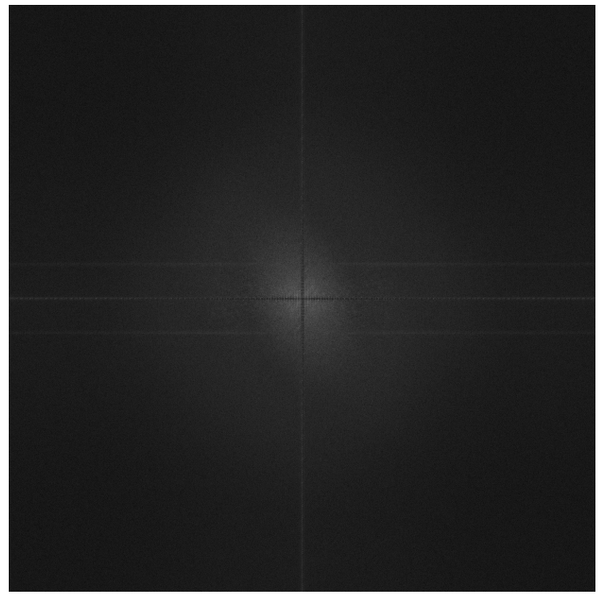


Fig. 1.1.11. Fourier transformation of tool mark with the Fourier transform of single dot subjected from it.

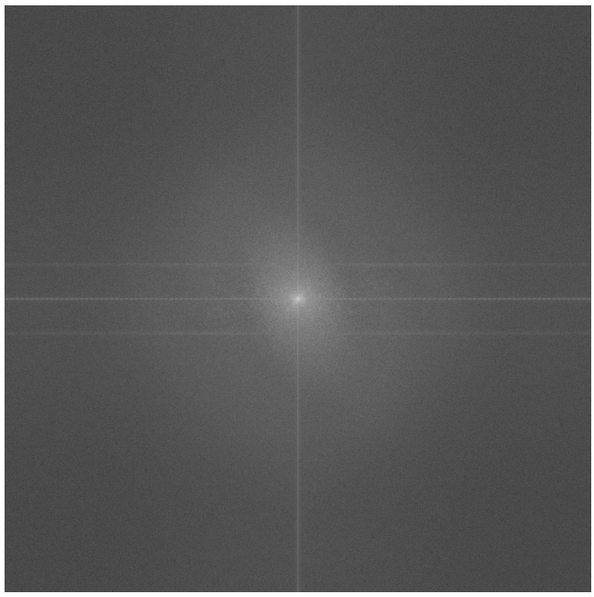


Fig. 1.1.10. Fourier transformation of a single dot

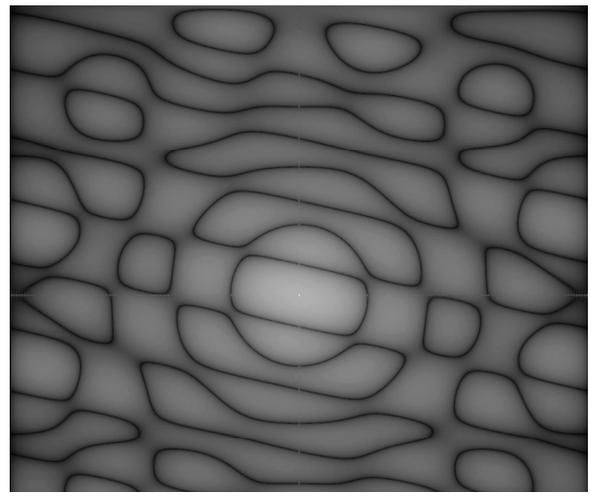


Fig.1.1.12. Result of the deblurring using the Fourier image of a single point.

Although the results were not perfect, there is an improvement in the quality of the picture. To achieve perfect results the psf would have to be measured for each individual tool mark with the prototype equipment. It is hoped that this limitation can be removed in future developments of the equipment to produce a known standard psf which can used to reduce the noise in the resultant photograph.

It was found that a single dot produced the best effects of removing some of the blurring produced by the noise inherent in the system, although many models were applied, e.g. double point, which produced a grainy picture of the tool mark. (See Fig 1.1.13)

The Fourier transformation of the original photograph had the results of the Fourier transformation of the double point subtracted from it (See Fig 1.1.14) and then the results were inverted to produce the photograph. In the resulting picture not as many features can be discerned, i.e. the ears of the Griffin are a similar contrast to that of the background (see Fig 1.1.15)

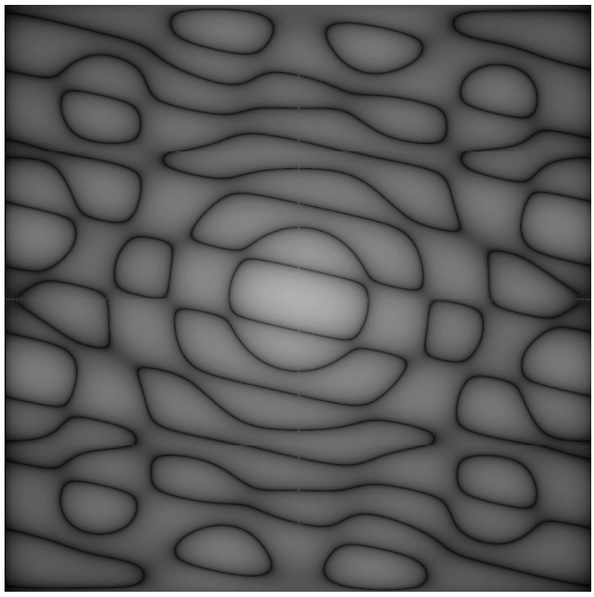


Fig. 1.1.13. Fourier transformation of a figure of double point

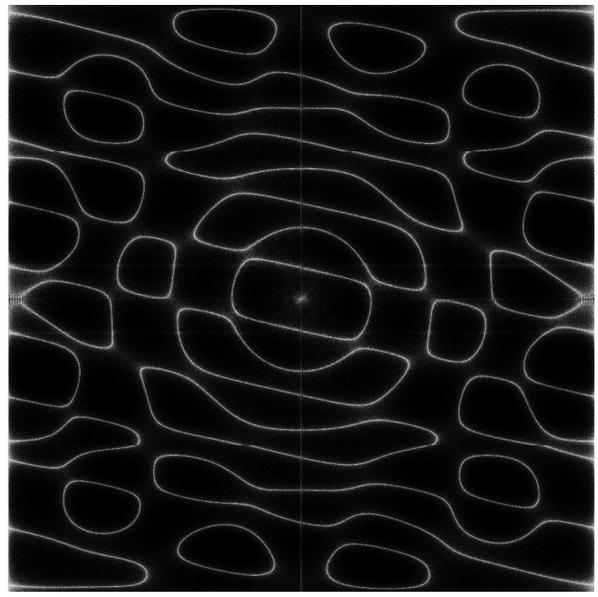


Fig. 1.1.14. Fourier transformation of tool mark.with the Fourier transform of double dot subjected from it.

These image enhancement techniques were applied to the images to produce the results that can be discerned in the following chapters. They can be compared with the methods that are applied to the developing of normal photographs and are not a transmutation of the photograph to change the results of the picture. The increase in the depth of field that was produced when compared with that of a photograph of a similar tool mark produced through the use of a binocular microscope is due to the ability to achieve longer exposures so that a lower ”f” number on the objective could be used. The larger aperture of the camera affects the hyperfocal distance meaning that a greater range of it is in focus than with a binocular microscope. The use of a laser to illuminate the tool mark means that it is possible to remove more of the noise from the resulting photograph than when a white light is used, which means that the image is sharper.

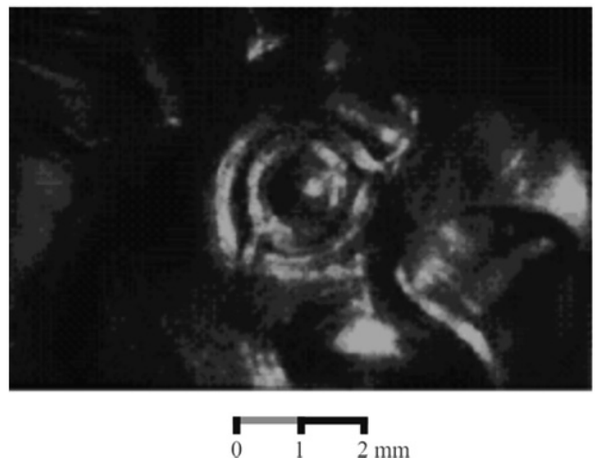


Fig. 1.1.15. The result of the figure of 8 psf image enhancement.

1.2 A Synopsis of the Research on Tool Marks by Scanning electron microscope

There have been only a few publications on the study of tool marks, the most famous of which was conducted by E. B. Larson in the late 1970´s concerning the Gundestrup Cauldron, the silver foil fibulae from the Sejlflod cemetery and on other sites, not specified in his study.[1] Savage, Lowery and Wilkins[2] have published part of a larger study of Bronze Age razor blades, whilst D. Leigh[3] worked on Anglo Saxon great square-headed brooches. Perea[4] worked on gold artefacts from the Iberian Peninsula from the late Bronze Age to the transition into the early Iron Age. Meeks[5] conducted a study on a necklace which had been repaired in the 19th century: he compares the original half with the later reproduction showing the differences in the manufacturing techniques.

Larson analysed the marks, caused by the use of punches, because he believed that these would produce the most identifiable characteristics to detect the punch, when used on other artefacts, for they were rarely reground or sharpened. That would mean that they could be followed more easily from one piece to another, due to the characteristic arrangement of the parts making up the motif. The former two categories do require to be periodically reground, so they can work at their maximum efficiency, resulting in their characteristics changing over time.[6] Larson found that it was possible to further subdivide the pressure tool marks into plain and fancy-pattern punches, the patterned punches varying in form from rigid geometrical configurations like circles, dots, triangles and squares up to finished complex ornamental punches.[7]

The 16 pieces of the Gundestrup Cauldron, which originally were found by a peat-cutter, were given to Sophus Müller in 1891, to conserve and reconstruct the cauldron. In 1977, . Larson dismantled the cauldron again for the first full technical analysis for this artefact ever made and a study of the punch marks (all other studies on the cauldron have been conducted on an artistic and stylistic basis).[8]

Partial casts were taken of the areas where punch marks, hammer marks, scraping marks and soldering marks could be observed.[9] From these partial casts some areas were selected as being the most representative, and a two-component silicon rubber cast was made.[10] These were then photographed, using a strong sidelight and from the 182 original casts, 50 were selected, because they possessed traces of patterned punches, which the author believed would give the best possible results for this type of work.[11] After all the preliminary work, the sample was reduced to 34 different parts, and from these the sharpest and most representative areas were cut out and prepared for the scanning electron microscope.[12] The reason why the SEM was chosen for this work was because the punches used by the craftsmen were of minuscule size, as in the case of punch A which was only 0.5 mm at its widest point.[13]

By using this technique, it was possible to identify 15 different patterned punches used in the decoration of the Gundestrup Cauldron, which could be grouped into tool sets due to the correspondence of punch marks on the various panels that made up the cauldron.[14] The province of manufacture could not be discerned from this evidence, because at present there does not exist a larger data base for tool marks for this period, or in fact for any other.

The same technique, which had been used on the Gundestrup Cauldron, was used in the study of the ten silver foil fibulae, along with known associated metallic grave goods.[15] The silver foil fibulae were divided into two subgroups, sometimes having animal heads in profile, which means that they have been used in the typological dating method by scholars and archaeologists.[16]

In total, 77 punch marks were found on the fibulae, with no connection between them and the identified tool marks from the Gundestrup Cauldron, but an examination of the other objects from the Sejlflod excavations did show that the same punch marks do exist on a number of different artefacts.[17]

The largest study of tool marks yet undertaken examined Bronze Age razor blades from the Prehistoric Museum at Moesgaard, although it has not been published due to an accident of one of the authors, delaying the work on the approximately 400 artefacts.[18] These problems have not stopped Savage, Lowery and Wilkins from publishing another paper on the decorations of three belt plates from Vognserup Enge (Kundby Sogn, Tuse herred, Zealand), Thorsted (Thorsted sogn, Hind herred, Ringkøbing amt) and Langstrup on the request of Dr. Jens Poulsen.[19]

It should be noted that this study did not set out to identify the specific tools used in the manufacture of the belt plate from Vognserup Enge and the comparative studies from the sites of Langstrup and Thorsted, but rather the type of tool and the techniques that were used to decorate the pieces. This was done by the taking of silicon rubber moulds of

[1] Larson 1987, 402.
[2] Savage et al. 1976, 459.
[3] Leigh 1990, 109.
[4] Perea 2004, 34.
[5] Meeks 1998, 127.
[6] Larson 1987, 396.
[7] Larson 1987, 396.
[8] Larson 1987, 395.
[9] Larson 1987, 397.
[10] Larson 1987, 397.
[11] Larson 1987, 397.
[12] Larson 1987, 399.
[13] Larson 1987, 400.
[14] Larson 1987, 399.
[15] Larson 1987, 399.
[16] Larson 1987, 404.
[17] Larson 1987, 406.
[18] Personal communications. P. H. T. Shorer.
[19] Savage et al. 1976, 459.

the artefacts, which meant that concavities on the objects appear as convexities and also left and right are reversed.[20]

The decorations studied on the Vognserup Enge belt plate appeared to have been manufactured using tracers with a convex form, which left a lentoid impression on the straight lines and in the spirals, though the tracer had a straight edge. This could be discerned from the characteristic 'feathers' that are produced by the discontinuity of the use of the tracer to form the curve. These 'feathers' could also be seen on the Langstrup and Thorsted plates.[21] The types of punch decoration found by the team when studying the Vognserup Enge and Langstrup plates were a toggle punch, and in the case of the former, a triangular punch also appears to have been used.[22] On the plate from Thorsted, there could have been four or five different types of punches used in decorating it, these being a triangle, toggle, diamond, a lentoid straight edge punch and perhaps a dot punch, but the latter may have been formed by the use of a toggle punch at an angle.[23]

The tool marks on all these pieces, however, were not totally conclusive because the authors believed that the tools were made from a copper alloy. This would mean that they could have worn rapidly in use and thus required to be resharpened.[24] On the Langstrup plate, a single toggle tool may have been used, for the gradual change in shape of the indentation may be due to the wear and subsequent reshaping.[25] This was the main reason why the authors of the study did not try to identify the individual tools used in the manufacture of these three pieces; there was, however, some work done on the comparison of the ratios of the punches, using the base and height of the triangular punches, while for the line profiles the breadth was plotted against depth.[26] These ratios could indicate that there is no relationship between any of the tools used in the manufacture of the three belt plates studied.[27]

In the complicated paper by D. Leigh, dealing with the great square-headed brooches, a third study concerned with tool marks, not only were the decorative techniques discussed, but also the tool marks were examined, though the exact technique that was applied is not stated in the paper. A major problem is that the author does not state the exact numbers of pieces studied, although there is a reference to thirty brooches, but pairs were counted as being one with no indication as to how many pairs were included in this work.[28]

Leigh noted that two kinds of decoration imparted a textural effect to the artefact rather than the colouristic effects. One of these is the 'notched' effect, which was created by a small "egg-timer" shaped tool being repeatedly struck into the artefact, usually along the ridges in the chip-carving, but sometimes also on flat surfaces.[29] The author realised that it was nearly impossible to characterise these marks, because they are only about one millimetre in length and because the range of deviation in the method, in which the tool was applied to the artefact, could disguise the actual punch mark.

In the study of the square headed brooches from Kent, it was found that the impressions could be divided into five groups, based on their size and shape, although it did not become clear whether these groups corresponded to five individual tools.[30]

The case of stamped patterns is the other form of textural decoration configurations studied by Leigh, which he believed to be the common techniques used by the Anglo-Saxons to decorate artefacts. When these punches are of unusual shapes such as triangles and crosses, whose form and dimensions are relatively simple to recognise, the identification of the tool is facilitated, but in the case of circular punches this is not so easy unless they are grossly different in diameter.[31]

In the research on the Kentish square-headed brooches, there was only one match of non-circular punches (discounting deliberate pairs where the same tool was used). The tool, which had been used, had a triangle with rounded corners and a central pellet, the defect in its manufacture also aiding in its identification on the brooch from Stowting, Kent and on a trio of brooches from the cemetery at Chesil Down, Isle of Wight. In the case of the circular impressions it was possible on the basis of size alone to observe three possible groups, in which individual objects of the group shared indentations that may have been caused by the same tool.[32]

Perea's study of the material from the Iberian Peninsula has shown that from the late Bronze Age to the early Iron Age there were 2 technical schools producing gold artefacts which used different technological techniques.[33]

The Sargrajas/Berzocana school is characterised by the casting of the required amount of metal into a prismatic ingot, which was then shaped by cold working on an anvil. The techniques which were used for repairs and joints were casting on and fusion.[34] The decoration was produced using an incisor to produce straight lines to form a geometrical pattern.[35]

The Villena/Estremoz school is defined by the use of a lathe for the turning of a wax model to form the basic

[20] Savage et al. 1976, 459.
[21] Savage et al. 1976, 465.
[22] Savage et al. 1976, 466.
[23] Savage et al. 1976, 468.
[24] Savage et al. 1976, 469.
[25] Savage et al. 1976, 468.
[26] Savage et al. 1976, 468.
[27] Savage et al. 1976, 468.
[28] Leigh 1990, 114.
[29] Leigh 1990, 109.
[30] Leigh 1990, 111.
[31] Leigh 1990, 111.
[32] Leigh 1990, 111.
[33] Perea 2004, 34.
[34] Perea 2004, 34.
[35] Perea 2004, 34.

shape of the cylindrical bracelet. They display varied surface features to decorate the bracelets ranging from a plain flat convex section to extremely complex sections produced by the use of mouldings. The finished casting was probably polished on the lathe to achieve a fine surface. [36] Casting faults were repaired by casting on in a number of examples.[37]

Although both schools were working in the western half of the Iberian Peninsula, they have never been found in the same archaeological context. The bracelet from Cantonha, Guimaraês is the only hybrid example discovered. This bracelet was produced using a small bracelet of the Villena/ Estremoz type and two of Sargrajas/Berzocana type which were joined together by fusion using molten metal and the terminals were cast on.[38]

The arrival of Phoenician colonists in the south of the Iberian Peninsula in the 8th-7th century BC introduced filigree, soldering of multiple elements and oriental iconography. It appears from the archaeological record that there was typological transmission between the Phoenician craftsmen and those of the Villena/Estremoz school, but the technique of lost wax casting was not introduced to the Phoenician craftsmen, who used their own techniques to reproduce native form.[39] This is exemplified by the Caramblo gold hoard which comprises 16 plaques, 2 pectorals and 2 bracelets. These have all the aforementioned Phoenician elements along with one element which comes from the Villena/Estremoz tradition in the form of solid points which were produced using the lost wax technique.[40] The bracelets are thought to have been produced by Phoenician craftsmen because the spikes are formed from pressed gold sheet resulting in a hollow form which was then soldered onto the bracelets and not cast which was the technique used by indigenous craftsmen.[41]

In the 4th century BC there was change in the demand for gold artefacts in the Iberian Peninsula. Once gold was no longer associated with the political and religious elite it became a commodity. From this period onwards it is possible to recognise production centres and workshops, not from the tool marks, but rather from the art historical point of view e.g. Villaricos hoop earrings with a coiled thread at the terminals. [42]

Although there have been a number of studies conducted on the gold artefacts of ancient Greek and related cultures,, they have either been to consolidate art historical conclusions drawn from the style in which the artefacts were constructed or to prove the already known construction techniques. The SEM has never been used on jewellery from the archaic, classical or Hellenistic periods or on Greek gold artefacts in a study of tool marks to try to find indications of the workshops.

The most useful study which has been conducted on a classical Greek piece of jewellery was that of Meeks, comparing ancient craftsmen and 19th century craftsmen. The necklace studied was bought by the British museum in 1872 as part of a large collection from Alessandro Castellani.[43] Upon examination in 1994 it was found that the strap necklace was a composite of the original surviving half and the reconstructed other half which had been put together before the piece was acquired by the British Museum. The Castellanis were renowned jewellers who for three generations were leading exponents of the 'Italian Archaeological jewellery' which had been founded by Fortunato Pio Castellani in Rome in the early 1840´s. As a goldsmith, restorer and collector of classical jewellery he is synonymous with quality workmanship in the classical style. It was his son, a dealer and jeweller, who sold this piece to the British Museum. However it cannot be proved whether this necklace was restored by the Castellani family or by others working in the Italian archaeological jewellery school. [44]

The quality and the differences of the workmanship and the techniques of production from the original were compared with the later reproduction. The exact details that were studied were the loop in loop chain links, the rosettes, seed shaped pendants, clasps, surface characteristics and the chemical composition. [45]

The differences in the gold wire which were found are due to different production techniques of the wire. Ancient Greek wire has a spiral indicating that it was produced by twisting a strip of wire. The simplest and most basic technique which could have been used was to hammer out a gold ingot into a square cross section which would then be twisted to produce a barley sugar effect and then it would be rolled between two hard flat surfaces. This would result in a wire which has a relative uniform diameter along the length, a round cross section, a smooth surface and four independent spiral grooves on the surface.[46] Ancient Greek wire is slightly thicker than 19th century wire and has variations in the diameter. 19th century wire was produced by drawing the wire through a draw plate and thus has a standardised diameter with parallel scratches on the surface.

The soldered join of the hoop shows that the classical Greek craftsmen were superior to the 19th century craftsmen. In the former work the joint is hardly visible because the alloy that was used to form the solder is very similar to that which was used to produce the wire. This indicates that the Greek craftsmen had used the colloid

[36] Perea 2004, 35.
[37] Perea 2004, 35.
[38] Perea 2004, 35-37.
[39] Perea 2004, 38.
[40] Perea 2004, 37.
[41] Perea 2004, 37-38.
[42] Perea 2004, 38-39.
[43] Meeks 1998, 127.
[44] Meeks 1998, 127.
[45] Meeks 1998, 128.
[46] Oddy, 1977, 83.

hard soldering technique whilst the later craftsmen did not have this technique available to them as it had not been rediscovered and so the alloy which was used to solder the gold wire together has a different composition which means that it had a lower melting point than that of the wire.[47]

Although these studies are exceptionally well presented, due to their limitations they only just begin to explore the potential of studying tool marks and technology to discern which society had produced an artefact. The results from the study of the Gundestrup Cauldron prove that it is possible to produce tool kits from the tool marks which were found on the separate panels. It was also found by Larson in his study of the fibulae and the associated goods that it is possible to confirm there was no link between these artefacts and the cauldron.

The study of the three belt plates which was conducted by Savage, Lowery and Wilkins to identify the type of tool and the techniques which were used to decorate these pieces shows that it is possible to identify the type and form of the tools. It was found that there was no link between any of the plates according to the ratios of the base and height of the triangular punches.

In the case of the square-headed brooches from Kent which were studied by D. Leigh it was found that it is possible to discern usual shapes relatively easily but circular punches were found to have a major limitation in the identification of tools and particularly when they were grossly different in the diameter.

The material from the Iberian Peninsula shows that it is possible for different technical schools to be discerned from the different technological techniques that were used to produce the artefacts. The introduction of new technological techniques from other cultures could also be seen, e.g. filigree which was introduced by the Phoenicians.

Although artefacts from ancient Greek and related cultures have been studied, they have either been used to consolidate art historical conclusions or to illustrate known construction techniques. No study has been undertaken of jewellery from the Archaic, Classical or Hellenistic Greek periods to study the tool marks for the identification of workshops. The necklace in the British museum that was studied in the 1990´s by Meeks shows that is possible to observe the differences between relatively modern craftsmen and ancient ones through the techniques that were used to produce the various decorative features on this necklace.

[47] Meeks 1998, 130.

1.3 Problems of Chronology

Archaeology is intended to restore the historical meaning of preserved monuments, even though it is often not possible to achieve this from the surviving material. One of the most important bases for any kind of history is chronology, i.e. the placement of whatever happened in time. All chronologies have limitations that have to be understood, so that they can be applied to their best potential. No archaeological record is complete; it is biased by limitations that occur during the excavation, regional concentrations, international politics and the survival of the monuments. Besides this, any typology, when it is constructed, is affected by unintentional personal biasing of the researcher; the material studied can also affect the results because it is often impossible to study all of the artefacts that are available. The best results can only be considered as an indicator of the development of the material culture, since an individual occurrence is separate from the entirety and the development of any given piece can only be compared with generalisations.

A traditional chronology relies on sequencing, stylistic analysis and cross dating of the material to achieve a relative chronology. Chronologists establish a relative sequence from stratified deposits from settlements or sanctuaries and from grave groups. For the earlier periods of Athens, Knossos, Argos, Euboea and Corinth a fairly detailed relative chronology has been constructed. Ceramics can also be used to construct a relative chronology; the majority of the ceramics that were produced by the Greeks had painted decoration and thus a fairly accurate relative sequence can be produced by the grouping of ceramic vessels according to the painter, estimating the degree of stylistic overlap between various artists and the length of the artist's working life; by using this technique a good relative chronology for black and red figure ware was produced by Beazley.[1] The corresponding relative chronology for Protocorinthian and Corinthian ceramics was constructed by Payne.[2] Although both of these chronologies are over 40 years old they are still the foundation of all the research that has been carried out on these ceramics ever since their publication. Through cross referencing of the relative local chronologies an indication of the time span in which the ceramics have been used can be found.

Although the chronologies are accepted by the majority of scholars for the Greek artefacts not all of the problems have been clarified. The chronologies themselves have in the recent past become very controversial with a number of scholars questioning the fixed points and their dates, e.g. E. D. Francis and M. Vickers,[3] who in a series of articles argued that the chronology is out by 60 years.

[1] Beazley 1956; Beazley 1963.
[2] Payne 1931.
[3] Francis & Vickers 1983; Francis & Vickers 1985; Francis & Vickers 1988.

Although the ceramic chronologies have been used for the dating of burials and settlements as though they were absolutes, incautious use of them may lead to inaccurate dating. The general assumption of archaeologists is that each pottery style is a monolithic event undergoing creation, maturing, decay and then disappearance. Although this has been found in some excavations to be the case, e.g. in the Kerameikos cemetery where there is a stratified development from the Late Geometric to Black Figure ware,[4] the results of other excavations have shown that this is not always so, e.g. in Thera where subgeometric urns contain Attic Black Figure ware of the 6th century BC.[5]

The primary dating technique that has been applied to Scythian remains, when applicable, has been by Greek imports, especially ceramics. At present, the chronologies of the Greek pottery for the Black Sea region are not complete, although ongoing research may clarify this problem.

For instance, the chronology of Corinthian painted vessels was primarily based on the foundation-dates of the Greek colonies in Southern Italy and Sicily, where it was assumed that the earliest pottery found during excavations, usually Proto-Corinthian or Corinthian ,which are the highest proportion of the ceramics excavated.[6] The principal historical sources used for the dating of the foundation of these colonies are Thucydides[7] and Eusebius, but this has led to a circular argument in the dating of Corinthian pottery, and there is very little conclusive evidence from other sources, which would allow us to independently verify the results. A commonly cited example comes from a double inhumation at Pithekoussai, dated by a scarab of Pharaoh Bocchoris who reigned around 720-715 B.C., discovered together with nine vessels, three of which were EPC aryballoi, datable to the last quarter of the 8th Century BC.[8]

The use of the Corinthian pottery chronology for dating material from the Black Sea region is limited to the period from around 690 to circa 630 BC, where dead reckoning and inspired guesswork has to be applied, based on the stylistic and typological development and thus different dates can be assigned according to which expert is consulted.[9] The accepted date for the foundation of the settlement of Berezan, the first Greek colony in the northern Black Sea, is 647-646 BC following Eusebius.[10] This means that it is very difficult to prove this date conclusively from the archaeological material using Corinthian pottery as the foundation date for this city lies within the range where the chronology of Corinthian vessels has ambiguities and relies on subjective interpretation

[4] Morris 1987. 14.
[5] Morris 1987, 167.
[6] Biers 1992, 64, Amyx 1988, 399.
[7] Thucydides 6.3-5.
[8] Amyx 1988, 415.
[9] Amyx 1988, 428.
[10] Solovyov 1999, 7.

Athenian wares then come to the fore in understanding Scythian chronology and the development of art styles.[11] The chronology for Athenian Black figure vases was constructed using the Corinthian chronology as a base. In many tombs, Corinthian and Athenian pottery are found side by side. It is normal to use the absolute dating from the Athenian pottery, which is checked with the stylistic sequence from the Corinthian pottery.[12] The absolute dates for Athenian pottery are mostly based on historical events, with the gaps being filled with judicious observations on the rate of innovation, the progress of painters and workshops, and the estimated volume of production.[13] There are at least 63 potters and painters from Athens in the 6th century BC, [14] but there can be confusion caused because of the tendency of the Greeks to use the same names as their fathers and grandfathers.[15] The methodology used to construct the chronology of Athenian Black figure wares is vase-forms or styles, which can plausibly be associated with historical events from their excavated contexts with other objects, commonly different types of pottery, and stylistic comparison with other art forms or vases for which a chronology has already been established.[16] Once again, it can be argued that the foundations of this chronology are not static and further research may produce different absolute dating. Athenian Red Figure Vases chronology is constructed in the same way as that of Athenian Black Figure Vases, although it is not based on the Corinthian pottery chronology directly and thus it has the same limitation when being used.

As a bases for the Greek chronologies along with the fixing points I decided to use the one supplied by James Whitley[17] as this chronology does take into account the limitations which have been discussed and that it constructed for western Europe and not the Black Sea . See Fig 1.3.1.

It is important to understand the Greek chronologies and their weaknesses because the majority of Scythian kurgans (barrows) have been dated through the inclusion of Greek imports among the grave goods. This has also led to all Scythian artefacts being chronologically dated even when they do not contain any Greek artefacts by cross reference to the Greek chronologies through the stylistic comparison of the Scythian material.

It is impossible to refer the reader to the continuing debate in all of the literature. It suffices to say that the continuing excavations have not solved the origins of Scythian animal art, due to the fact that diffusionist concepts, which have been applied, assume that there is evolutionary progression in the development from a central point of origin with gradual quantitative changes taking place, the qualitative jumps not being easily discerned in the archaeological record. Given the complexity of nomadic societies and the theory of inherent mobility it is not possible to understand the transitions in the Scythian animal style in their entirety from the data recovered in excavations. We are always examining only a point in time without the foundations of a dependable chronology or the understanding of the cultures involved.

The dependence upon native ceramics for dating material cultural remains of the Black Sea region is limited, as the evolution of pottery in the North Pontic region, although it has been studied for a long time, is not fully understood yet. The local indigenous pottery was hand formed and the majority of the recovered material has come from burial sites. There are localised variations, not yet clearly defined due to the difficulty of recognising the different groups, commonly referred to collectively as Scythian.

The Scythian chronologies are based on either their weapons in the form of arrow heads and akinakai, or on the animal style which has been used to decorate the gold and bronze artefacts. The merits and and disadvantages of these chronologies will be discussed in the following pages.

For the Scythians it is rather the history of the material culture which can be discerned than the history of the people.[18] The evolution of Scythian culture is a complex problem for which, at the moment, there is no independent chronology that can be applied to the complete material culture and definition. The Scythians were one of the numerous nomadic peoples who occupied the steppes of Eurasia in the 1st millennium BC. The standard indicators that are used to identify the Scythians are the occurrence of specific weapons, horse equipment and the animal art style. The chronologies that exist for the dating of these artefacts are convoluted and often produced from circular arguments. These chronologies are applied without an understanding of their limitations. It is possible to produce conflicting dates from the same material depending upon which chronology is applied. Due to the expense of natural-science dating techniques (e.g. radiocarbon, dendrochronology, thermoluminescence), they have not yet been extensively used in the Black Sea region.

Of major importance are the 6 existing chronologies for Scythian arrowheads, written by P. Rau,[19] A. I. Meliukova,[20] V.G. Petrenko,[21] A. Hančar[22], H. Eckhard[23] and V. Illins´ka.[24] The work by Rau is now out of date, whilst the four works by Meliukova, Illins´ka, Petrenko and Eckhard do not supply exact dating for the majority of types and variations, giving rather a general reference frame for them. As for the work by Hančar, although

[11] Boardman 1999, 14.
[12] Boardman 1974, 104.
[13] Boardman 1974, 104.
[14] Whitley 2001, 178.
[15] Biers 2005, 71.
[16] Boardman 1974, 104-105.
[17] Whitley 2005, 62.
[18] Perevodchikova 1994, 8.
[19] Rau 1929.
[20] Meliukova 1964.
[21] Petrenko 1967.
[22] Hančar 1972.
[23] Eckhardt 1996.
[24] Illins´ka 1973, 13-26.

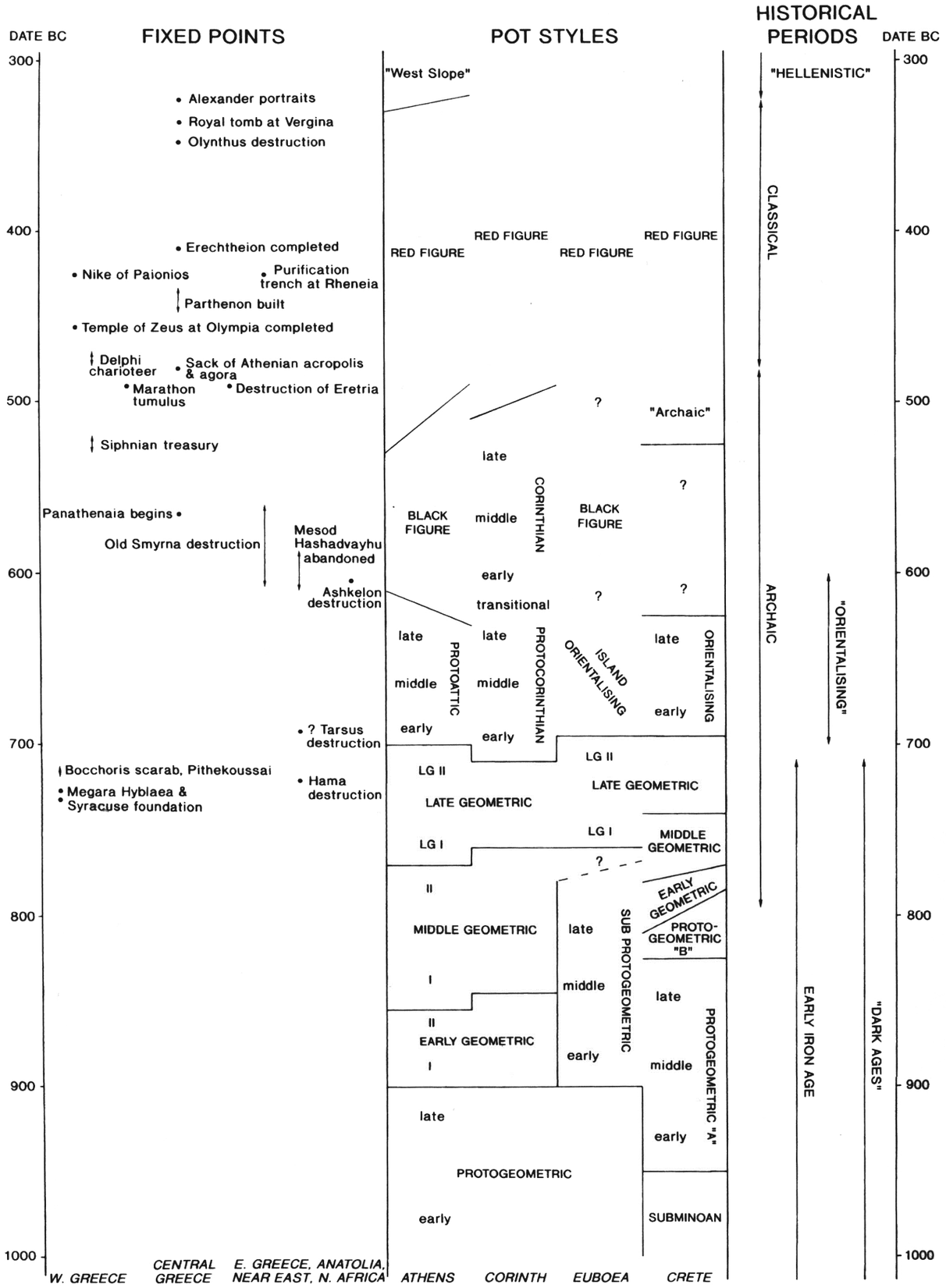


Fig. 1.3.1. Geek chronology (adapted from Whiteley 2005).

the chronology does have a time frame, she does not explain how this was evolved and it is based on central Europe. It has also been found that the application of these chronologies can produce contradictory results, as in cases when "early" arrow heads are found together with "late" forms in closed complexes. This could be due to specific uses of the arrow heads (differentiated perhaps for hunting birds or large/small mammals, heavily/lightly armoured enemies etc.) and not due to supposed chronological developments.[25]

The chronologies developed for the akinakai (Scythian daggers/swords with specific heart-shaped haft) developed from the hypothesis that these weapons are an important indicator of the ethnic presence of Scythians in whatever area they are discovered. The first chronology was developed for southern Russia by W. Ginters in 1928.[26] All of the known examples from southern Russia and the Don region were included in the study, from which he concluded that it was not possible to construct a precise chronology in the evolution of this weapon; the author believed that the original prototype for this weapon was not an indigenous development but rather that it was imported from the Middle East.[27] This typology was the standard reference work for akinakai until 1964 when A. I. Meljukova published a comprehensive study of the akinakai from the Scythian populated regions and compiled a new typology from the results. It is based on two groups of akinakai: with or without antenna, with six sub-groups for the former and three for the latter, depending on the shape of pommel and the heft.[28]

Further west, on the edge of the actual "Scythian" area, excavations from Romania (e.g. Ciumbrud, Ferigile and Bîrseşti) provide the bases for a relatively finer chronology. In 1990 a chronology was produced for the short swords, daggers and fighting knives from Romania.[29]

I am here partly using the chronology proposed by Vulpe[30], since it was published fairly recently and has the advantage of taking into account influences from the Aegean, Central Europe and Eastern Europe. Each of these regions has its own chronological system, often difficult to integrate to the others. The chronology by Vulpe was proposed for a region where these cultural circles meet, and is therefore suited for my purpose, even though I am aware of the fact that it is still contested in important aspects[31].

In the study 218 weapons were compared to produce a chronology, but only 86 of these were akinakai and the statistical results have not been adequately proven, assuming that the Hallstatt chronologies are not in themselves subject to further refinement and debate. The fact that a number of the variants have a limited sample of only 1 or 2 akinakai, e.g. the Ferigile[32] and Piliny[33] types, indicates that more research has to be undertaken to see if this chronology, based on Romania, can indeed be used to date akinakai from other regions. According to this study by Vulpe, the akinakai were divided into three groups, each with sub-variants,[34] in principle using the same criteria as the study by Meliukova. The discovery of more akinakai at Mărişeu and Budeşti-Finaţe meant that a sub-variant could be produced for this region which was referred to as "Posmuş" by the author and is considered to be one of the oldest forms in the Carpathian Basin.[35]

The study of the Scythian art style, commonly referred to as animal style of the Scythian epoch, is a difficult field to work in, partly because of the huge number of artefacts which come from the entire Eurasian steppe and grows every year, already exceeding thousands. The quality of the publications of the excavations, even when they are published in any detail, leaves much to be desired. The popular literature often regurgitates the same world famous excavations, which contained exceptional material, but cannot be considered as relating to the normal population and thus confuses the issue still further.[36] The catalogues of the artefacts that have been excavated in the past, especially the gold and silver, have sometimes not even been registered yet in the principal museums of Russia and a whole generation of students, who have studied in Moscow, have not been able to see the material in a permanent exhibition. Finds from the Altai region, where organic material is preserved in permafrost lenses, indicate that Scythian animal art was applied to wood, skin and felt, although this has not survived in the archaeological record from other areas.

It is believed that the Scythians were an illiterate people and that the imagery is a form of communication. A number of scholars have tried to decipher this art by studying, in two different ways, the type of creature that was stylistically reproduced. The structure of the universe is believed to have been divided into three levels in ancient cultures:

[25] See for example: Boroffka 2002, 233-240.
[26] Ginters 1928.
[27] Ginters 1928, 88.
[28] Meliukova 1964, 46.
[29] Vulpe 1990.
[30] Vulpe 1990, 102 sqq.
[31] The originally proposed chronology of the Ferigile (Vulpe 1970; Vulpe 1967) group was changed repeatedly by Vulpe (1979; Vulpe 1977) as a consequence of the very pertinent remarks by Lang (1976). The publication of the Ferigile necropolis is unfortunately so incoherent that the complete inventories of the graves can not be determined for an independent review. It must further be remarked, that the individuals buried in Ferigile appear to have been mostly children and ethnic attribution is still heatedly discussed (e.g. Vasiliev 1999; Vasiliev 1994; Vulpe 1990; Vasiliev 1989; Marinescu 1984; Vulpe 1984; Vasiliev 1980; Vulpe 1972; 1970). Besides that, the chronological relationship between the Basarabi and the Ferigile cultures has also come under criticism again recently and the two cultures may overlap considerably in time: see, for example, Boroffka 1998; Kull 1997a; Kull 1997b; Roeder 1997; Boroffka 1995.
[32] Vulpe 1990, 31.
[33] Vulpe 1990, 42-43.
[34] Mihăilescu-Bîrliba 1976, 109.
[35] Marinescu 1984, 70.
[36] An example of this type of literature is the catalogue of the exhibition of the British Museum for the Greek Gold Williams *1994*. Although the quality of the publication is excellent, there is no new information about the material being studied. A brief insight to the results of the research that was conducted in the British Museum when the material was restored is given in the paper by D. Williams in the "Art of the Greek Goldsmith": Williams & Ogden 1998.

the celestial, the middle and the lower; this philosophical concept is often referred to in the current literature as the world tree (leaves, trunk, and roots).[37] They are represented in the animal art style of the Scythian culture by birds and griffins for the upper, herbivores and carnivores for the middle, while the lower could be represented by fish and snakes. It is also possible to meet mediators between the different groups, e.g. boars can be represented either as carnivores or herbivores. The vertical philosophical concept can be discerned on Scythian artefacts that have been decorated with motifs in the animal style. The second technique that has been used by scholars is the attempt to understand the artistic meaning of the animals and the traditions behind them.[38]

The latter concept was originally introduced by the Russian historians and archaeologists M. I. Rostovtzeff and G. Borovka (Boroffka)[39], who identified the basic criteria of the Scythian animal style. The accuracy of their conclusions is still accepted by most modern scholars. The Scythian animal style differs from other artistic styles by the way in which the body of the animal is modelled and its separate components, i.e. the feet, horns, beaks, eyes and mouths are comprised of planes at convergent angles. These planes form relatively large areas with sharp edges, resulting in the characteristic fall of light and shadow complementing each other. Some parts of the animals are commonly exaggerated, e.g. the horns of deer are the same length as the body, enormous eyes can occupy the whole of the head, frequently designating the edges. Nostrils and mouths of predators can also be used to denote the limits of the head, a result which often appears to contour the form of these parts of the animals as dictated by the outline. In order to place emphasis on a particular part, that part is not only represented unnaturally enlarged, but can sometimes be supplied with additional images of animals or parts thereof.

In the case of the predators, it is often difficult to assign the exact species that is being portrayed by the stylized representation. For example, the wolf is considered to be a local Eastern European concept compared with the exotic feline predators which are thought to have been introduced from the Middle East.[40] Wolves are thought to be discernible by the shape of the mouth, in the transitional form when the head is not elongated. (The shape of the tail does not help with the recognition, because it is usually the equally long tail with a ringlet at the end.)

Wild boars, which are omnivorous and therefore can be considered as being partially predatory, are represented as a serious danger with their firm jaws and canine teeth. The hooves are often represented in the position of a herbivore, i.e. the feet are tucked in, but they can also be represented in the pose of a predatory animal. It is therefore thought that this animal may be a mediator between the two spheres of predator and prey.

Imaginary creatures are created by the combination of the body of one animal with other features from another creature, e.g. feet, horns, wings and the tails of snakes; it appears that these combinations were strictly controlled by the philosophical ideas about the world. Each ancient society had its own way of representing and depicting fantastic creatures. The syncretic essence of the Scythian animal style was influenced by contacts with neighbouring cultures, which were incorporated into the indigenous style. This has resulted in local variations, which can be of aid in trying to identify where the individual pieces were manufactured.

This is best exemplified by the use of a specific object, where the indigenous and the external influences can be discerned and thus diagnosed. In my opinion the most profitable are those conventionally designated as griffins. This imaginary creature appears to have been introduced from the Middle East, probably during the time of the Scythian incursions into this region in the late 8th – early 7th centuries BC. The earliest known form is often referred to in the literature as being constructed in the Scytho-Iranian animal style (see Fig 1.3.2-5).[41]

In these pictures, the Middle Eastern influences can be observed in the style; in the modelling of the surface there is no indication of the typical Scythian convergent planes with their smooth transitions, while other features are purely Scythian, e.g. the lying deer, the bird heads, and the rolled felines. There is still a debate on the origin of the foreign influences: some scholars believe that it is Assyrian[42], whilst others believe it to be Urartian,[43] or Median, as indicated by the Ziwiye treasure manufactured with Urartian influence incorporated into the design.[44] This confusion arises because of the lack of research that has occurred in Iran and Iraq during the last decades, mostly due to political problems and the religious ideology.

In the 5th century BC the appearance of the griffins changes on Scythian artefacts. At this time there are two different types of this creature present, with either Greek or Persian influences apparent. The Greek form of *"orlingolovye"* griffin has the same combination of predatory beast's body with the head of a bird. The major variations that appear in them are: the wings are no longer a bent crescent, and they are closer to the natural form, the protrusions on the foreheads and the curls that ran down the neck disappear, the latter being replaced by a toothed crest, the ears are no longer produced in the same style as they were previously, but are reduced in size. Representations of this griffin type appear on Greek coins and painted vases of this period. In the Persian *"orlingolovye"* griffins they are similar, with

[37] Perevodchikova 1994, 13.
[38] Perevodchikova 1994,16.
[39] Rostovtzeff 1973; Boroffka 1928; Borovka 1928; Boroffka 1927.
[40] Perevodchikova 1994, 45.
[41] Kossack 1987, 65-85.
[42] Gautier 1925, 224; Pridik 1911, 20-21.
[43] Jessen 1947, 45; Turayev 1935, 77.
[44] Chernenko 1980, 26; Lukonin 1977, 33; Piotrovskiy 1959, 252.

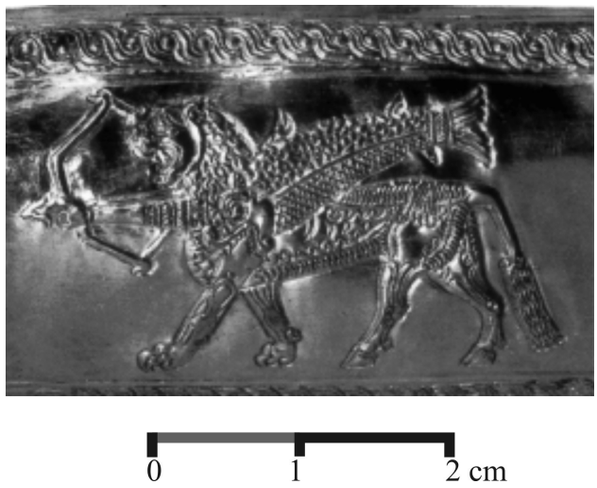


Fig. 1.3.2. Feline headed griffin akinake sheath Kelermes Kurgan (adapted from Galanina 1997).

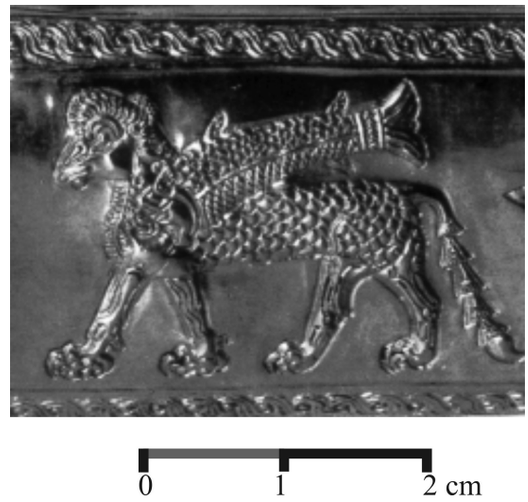


Fig. 1.3.4. Ram headed griffin akinake sheath Kelermes Kurgan (adapted from Galanina 1997).

Fig. 1.3.3. Bird headed griffin akinake sheath Kelermes Kurgan (adapted from Galanina 1997).

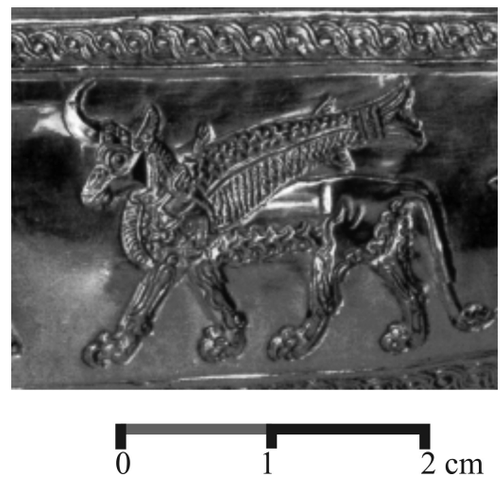


Fig**.** 1.3.5. Goat headed **g**riffin **a**kinake sheath Kelermes Kurgan (adapted from Galanina 1997)**.**

the use of the same combination of body and head, but on the head there are horns of a mountain goat, which are bent in a specific manner and are ribbed.[45] When the griffin is represented with a predatory beast's head it is referred to as *"L´vinvoglovymi"*. The Achaemenid form has the same type of wings with male goat horns. This type of griffin is very common in the Scythian animal art style, with the attention placed on the eyes, ears, mouth, horns and claws; however, it should be noted that the syncretic elements in the Scythian style are very diverse.

The origin and the additions to the Scythian animal style are a complex problem because this art style seems to appear in the archaeological record with its characteristics already fixed and organised into a united system without evolving from previous art forms of the indigenous population. From the information that is available at the moment, it appears that this art style appeared practically simultaneously throughout the Eurasian steppes, although this was not apparent to the first researchers working in this field. In particular, with the earliest excavations that were conducted in Southern Russia on the kurgans, the links with the Siberian material in the collection of Peter I were not recognised.

The earliest excavations of the kurgans were conducted in the vicinity of the Greek colonies and the artefacts that were discovered there are a combination of Greek imports and indigenous manufacture, forcing the researchers to the conclusion that the roots of the Scythian animal style must be sought in the adjacent civilisations. The theory of the Ionic Greek origin of the Scythian animal style was

[45] Perevodchikova 1994, 52.

advanced by B. V. Farmakovskiy[46], who focused attention on the special features of the art style of the Greek cities of Asia Minor and the Ionic islands. It was recognized that the art of the Ancient East had been incorporated into archaic Greek art and some of these could have been used as prototypes by the Scythians. M. I. Rostovtzeff[47] introduced the hypothesis that Iran may have been the origin of the Scythian art style on the results of the comparison of copper alloy artefacts.

This brilliant researcher also recognised, even from the limited data available at this time, the links to north western China. E. H. Minns[48] expanded on his theory from 1913, that the origin of the Scythian animal style was probably Siberian, using a demographic population zoning of deer and the distribution areas of the deer images in Scythian art, the only region where they coincide being Siberia.[49] Further evidence that the Scythian animal style developed from the Siberian animal style is the Sejma-Turbino culture, whose copper alloy artefacts have been discovered ranging from Mongolian Altai to Borodino to Southern Finland and Estonia.[50] The distribution of the 422 copper alloy artefacts and 30 moulds indicates that the cultural artefacts from the Sejma-Turbino group are a transcultural phenomenon because they have been discovered in the area of the Andronovo culture and the Abaševo culture.[51] This model of the transcultural objects has now been questioned by H. Parzinger who believes that the Andronovo culture in the first half of the 2nd millennium BC spread from the steppes between the Ural and Itrysh to the south first in the direction of the Aral Sea and later as a sub group in the direction of Tien-Shan and the Altai mountains.[52]

Material in the animal style east of Irtysh and Ob, which belongs to the Karasuk and Tagar cultures, is later than the material from the Sejma-Turbino group and the Andronovo culture, which may have chronologically coexisted. Karasuk culture metalwork may have been influenced by the earlier two cultures in the last third of the 2nd millennium although this is hypothetical due to the lack of archaeological information from the southern Altai and the adjoining regions of the Sinkiang and Mongolia.[53] At the beginning of the 1st millennium there is the appearance of ferrous along with copper alloy artefacts which date the Tagar culture. These cultures produced an animal style which is different to that of the Andronovo and the Sejma-Turbino cultures and the early Scythian animal style is thought have derived from influences of all four cultures.[54]

The carved artefacts from the East of the Urals and west Siberia are all unprovenanced and can not be archaeologically dated except by art historical methods although they are produced in a similar style to that of the copper alloy artefacts which have been previously discussed.[55]

The above mentioned difficulties in the dating of Scythian artefacts, especially the jewellery, were a major factor in deciding to undertake this technological study, to see if it is possible to clarify this problem of cultural attribution and propose independent dating through the manufacturing technology involved in the production. The study of Scythian incursions, be it a temporary or permanent occupation of the region, is very difficult because there is no accepted definition of the material culture of this important force in prehistory. The ethnic makeup of this culture is also open to debate, with national pride and prejudices becoming involved, resulting in uncertain sub-divisions of this culture. To expect a continuity in the social, ethnic and material culture for a group which ranged over such a large territory is a product of our society and may not be a reasonable expectation for a time when it could have taken months to communicate between the different regions ranging from the Carpathian Basin around the Black Sea to Siberia in the North.

[46] Farmakovskiy 1914.
[47] Rostovtzeff 1932; Boroffka 1930; Boroffka 1928; Boroffka 1927; Rostovtzeff 1925; Rostovtzeff 1922.
[48] Minns 1942.
[49] Minns 1942, figs. 1-2.
[50] Parzinger 1997, 224.
[51] Chernykh 1992, 215-216.
[52] Parzinger 1997, 238.
[53] Chernykh 1992, 269.
[54] Parzinger 1997, 243.
[55] Parzinger 1997, 238-241.

CHAPTER 2

Case studies

2.1 Introduction

This chapter will discuss the possible influence of other cultures on the Scythian culture in order to show that the Greeks may not have been the dominant culture influencing the development and production techniques of the Scythian gold jewellery which is discussed in the following chapters.

Although many objects from the Classical World have been studied from an art historical and technical perspective, very little from the Eurasian steppes has been studied from the technical angle. This could be due to the limited access to this material under the former Communist regime, which rightly considered Scythian art to be among the most prestigious, culturally valuable and art historically important materials to be excavated on the territory of the former Soviet Union. There has been so much material excavated, both legally and illegally,[1] that a very large part has never even been adequately published or studied.[2] This fact has resulted in a biased image in favour of the Classical Greek goldsmiths, who have been assumed to have played a predominant role in the production of the internationally renowned gold artefacts from this region of the world. It is surprising that the majority of the masterpieces of Classical Greek art have survived in the Ukraine, where there is equally as large a problem with grave robbers as in Greece. In nearly all of the excavated kurgans there is evidence of ancient and modern thefts having taken place, e.g. at the Chertomlyk Kurgan.

Whenever one is dealing with a culture, it is a mistake not to take into consideration the previous indigenous cultures within the region that is being considered. Previously when considering the appearance of a new culture in the archaeological record – because of a change in burial customs, for example - it has been thought that the original culture was removed, either by genocide, or by the complete domination of the indigenous people by the new culture. This may be a complete fallacy and a product of our imaginations, because no culture can be totally eradicated overnight. The easiest way to take over a culture is to eradicate its leaders, for the general population does not worry who is in charge of them, as long as their own lifestyle has not changed.

This means that when one is considering the Scythians it is also necessary to consider the cultures that were in this region before the Scythians, to see if the Scythians had taken an existing culture and dominated that, using the exchange mechanisms and the cultural contacts that had already existed within this culture. The Scythians would have to have exploited an existing power base to gain dominance of the indigenous cultures. The wide ranging contacts of the Scythians could not have been established without some previous knowledge of these cultures. The Scythian culture ranged over a vast area of land, from Transylvania in the West, to Kazakhstan in the East, from Siberia in the North to the Persian Empire in the South. The control of vital resources would have been of vital importance to these people, e.g. iron, copper, tin, salt and gold, which would first of all have to be found and then exploited before being exported to other regions; if these resources had been exploited earlier, then the Scythians would not have had to rely on external sources for these raw materials - they would be able to re-exploit these materials after finding where they were situated and gaining control of these regions.

The Scythians had gained control of the salt and gold fields in Transylvania, which could be the furthest westerly area of domination by Scythians.[3] The control of these gold fields and, perhaps, the more important salt fields would have meant that the Scythian kingdom around Olbia would have had access to these valuable resources and not have to rely on transport of gold from the Caucasus. However the exploitation of the gold bearing alluvial sands cannot be archaeologically proved at the moment due to the lack of research done in this area at the present. The exploitation of the salt has been found by radiocarbon dating to have occurred from the Bronze Age;[4] although there is no direct evidence that the Scythians were involved in the mining of salt, it is probably only be a matter of time before the evidence appears to link the Scythians with this vital resource.

In Eastern Europe, it may be possible to show that the Scythians did exploit the basis of the Bronze Age cultures, because the Scythians can be seen to use the basis of the Eurasian metallurgical province that was made up of five areas: the Caucasian, European, Irano-Afghan, Central Asian and Eurasian. This was a maximum area of around eight million cubic kilometres when the loose confederation

[1] Much of the illegally excavated material has ended up on the open art market or been melted down for bullion and this trend will have probably increased after the collapse of the Soviet Union. In the Ukraine there are approximately 50,000 unexcavated kurgans from the Scytho-Sarmatian period and due to the geographical dispersion of these monuments it is not possible to protect them adequately.

[2] Wherever possible I have given the numbers of examples of any one plaque type and their find location. For most Scythian clothing plaques, however, such information is not available: Jacobson 1995, 165.

[3] The concepts for the region of Scythian dominance were originally based on the description of Herodotus, who stated that the borders ran from the Ister (Danube) in the west to the Tanais (Don) in the east. Herodotus's knowledge of the local tribes fixed the northern border of Scythia and their settlement pattern. Herodotus IV, 107

[4] Boroffka & Heck 2006, 81.

was at its zenith.[5] The western border was around the Dnieper and the eastern border was in the middle Yenisei basin, whilst the most easterly focus was in the foothills of the Altai and eastern Kazakhstan; the southern border ran around the coast of the Black Sea, the sub-Carpathian steppes, and skirted the desert regions of Soviet Central Asia; the northern border is not as well-defined as the rest. Many cultures were joined in the loose confederation, the nucleus being the communities of the steppe and the forest steppe dispersed across eastern Europe, western Siberia and Kazakhstan. The results from the archaeological work conducted in this region indicate that there was a pastoral economy with some agricultural based societies. This knowledge of agriculture resulted in a revolutionary change in the economic base of the societies. Mining and metallurgy were also very important. Nearly all of the copper ore deposits in the Urals, the Kazakh metallurgical region, the Altai mining and metallurgical centre and the small outcrops of copper oxide ores that form the Changali mines in the desert regions of Soviet Central Asia were used by the Late Bronze Age. The amount of copper ore mined from two of the Kazakh copper ore deposits, Dzhezkagan and Kenkaezgan, lay in the region of 1.5 to 2 million tons; between 60,000 and 100,000 tons of copper could be melted from this ore.[6] Another required material for production of bronze, tin, was also exploited; mines from this period have been found at a number of locations, which form a long chain through the Kalba and Narym ranges of the western Rudny Altai.[7] There are also mines for tin ore in southern Soviet Central Asia at Changali and Karnab in the Zirabulak-Ziyadin Mountains, where ancient mining workings have been recorded.[8]

The transport of raw materials from the area where they were mined to the places where they were required would have meant that there were extensive trading networks between various cultures. It appears that the Late Bronze Age societies were not isolated but had economic, ideological and kin-based interconnections through which the mechanism of exchange of these vital materials was facilitated. These connections were probably exploited by the Scythians at a later date when they came to dominate most of this region.

A large number of scholars do not believe, or accept, that there may have been a metallurgical tradition in this area of the world before the Greeks had contact with the Scythians; they have always used the lack of gold artefacts from the preceding cultures to indicate that the techniques and technology of gold jewellery production are a product of the Greek colonisation of the North Pontic area. This may be a product of archaeological bias, because there is evidence of gold working in two important cultures from the early and middle Bronze Ages: the Early Bronze Age culture referred to as Maikop which was spread in the area known as the northern Caucasus, and the Middle Bronze Age culture in the Transcaucasus, referred to as the Trialeti culture. The Maikop culture occupied the western region of the northern Caucasus and the majority of its sites were located in the Kuban region, extending to the Black Sea and the Sea of Azov. It is also present in Georgia and Abkhazia. Most of the excavations have been conducted on the burial grounds, with only a few settlements having been discovered.

The culture derives its name from one excavation that was conducted by N. I. Veselovsky in 1897 in the vicinity of the town of Maikop. This was a very rich kurgan which contained 68 gold appliqués representing lions, 19 depicting bulls, 10 petalled rosettes, and a large quantity of gold rings. Next to the skeleton there were six silver rods, some of which had long-horned terminals, two in silver and two in gold. Along the eastern wall of the grave, 17 vessels were discovered: one of stone, 2 golden and 14 produced from silver. Two of the vessels were decorated with scenes, in both cases with animals; one had a mountain depicted with bulls, leopards, goats, birds and other animals in a kind of procession.[9] Another rich kurgan was excavated in 1889 near the village of Staromyshastovskaya, also containing a large assemblage of silver and gold objects: the silver vessel with a lid, silver figurines of a bull and an antelope, a bull's head made from gold, rosettes, 40 little rings, and more than 2500 gold and silver beads, as well as approximately 400 carnelian beads.[10]

The Trialeti culture is known from the excavations conducted by Kuftin in the 1930´s and later continued in the 1940´s and 1950´s at Trialeti in southern Georgia. In kurgans 5 and 17 there were a number of gold and silver artefacts found.[11]

No direct link from the Maikop and Trialeti cultures to that of the Scythians can be constructed, because there is at least one thousand years between these cultures. However, they do indicate that in this region of the world before the advent of the Greek incursions there were highly skilled goldsmiths, as well as coppersmiths. It is no longer valid to insist that the Greeks introduced the techniques of filigree and granulation to the Scythians because this technique was already known much earlier in the region and thus could have been introduced to the Scythians from this source. The lack of continuity in the archaeological record may be a product of thefts, producing archaeological biasing in the record. To prove if these techniques were in continuous use in this region would be exceedingly difficult and problematic and outside the borders of this work.

It has been considered by many scholars that the techniques for working with gold had been introduced by the Greeks into Scythia and that the indigenous culture

[5] Chernykh 1992, 191.
[6] Alekseev & Kuznetsova 1983, 206, 211.
[7] Chernikov 1960, 118-36, 1949, 10-36.
[8] Litvinsky 1950, 51-62; Parzinger & Boroffka 2003, 15-145.
[9] Chernykh 1992, 67.
[10] Chernykh 1992, 71-72.
[11] Chernykh 1992, 111.

had no experience of working with this medium before the Greeks arrived in the Black Sea. This has been inferred from the fact that gold working has been discovered in many excavations conducted on Mycenaean sites, where many gold artefacts have been discovered. These artefacts indicate that there were contacts with the Near Eastern countries from which it is believed that the more advanced techniques were introduced. It was previously believed that with the collapse of the Mycenaean world, about 1100 B. C. after approximately a hundred years of turmoil, these techniques were forgotten and reintroduced through the renewed contacts with the Near Eastern countries at the end of the Dark Ages. However the latest studies have shown that this may not be the case. For example, earrings that were produced with cones or pyramids from granulations have been studied: the earliest known such artefacts are the late Middle Minoan ones from Poros near Knossos. From this form the early Late Minoan earrings in the form of a stylised bull's head arise. Similar forms can be discerned in the later Cypro-Mycenean and geometric Cypriot jewellery as well as among early Greek geometric forms with three cones of granulation from Lefkandi.[12] Technology is also an indication of continuity from the Mycenaean world to the early Iron Age Greek goldsmiths. Granulation is the most frequently cited example, used as early as Middle Minoan on Crete and practised until the end of the Bronze Age (or later) in continental Greece and in Cyprus. Cloisonné was practised in the Mycenaean world, examples of which are the gold finger rings from Sellopoulo or the sword hilt from grave IV in the Acropolis circle of Mycenae.[13] Engraving, however, cannot be conclusively proved to have survived from the Bronze Age, because its use was limited in the late Minoan period, e.g. to double axes and the few pins with engraved decorations. The production of plaques using the same motifs is also an indication of continuity; they were produced by forcing thin gold into a mould. This is the most common form of decoration that can be discerned for material found in the shaft graves at Mycenae, especially in the small plaques of animals which were cut along the outline of the design. This technique of mass production recurs extensively in the later Mycenaean period, e.g. in the gold relief beads which have identical motifs.[14]

The Scythians had contact with other cultures e.g. the Near East and western Asia during incursions into these territories. The Scythians were crossing the Caucasus in the 7th century BC on their way to the Middle East and settling in this area on the their way back in the 6th century BC.[15] The Oriental tradition of the Near East and western Asia consists mainly of a sheet gold technology, which can be characterised by the manipulation and the assembly of separate components, based on separate sheets, wire and granulation. These components are frequently minute and a large number of individual pieces were required to construct the whole assembly.[16] Whilst the tradition in Europe was based on the technology used by the coppersmiths, the artefacts are typically larger and produced by plastic de-formation of the gold mainly by the use of hammers. These differences in constructional techniques have resulted in differing stylistic traits, which can be mainly seen in the physical size, the ability of producing integral settings, design and the way that the laws of nature are adhered to, e.g. the way that separate parts are joined together. In Europe it was common to use mechanical fixing methods due to the difficulties in producing a uniform and controlled heat source that would allow the components to be joined by a solder. It was with the influx of the technology from the Orient that granulation and filigree appeared. How this happened is unknown at present; the theories that have developed are dependent on either Oriental craftsmen migrating to Europe or the technology being diffused to Europe.

The development of an indigenous gold and silver working tradition is dependent upon there being a local source which can be exploited. As these sources are limited in the world, many had been exploited since the Bronze Age, which resulted in many of these sources being exhausted by the period that this study is concerned with. Even when these mines were not exhausted, the later exploitation of these ore sources may have eradicated all evidence of early mining. Two of the potential gold sources which can be shown to have been under Scythian control from the 7th Century BC have already been discussed; however, there were many more sources of gold and silver which were exploited in the period under consideration. The gold and silver mines that were under Greek control were the mines of Macedonia and Thrace, of Siphnos and Thasos; alluvial gold was exploited in the region of Mount Tmolus and in the Pactolus River, silver was mined in Macedonia and in Thrace.[17] The sources of gold around the Black Sea are not well-documented, but it is a well-known fact that alluvial gold was exploited in Georgia; this source may be the foundation of the famous story of Jason and the Argonauts and the golden fleece, because of the use of unwashed fleeces being used to collect gold as the river water flows over it even in modern times.[18] The Urartian sources may have also been exploited by the Scythians; however this cannot be proved archaeologically, since kurgans in this area cannot be excavated, because they are too near the modern international borders. It is believed that this gold field lies in the area that the Scythians used to make their incursions against Urartu.[19] There is no evidence of a Scythian enclave in the Caucasus and all of the Scythian finds are found within indigenous population cemeteries, so the Scythians did not control this area; they may have only passed through this area on their way further south.

[12] Williams. 1998, 9.
[13] Williams 1998, 10.
[14] Williams 1998, 11.
[15] Nagler 1996, 15; Vinogradov 1972, 10-80; Vinogradov 1963.
[16] Williams 1998, 14.
[17] Treister 1996, 21.
[18] Scythian gold, ZDF historical television programme 2008
[19] Pers. Comm. Dr. I. Motenzenbecker.

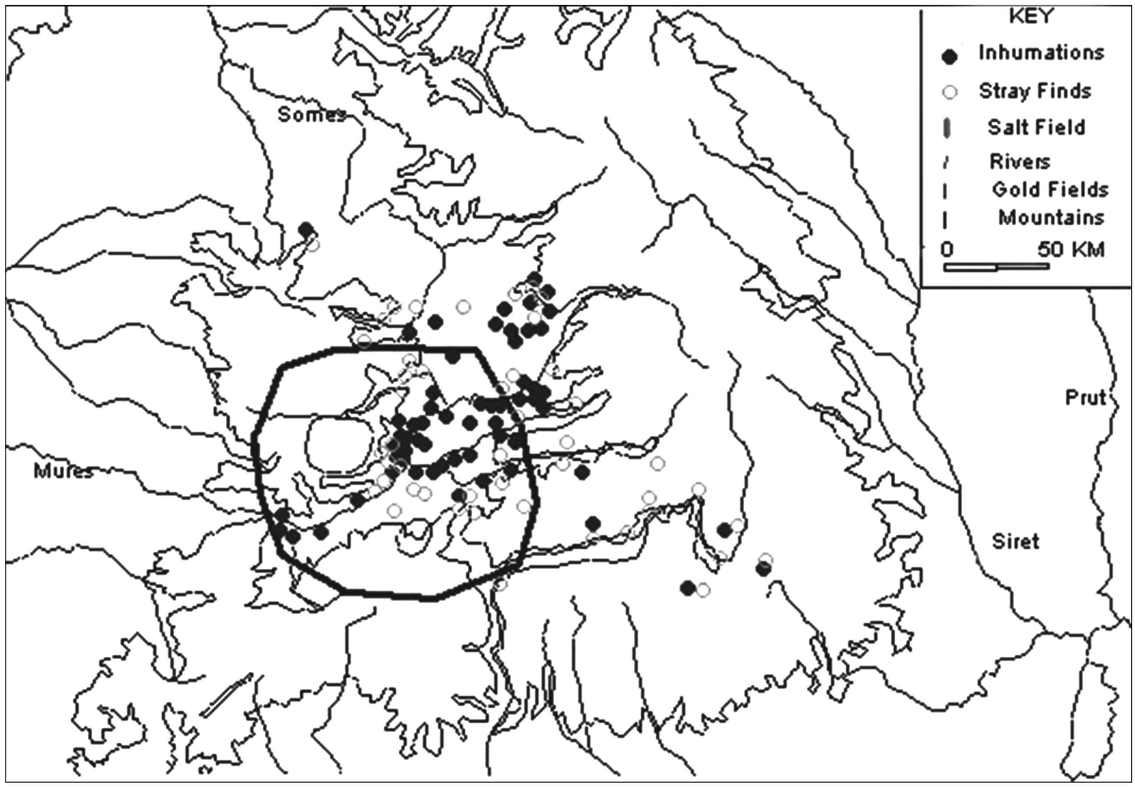


Fig.2.1.1. Scythian stray finds and inhumations in relationship to the Transylvanian gold and salt sources

The potential gold mines in Transylvania can only be considered through addressing remains of material culture from excavated sites near the known mines. None of these mines have been excavated to identify which culture they were exploited by; it has always been assumed that they are Roman. This conclusion was drawn because of the lack of archaeological material from the Middle Ages or later indicating that this area was not occupied at this time.[20] A lack of interest in the evidence of previous exploitation in this area, when there was a re-exploitation of the mineral resources in the middle of the 17th century AD has also contributed to the fact that little is known about prehistoric workings.[21]

From the map of Transylvania it can be seen that none of the Scythian stray finds and inhumations have any relationship to the gold mines that were exploited by the Romans or in the 17th century AD. There is also no evidence of exploitation of the alluvial gold by the discovery of any archaeological sites which could be linked with this process. The discovery of ancient gold working sites has proved to be very difficult. The only archaeologically proven exploitation of alluvial gold was discovered at Sardis and this is only apparent from a few grains of alluvial gold discovered in the excavations. The richness of this source of gold may have meant that the Scythians did not need to exploit the gold, while the Romans had to mine because the alluvial gold had been exhausted.

The inhumations and stray finds discovered in Transylvania show that the Scythians were concentrated in the valleys between the 2 sources of gold ore in the mountains and thus in an ideal position to exploit the alluvial gold. The type of exploitation was probably a local industry exploiting a local resource dependant upon a local support system; the concentration of Scythian kurgans indicates the incorporation into their political system and distribution system. Due to the climatic conditions (harsh winters) the exploitation of the alluvial gold would have been on a part time basis with it being based on the summer months. The production centres would have been dispersed over the valley systems and probably left very little in the archaeological record, because it could just be the traditional technique of panning the gravels to recover the gold. Although there is no direct evidence for the exploitation of the gold in this region, the construction of the mines by the Romans to exploit the gold through the more difficult technique of mining and extracting the gold from the ore, shows that the deposits were known (Fig.2.1.1).

[20] Wollmann 1996, 351.

[21] Wollmann 1996, 351, Bergswerkdirection 1856/876. Boroffka & Heck 2006 also give gold deposits in the Dobrudja, near the mouth of the Danube, and the Scythian cemeteries nearby (e.g. Celic Dere, see Simion 2003) could be connected to this. Such a gold source would also be nearer the other Greek colonies around the western Black Sea, however the connection between the Scythian finds and the ore deposits has not been properly studied yet.

It is impossible to estimate how much gold could have been won from the alluvial flood plain by the Scythians, but potentially this source would have been richer than the river Pactolus due to the tectonic movements that affected the flow of this river, and which did not affect the rivers in Transylvania. The exploitation of the alluvial gold from Transylvania could have supplied enough gold to produce all of the known Scythian gold artefacts and may be the reason for the founding of the Scythian artesian town of Belescoe and the source of the wealth of the richest Greek colony in the North Pontic, Olbia. Transylvania in Romania is still considered to be a valuable source of gold and will be exploited in the future by open cast mining.

The Greek colonisation of Eastern Europe and its effects on the Scythians will now be explained along with the limitations in our knowledge because this colonisation affected the style of gold artefacts which are the focus of this study.

If it is proving difficult to understand the reasons when and why colonization occurred by the Greeks in Western Europe, it is proving even more difficult to draw conclusions from Eastern Europe, where research is more spasmodic. The Greek colonies in the North Pontic region have not been excavated to the same degree, although there are exceptions to this, e.g. Tanais. Many scholars believe that it was the export of corn which caused the foundation of many of these cities. However, as much of the early layers have been destroyed by later occupation of these regions, it is probably impossible to prove this by archaeological means. The exploitation of the iron ores in the Kerch-Taman peninsula does not appear to be the primary consideration for the foundation of the colonies as the main exploitation of the iron ore occurred with the second or third generation of colonists.[22] Colchis has been given special status by scholars because of Strabo (1.2.39), for no Greek city state with an agrarian economy developed in this region; before and during the Greek colonisation the coastal region was filled with local settlements with a developed class system and aquaculture. Colchis may have been supplying the eastern Transcaucasus, the Near East and the Aegean basin because of the lack of early materials related to iron metallurgy in these regions; the remains of many smithies have been excavated from the 9th - 6th Centuries BC in Colchis.[23] The control of this source of iron may have had an influence on the Greeks in the formation of the colonies in Colchis; however this is very difficult to prove archaeologically, if not impossible. It was probably not one of the controlling factors for the foundation of these cities because the small seasonal exploitation of the iron ore was probably not economically viable for transportation to Greece. By the 6th Century BC enough iron was already in Greece to make this unnecessary. Gold, that is also available in Colchis, may also have not played such an important role in the foundation of these cities, because there were other sources of gold nearer to Greece, e.g. Thrace and Lydia, although the foundation of apoikiai in Colchis may be due to the shortage of gold after the conquest of Lydia in 546 BC.[24]

It is now impossible to tell how much raw material was required for import into Greece, although through the analysis of lead isotopes it can be shown that silver used in the production of Greek coins from the mid 6th to early 5th Centuries BC (three out of a total of 112) could possibly have been minted from metal originating in Iberia.[25] However there is a lack of analysis of coins that are earlier or later than this period and thus the arguments based on the exploitation of metals as the reason for the colonization by the Greeks in other regions has been constructed from a partial database. The alloy that was used to produce bronze has also been studied in trying to answer the question of where the origin of the tin was. It is believed that the tin was transported from north-western Europe to the Aegean basin. In the analyses conducted by the British Museum on the amount of tin used to produce bronze it was found for the late Bronze Age that concentration varied between 5.6 to 15.8%, the average being 7.4%. Approximately the same amount of tin was used in the production of bronze in the Greek geometric period; in the Archaic period the average tin content was around 8%, 7.4% in metal used for dedication statuettes, 8.9% in decorative bronzes, 9.9% in mirrors and 8.5% in vessels. In the production of bronzes in the classical period the average amount of tin was 8.5%.[26]

It is also impossible to tell from the archaeological record if orientalization occurred through the import of finished goods or due to the influence of craftsmen migrating to Greece. There is evidence from a number of excavations that Phoenician craftsmen were residing in Greece, especially at Kos, Rhodes, Crete and possibly Ephesus. The late geometric jewellery of Greece preserved a strong Phoenician influence, which may suggest that there were still a few master craftsmen from the eastern Mediterranean, especially in Crete and Attica. A pair of gold earrings from the "tomb of a rich Athenian lady", dated approximately 850 BC, was produced in local design, however using Syrian/Phoenician techniques of filigree and granulation. This was perhaps the work of a Near Eastern goldsmith who resided in Athens. The status of these individuals within Greek society may be shown by the burial of the Phoenician goldsmith excavated in the mid 9th Century tomb at Tekke on Crete. J. N. Coldstream thought that he had a special connection to the local aristocracy, which may have been through marriage. The apprentices of this individual are thought to be his sons and grandsons, who gradually adapted to the local taste.[27] It should be noted that J. Boardman suggested that the craftsmen working in Crete, Attica and Euboea were producing artefacts whose style can be matched to what was produced in North Syria

[22] Treister 1996, 170.
[23] Treister 1996, 171.
[24] Treister 1996, 172.
[25] Treister 1996, 152.
[26] Treister 1996, 156.
[27] Treister 1996, 158.

or in Phoenicia.[28] Although the hypotheses about the work of the Near Eastern craftsmen in Greece has not been accepted by all scholars, it cannot be argued that there is a clear change in the source of raw materials and in the technology at the junction between the geometric and orientalization periods.

A high standard of production had been achieved in Urartu and Assyria, however; this is known for the organisation of the early Iron Age workshops and we see from the tribute lists of northern Syria that the state was involved in the acquisition and distribution of metals. It is believed that the Greeks copied these prototypes, not only in the control of metals, but also in the creative interpretation of forms and decorations, which led to the formation of the Greek orientalizing style, although the extent of the influence from these two societies in the formation of Greek metal working technology has been evaluated in many ways. The excavations conducted on the settlement of Al Mina by C. L. Woolley have been used to support many of these models. Al Mina is situated in northern Syria and at the mouth of the river Orontes, having the largest concentration of proto-geometric pottery found in any eastern country. It has been concluded that this is an indication of seasonal occupation by the Greeks for purposes of trade.[29] The casting mould is one of the most important artefacts to be excavated in Al Mina in art historical, the early economy and for the evaluation of the role of the indigenous population and that of the Greek inter dependencies**.** The closest parallel to one of the motifs which was carved in the mould is a crescent shaped pendant found in a grave at the Kameiros necropolis dated to around 700 BC. Another parallel is the fold of a mould of grey -green Serpentine dated from the mid 8th through the early 7th Century BC, which was discovered during the excavations conducted on the lower western Palace at Zinčirli. [30]

It has been concluded from the discovery of this mould that, soon after the foundation, a north Syrian jeweller, with a high probability originating from Sam´al, was working in Al Mina.[31] The motifs in the mould also have Phoenician parallels, but as there are other artefacts with north Syrian origins, it is considered that there were Greeks (probably from Euboea and the Cyclades) and Syrians coexisting at Al Mina.

The boat-shaped earrings are known in the Near East at least since the second half of the 3rd Millennium BC and were common through out the Middle East and Greece. The mould discovered at Miletos was not made to produce a finished earring but rather a semi-product, in the shape of a "rudder" or "spearhead", which would then have to be formed and soldered together in order to produce an earring.[32] This technique was not normally used by the Greek craftsmen, who would have cast it as a single piece, while in the Middle East it was common to use this technique to produce boat-shaped earrings by the technique of joining two halves together. In the recovered material known as the Lydian treasure there are eight punches or formers which were used to produce each half of boat-shaped earrings.[33] These indicate that the individual halves were not cast; they were rather forced into the required shapes. The so called moulds could be a matrix, for the pressing of thin gold sheets using a punch or force to apply the pressure. The design of the earring from Miletos has close parallels with moulds from Assur and Ras Shamra, where the same type of edge moulding is used to produce the same effect of pseudo-granulation.[34] This design of earrings indicates that there was either a strong influence of neo-Assyrian or north Syrian metal working traditions, or that the Milesians had seen the original mould forms in operation. The existence of the mould from Al Mina indicates that there was cohabitation between the Greeks and north Syrians in one of the earliest Greek trading emporia in the eastern Mediterranean.[35]

One of the greatest difficulties in understanding Greek colonization is the mechanism of exchange that was conducted between the indigenous population and that of the Greek colonists. In Scythia this exchange mechanism could not have been on a monetary basis, because of the lack of Greek coins found in excavations away from the Greek cities. If the exchange was based on finished materials being exchanged for "low value" raw materials, e.g. corn, then this would be very difficult to prove archaeologically. It is probably a combination of factors that allowed the Greeks to set up a successful colony. The most important of these would have been the availability of land with good harbour facilities. The land could have been exploited for the first-time or a settlement of the indigenous population could have been exploited. To gain access to this land permission would have to be granted by the indigenous leaders, as the introduction of the Greek colonists into the local political situation could have been considered as a threat. Therefore this threat would have to be eradicated before a colony could be successfully founded. In the case of Olbia the Greeks may have offered the Scythian ruling elite facilities and lifestyles whenever they came to this colony that contradicted the social norms of the Scythians; this meant that the individual's life was dependent upon the discretion of the Greeks and thus the person open to oppression: "Now the Scythians make this Bacchic revelling a reproach against the Greeks, saying that it is not reasonable to set up a god who leads men onto madness. So when Scyles had been initiated into the Bacchic rite, someone of the Borysthenites scoffed at the Scythians: 'why' said he, 'you Scythians mock the revelling and being possessed by the god; but now this deity has taken possession of your own king, so that he is revelling and is mad and possessed by the god. If you do not believe me, follow me now and I will show him to you.'

[28] Boardman 1980, 179.
[29] Boardman 1994, 22.
[30] Treister 1996, 160.
[31] Treister 1996, 161.
[32] Treister 1996, 162.
[33] Özgen & Öztürk 1996, 228-229.
[34] Treister 1996, 162.
[35] Treister 1996,163

The chief men among the Scythians followed him, and the Borysthenite brought them up secretly and set them on a tower. Presently, when Scyles passed by with his company of worshippers, they saw him among the revellers; whereat being greatly moved, they left the city and told the whole army what they had seen.".[36] For this crime Scyles was deposed and later executed by his brother Ostamasades,[37] for it was considered to be a crime by the Scythians for one to be contaminated by external cultures; to avoid this, the citizens had guarded the gates of the city, so that Scyles could not indulge in Greek practices.[38]

What is not known, and will probably never been known, is the relative value of Greek imports into Scythia. It is only safe to assume that Greek pottery being a relatively rare commodity in this region had a higher value than in Greece. When Greek pottery is compared with Scythian pottery, it is evident from a modern perspective that Greek pottery is of a much higher quality because of its decoration and the way that it was produced. The relative value of Greek pottery, compared with Greek silver vessels, considered to be the models for Athenian painted pottery by M. Vickers, is in the region of 1:333. The highest recorded price is three drachmas for red-figured hydriai, when compared with the series of 27 silver hydriai, each of which weighed around 1000 drachmas as recorded in the Acropolis inventories from 398/7 BC onwards, when the silver vessels had the same size as the painted ceramic vessels. However, the calculation based on the comparison between pottery and silver vessels suggests that the silver vessels were smaller and thus the ratio could have been 1:775 or even as high as 1:1000.[39] In an inscription from 421/20 BC there is a record that indicates the price of a talent of tin was around 233 drachmas. In the same inscription the price for one talent of copper was 35 drachmas and 1 obol.[40] Bronze, as a scrap metal, had value according to which one talent of bronze cost 60 drachmas and 1.5 obols. These prices were reconstructed by W. M. Murray using a bronze ram that was found off the coast of Israel in 1980. The weight of this ram is 465 kg, and he arrived at the conclusions using the inscription IG II2 1692 as the basis, because it refers to the sale of probably five rams which weighed more than 3 talents together for the price of 524 drachmas.[41] However this price may be incorrect as the inscription is dated to around 325/4 BC, while the ram was probably produced in Cyprus during the reign of Ptolemy V Epiphanes (204-181 BC). Thus using the weight of 77 kilograms for the weight of the ram of an Attic trireme, the price of bronze at the time of the inscription was higher than the price of tin.[42] Iron had the value, in 365-335 BC from the building accounts of Epidaurus, of approximately 14 drachmas and 2 obols for one talent.[43] Lead's value is known from the same inscription as that of iron and was one talent of lead for 2 drachmas and 5 obols.[44] The two most important precious metals used in Scythia (that are known from the archaeological record) were gold and silver.

It is only possible to reconstruct the value of metals after the period that is being discussed in this thesis; however they can be used as a basis for a loose interpretation of the respective prices of these materials during the 7th-5th Century BC, because there is not enough data from the Geometric and Archaic periods.

Giving an account of the incursions of the Scythians into the west is even more difficult than describing their contacts with the Greeks, primarily due to the lack of a cultural definition of the nomadic folk. Although there is definite proof that their sphere of influence ranged as far as the western border of modern Poland, it is not possible to say if this was due to raiding, trade or occupation of this area. The theory of an invasion of the Scythians over Central Europe was already being presented in the first half of the 19th Century, although it was not based on the limited archaeological material available at the time, but rather on the written documents, especially Herodotus and Strabo. The Sigynnae tribe were used as proof that the Scythians had occupied parts of Bohemia or Moravia.[45] With the discovery of the gold artefacts from Witaszkowo in 1882 and of arrow heads of Scythian type all over Moravia and Silesia, interest in this question was revived.[46]

The theory of the raiding of this area was expanded by H. Seger and M. Jahn in the 1920´s, with their articles about the *militaria* discovered in Silesia, especially those relating to the defended settlements of the Lusatian culture. These two authors concluded that raids occurred around 500 BC, invasions penetrating this region through the Moravian Gate and along the eastern bank of the Odra.[47]

Eastern influences can be discerned in the territory of Western Podolia from the end of the 7th Century BC, coming from the forest-steppe Dnieper zone. The middle Dniester basin had been populated by the Thracian-Hallstatt of the Holihrady Culture and a minority of a Chernoles culture population, until the majority of the Thracian population was expelled by the Scythian West – Podolian culture[48].

The burial rites of the West-Podolian culture were cremations and inhumations in barrows. The grave goods indicate that this area was relatively poor when compared with the grave goods of the Scythian groups occupying the forest-steppe regions of the Southern Bug and middle Dniester[49]. Thus the West-Podolian group has been

[36] Herodotus IV, 79.
[37] Herodotus IV, 80.
[38] Herodotus IV, 78.
[39] Vickers 1985, 116.
[40] Treister 1996, 248.
[41] Treister 1996, 249.
[42] Treister 1996, 250.
[43] Treister 1996, 250.
[44] Treister 1996, 250.
[45] Bukowski 1977, 15; Polacký 1867, 39; Šafařik 1837, 241.
[46] Bukowski 1977, 15; Reinecke 1896, 1; Jentsch 1883, 286-289; Furtwängler 1883.
[47] Bukowski 1977, 15; Jahn 1928, 273 fig. 2; Seger 1926, 79.
[48] Bukowski 1977, 228; Bukowski 1969, 456; Sulimirski 1936, 5-6.
[49] Bukowski 1977, 228; Bukowski 1969, 465; Meliukova 1958, 39; Sulimirski 1936, 5.

considered to be the most westerly of the forest-steppe concentrations commonly referred to in the literature as the "Farmer-Scythians" mentioned by Herodotus.[50]

As regards the Carpathian basin, there are two basic hypotheses expounded by scholars. The first is that there was no occupation of this region by the Scythians and that the material cultural artefacts discovered in this area are the result of trade.[51] However the other body of investigators considers the possibility of the migration of large groups from the east, resulting in a mixed population and a fusion of culture and ethnic characteristics. Both groups accept the production of Scythian types of artefact within the Carpathian basin. The greatest difficulty in dealing with the Carpathian basin is the lack of publication of the material from this region in proper contexts. This problem has continued since the collapse of the communist regime due to the lack of funding. The articles that are available are from burial grounds, e.g. the Ferigile Culture.[52]

In the phase preceding the occurrence of the Scythian material, in the Carpathian basin and the adjacent regions to the north and east, the material cultural elements suggest that in Moldavia and a large part of Romania, the Babadag culture and the Moldavian counterpart, referred to as the Kishinev culture, were developing, whilst the Sakharna-Soloncheny Culture settled in the middle Dniester. They are believed to have existed from the late 8th century to the beginning of the 7th century BC.[53] The correspondence between the Sakharna-Soloncheny and the second phase of the Chernoles culture shows that the final phase of this culture is simultaneous with the Zhabotin Culture of the second half of the 7th to the beginning of the 6th century BC. The similarities in the cultures from these two regions could indicate that there was a connection between Moldavia and the transmission of cultural elements from the Carpathian Basin towards the Dnieper region[54]. The incursion of the Scythian related material into this region has been traditionally dated to the 6th to 4th centuries BC, with the penetration of Transylvania and Transdanubia being dated to the first half of the 6th century BC and that of the whole of the Carpathian Basin to the second half of the 6th century. The material cultural finds indicate that there was a strong link to the Scythian groups over the middle Dnieper course, especially those in the region of Kiev and the Sukla Basin. The cremation of the deceased could also indicate connections with the zone of the Dnieper west bank, where it was common practice[55].

As regards the Scythian influence on the Lusatian Culture, which does not appear to have been a continued occupation, close parallels could be drawn with the evidence of the raiding of the Urartu culture. There are destroyed settlements where Scythian arrow-heads are discovered in large numbers. The remains of bodies have been discovered in the burnt out buildings, e.g. at Wicina and Zielona Góra, and the majority of the population may have been carried away into slavery.[56] There is no conclusive evidence, for there have been no burials within this region; the artefacts from Vettersfelde will be considered later in this thesis. (There may have been a burial, discovered in south-west Slovakia near the settlement of Rimaské Janovce in 1944, but all of the artefacts which were discovered by the workmen have been lost.[57])

There is archaeological evidence of a change in the social hierarchy within the Lusatian Culture at this time, with a centralization of power within oppida.[58] The evidence for there having been a major incursion into modern Poland is very fragmentary. There were, by 1977, 105 confirmed archaeological sites where Scythian type arrow-heads had been discovered.[59] These have been dated by the use of the typology developed by A. I. Meiliukova[60] and refined by V. G. Petrenko.[61] The phasing within these chronologies does have problems with the discovery of so called classical forms at the same sites as later types of arrow-heads, which according to the two afore mentioned authors did not co-exist: for example at. Vyšný Štramberk arrow-heads have been discovered in the excavation which can be dated to the 6th century BC together with arrow-heads which are dated from the middle of the 4th century BC.[62]

The conclusion that can be drawn from this chapter is that the influence of the Greeks on the development of jewellery may not have not been as important as previously considered because their presence was limited to the coastal periphery of the Black sea and probably did not extend to the hinterland. The influence of the Greeks on the manufacture of jewellery in the North Pontic region will be expanded on in the next chapters using specific examples.

[50] Bukowski 1977, 229.
[51] Dušek 1964, 55; Popescu 1962, 443; Dušek 1956, 142; Popescu 1958, 9.
[52] Vulpe, 1967, 1970, 1972
[53] Meliukova 1972, 57.
[54] Bukowski 1977, 234; Meiukova 1972, 71.
[55] Bukowski 1977.
[56] Hensel 969, 146.
[57] Bukowski 1977, 251; Balaša 1960, 60.
[58] Nebelsick 2002, 5.
[59] Bukowski 1977, plate 2.
[60] Meiliukova 1964, 20 sqq.
[61] Petrenko 1967, 44, tables 34 and 35.
[62] Bukowski 1977, 181; Hančar 1972 3-25. See also Boroffka 2002, 233-240.

2.2 Vettersfelde/Witaszkowo

The examination of the gold hoard found at Vettersfelde/Witaszkowo by the author was done using the Macro Laser Imaging Technique at the invitation of the Antikensammlung Berlin.

The gold hoard was discovered on 7th October 1882 in the central one of three drainage channels which had been opened on 5th October. It was found circa 30 cm. under the surface and, according to the finder, there was also a quantity of large pieces of pottery lying in the vicinity of the discovery, which may indicate that the gold artefacts were buried in a large ceramic vessel. However, as none of the pieces from this pot have survived, it is impossible to say anything more about these fragments.[1]

On the 1st of August 1883, a small excavation was conducted near the place where the gold hoard was discovered by Eduard Krause (the curator of the ethnological and prehistoric departments of the Royal Museums in Berlin), Paul Telge (the goldsmith who produced the replicas[2]) and August Lauske (the farmer who discovered the hoard).[3] There was evidence of burnt earth and some sherds of pottery were found, one of which belonged to the bottom of a thick-walled vessel, coarsely made and badly fired. The outer surface was oxidised (reddish in colour) whilst the core was fired under reducing conditions (blackish in colour).[4] Around a hundred strides to the east of this area another archaeological feature was also excavated on this day, which had been discovered by the ploughing of the field, 30 cm under the surface. It was a circular pavement, 80 cm in diameter, with a large stone set in the middle. Above this there was a layer of burnt earth of 1.10 m. diameter and 15 cm thick. Beneath the stones, there was a burnt earth layer that was 35 cm deep. From this excavation only two small sherds of pottery were found.[5]

In 1914 a gold strip with a cloverleaf rosette finial was discovered after the field had been ploughed by the farmer in the vicinity of the original find place.[6] This piece along with the small gold plaques discovered by the father of August Lauske have been lost.[7]

In 1921 a small scale excavation was conducted on the suspected site of the hoard by C. Schuchhardt; the results of this excavation were never published and all records from this excavation were lost in the Second World War.[8]

With the change in population due to the forced relocation of refugees after the Second World War, caused by the redrawing of the political boundaries of Poland, the location of the exact find spot was lost. In 1964 a brief field walking campaign was conducted in the vicinity of Vettersfelde/Witaszkowo to try and rediscover the location of the place where the hoard was discovered. The results of this survey were the discovery of 4 prehistoric sites.[9]

The site of the hoard was found again in 2000 by L. Nebelsick in an exhaustive examination of all of the literature. He discovered that the site could be relocated approximately through the use of Krause's description[10] and the paper by Jentsch, "Der Fundort ist übrigens auf den Generalstabskarten (Aufnahme 1845/6 berechtigte Ausgabe B1 218 Gruben) unterhalb der Orte Jetzschoer Senke durch z (for Ziegelei) genau markiert".[11] The description, with the landmarks that are mentioned in it, was used to identify the field which had once belonged to August Lauske, in which an archaeo-magnetic survey and excavation were undertaken in 2001. The results have not been published in their entirety yet, but prelimary information indicates that there was intensive Iron Age activity on the site, indicating that it may have been a ritual site or a settlement.

From this limited amount of evidence, from the small excavation conducted at the find site of the gold hoard from Vettersfelde/Witaszkowo, it has been debated whether the site was a settlement or a cemetery.[12] The damage to the gold hoard by fire indicates that the site was probably a settlement destroyed by fire. However, as most of the site was destroyed by the exploitation of clay for the production of bricks,[13] before the archaeological importance of this site was known, it is impossible to answer this question conclusively. The information that has survived from this excavation indicates that post holes from a house were discovered, leading to interpreting the site as a settlement, and not as a cemetery.[14]

The dating of these artefacts has been dependent upon an art historical approach, along with historical dating from the classical authors, and the interpretation is very difficult because there are dangers in the ready acceptance of an absolute date derived from history.[15] it has not been previously possible to achieve an independent date for these artefacts due to the lack of preservation of the ceramic sherds that were discovered along with the gold artefacts. Fürtwaengler originally dated the gold hoard from Vettersfelde/Witaszkowo to the end of the 6th century BC based on their artistic style, and he thought that it could have reached Vettersfelde/Witaszkowo due to the incursion of Darius.[16] The excavations that have now been conducted in the vicinity of the original find indicates, by the pottery, that this hoard may have been buried in the 2nd half of the 7th century BC up to the middle of the 6th century

[1] Furtwängler 1883, 4.
[2] Telge 1855, 15.
[3] Telge 1885; Krause 1883; Furtwangler 1883, 4-5.
[4] Furtwängler 1883, 4.
[5] Furtwängler 1883, 4 -5.
[6] Jentsch 1915.
[7] Krause 1883, 490.
[8] Nebelsick 2002.
[9] Malinowski 1964, 217.
[10] Krause 1883, 488.
[11] Jentsch 1884, 14.
[12] Parzinger 1993, 203-237.
[13] Furtwängler 1883, 4.
[14] Parzinger 1993, 203.
[15] Biers 2005, 62.
[16] Furtwängler 1883, 11-52.

BC. In the dating of the Vettersfelde hoard, a maximum difference of two hundred years can be proposed using the chronology based on the Ferigile culture.[17]

In the case of the Akinakes (Misc 7850), the sword handle is related to Group II, type Orbeasca, which is believed to date to the late 8th /early 7th century BC and this type of Akinakes is one of the earliest forms.[18] The dating was derived from the age of the example from the necropolis of Tli through two Urartian imports which come from the same grave.[19] Another indicator that the dating of these artefacts is incorrect is on the sword sheath cover; the single lion on the upper edge appears to be stalking an Ištar - this 8 pointed star was used on Assyrian reliefs which are dated to the 9th-7th Centuries BC.[20]

Not all of the pieces that were discovered at Vettersfelde/ Witaszkowo were examined by M.L.I.T. because some are not suitable for this type of study.

The artefacts studied from Vettersfelde/Witaszkowo

Type	Inv. number*	Material**	Weight**	dimensions**
Fish	Misc 7839	Gold alloy	608.5 gms	L.41X W.15 cm
Ornamental Plate	Misc 7841	Gold alloy	282,5 gms	L.17X W 17 cm
Pendant	Misc 7851	Gold alloy		L.4 cm
Pendant	Misc 7846	Gold alloy	23.7 gms	L 6.9 cm
Earring	Misc 7853	Gold alloy	17.5 gms	L. 7.7 cm
Bracelet	Misc 7845	Gold alloy	48.9 gms	dia 7 cm
Sword sheath	Misc 7842	Gold alloy	137.2 gms	L.19XW.13 cm

A. Greifenhagen, 1970; **A. Furtwaengler, 1883

Table 2.2.1.

Gold working techniques

The gold working techniques employed on the gold hoard found at Vettersfelde/Witaszkowo are very advanced and show that the craftsmen were highly experienced in working with this medium. The way that the filigree and cloisonné is joined to the backing plate on the pendants and earring indicates that the craftsmen used colloid hard soldering.[21] This technique involves the use of copper carbonate known as *Chrysocolla*,[22] which has been ground to a fine paste and mixed with an equal amount of fish or vegetable glue. This is then added to water to produce a fine paste used to join the various pieces together. The artefact is then heated above 100 degrees Celsius when the copper carbonate changes to copper oxide: at 600º C the glue is carbonised, at 850º C carbon dioxide is formed by the combination of the carbonised glue and the oxygen from the copper oxide, the copper migrates into the gold to form an alloy which is localised and at 890º C the copper and gold melt and the join is produced between the pieces.[23]

However it should be noted that the reality is more complex than this simple model because of the inclusion of trace elements in the alloy which also affect the melting point making it either higher or lower, depending on how they affect the molecular structure of the alloy in its various phases. Each time that the artefact is heated to 860º C, the copper diffuses further into the gold reducing the concentration of copper at the surface and raising the melting temperature at the join.

Another important factor, when considering the joining of a number of pieces by the melting of a small area to form a join, is the effect of the mass of the individual pieces and the transport of the heat away from the area. The thicker the piece is, the greater the amount of thermal energy required to make the piece melt, placing more fragile areas at risk. The thermal resistance of the artefact also dictates how much thermal energy has to be added to the artefact to raise its temperature to the required level for the molecular bonding to change from the solid state to the liquid state.[24]

The production of an alloy affects the malleability, ductility and hardness of the metal; pure gold is a very ductile and malleable metal and it is also very soft, which makes it easy to work but prone to damage. A gold alloy that has been used to construct an artefact is not so ductile and malleable and therefore as easy to form to the required shape but it is harder and not so fragile.[25]

All of these principles had to be understood by the craftsmen who produced the gold objects from Vettersfelde/ Witaszkowo, if not in theory, at least in an empirical way and from experience working with this medium.

[17] Vulpe 1990.
[18] Vulpe 1990, 36-37.
[19] Vulpe 1990, 37.
[20] Kull 1997a, 572.
[21] The method was patented in the UK as late as 1933 (British Patent no. 415181).
[22] The best quality was said to come from Armenia; Jüngst 1981, 7.
[23] Brepohl 1994, 353.
[24] Brepohl 1994, 39-40.
[25] Brepohl 1994, 35- 39.

The Fish (Misc 7839) Fig 2.2.1

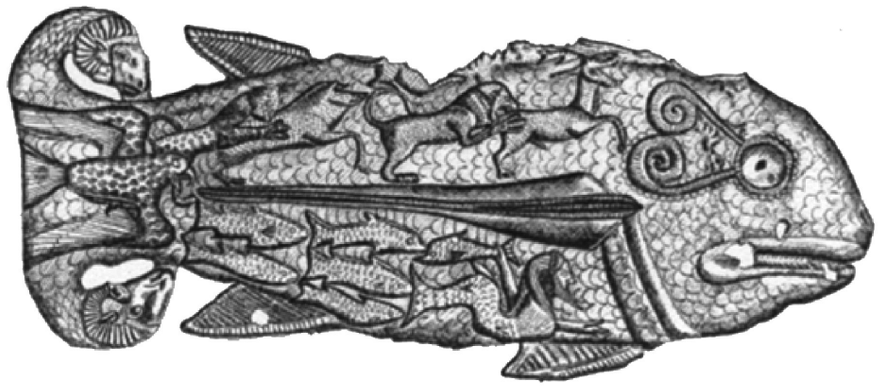


Fig. 2.2.1.
Drawing by A. Redkow, Staatliche Museen zu Berlin, Antikensammlung.
All Scales in cm unless otherwise stated.

The fish is constructed from a gold alloy the composition of which is unknown because it has not been analysed. However, due to its colour it was considered to be an alloy with silver to approximately 18 carat gold.[26] The fish is 41 cm long and 15 cm wide, the gold alloy is around 5 mm thick sheet and weighs 608.5 g. The basic form of the fish was probably cast with the fine decoration added later. The eye, which no longer exists, could have been similar to the eyes on the horse-headed gold artefact discovered at Bratoljubovskj-Kurgans in the hidden chamber within the central grave;[27] this was made from glass. The basic form of the fish cannot be identified with 100% certainty at the moment. It could be a stylised representation of a Tuna (*Germo alanga*) because the pectoral fin is long and thin, the ventral and anal fins are in the correct form and in the correct relative position. In the case of the dorsal fins the fish has been damaged by fire, but the rear of the two is in the correct position. The head and tail of the fish do not correspond with the Tuna, but this may be incorporated so that the fish is not so fragile and prone to damage because of its length. The fish is decorated with three scenes: an eagle, four animals with the remains of a fifth, six fish with a merman (Triton), and the tail has two ram's heads incorporated into the body of the fish; the eye of the fish has two spirals leading towards the tail of the fish.

Not all of the tool marks were studied from the fish because they are not conducive to this type of study, but 17 examples of tools marks have been examined by M.L.I.T.

Hour glass	gold fish	Misc 7839	Fig. 2.2.2 (SCY 1)
Lozenge	gold fish	Misc 7839	Fig. 2.2.3 (SCY 2)
Graver	gold fish	Misc 7839	Fig. 2.2.4 (SCY 3)
Lozenge	gold fish	Misc 7839	Fig. 2.2.5 (SCY 4)
Semi circle	gold fish	Misc 7839	Fig. 2.2.6 (SCY 5a)
Semi circle	gold fish	Misc 7839	Fig. 2.2.7 (SCY 5b)
Semi circle	gold fish	Misc 7839	Fig. 2.2.8(SCY 6)
Complex	gold fish	Misc 7839	Fig. 2.2.9 (SCY 7)
Circle	gold fish	Misc 7839	Fig. 2.2.10(SCY 8)
Semi circle and Lozenge	gold fish	Misc 7839	Fig. 2.2.11(SCY 9)
Semi circle	gold fish	Misc 7839	Fig. 2.2.12 (SCY 10)
Semi circle	gold fish	Misc 7839	Fig. 2.2.13 (SCY 11)
Semi circle	gold fish	Misc 7839	Fig. 2.2.14(SCY 12)
Semi circle	gold fish	Misc 7839	Fig. 2.2.15 (SCY 13)
Semi circle	gold fish	Misc 7839	Fig. 2.2.16(SCY 14)
Lozenge	gold fish	Misc 7839	Fig. 2.2.17 (SCY 15)
Semi circle	gold fish	Misc 7839	Fig. 2.2.18 (SCY 16)
Lozenge	gold fish	Misc 7839	Fig. 2.2.19 (SCY 17)

Table 2.2.2.

[26] Furtwängler 1883, 11.
[27] Rolle, Müller-Wille & Schietzel 1991, 370.

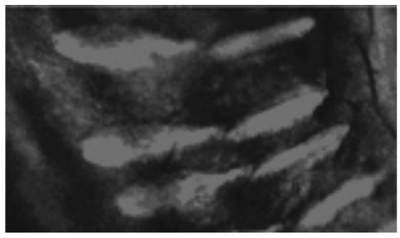


Fig. 2.2.2. (SCY 1).

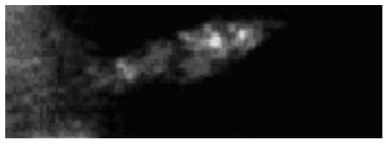


Fig. 2.2.3. (SCY 2)

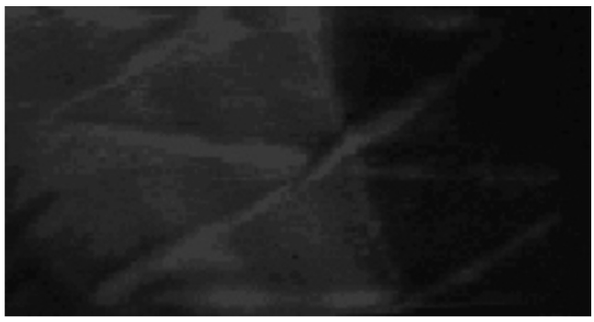


Fig. 2.2.4 (SCY 3).

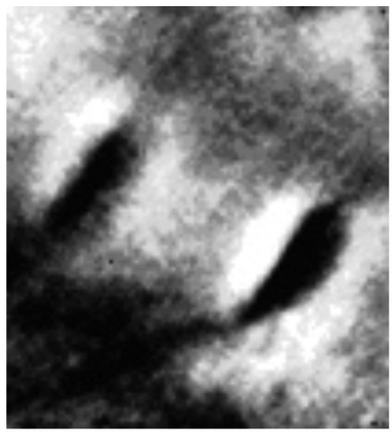


Fig. 2.2.5. (SCY 4).

Fig. 2.2.6. (SCY 5a).

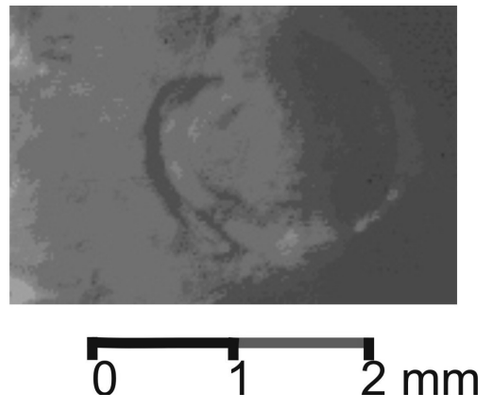


Fig. 2.2.7 (SCY 5b).

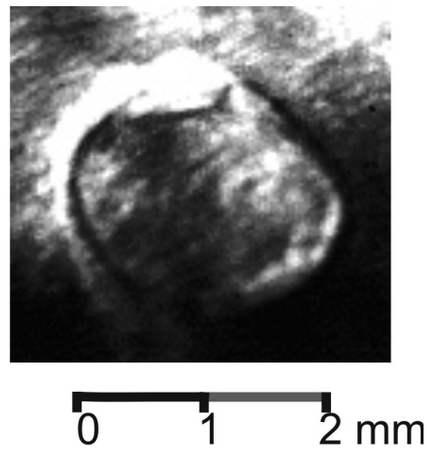


Fig. 2.2.8. (SCY 6).

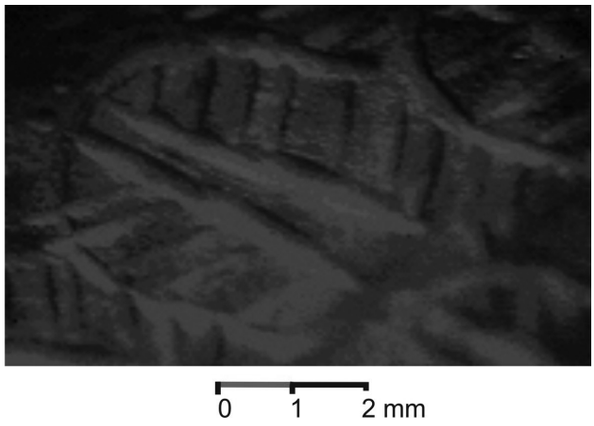


Fig. 2.2.9. (SCY 7).

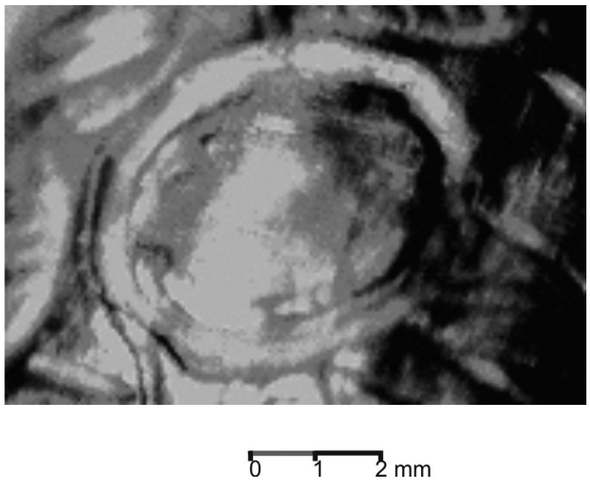


Fig. 2.2.10.(SCY 8).

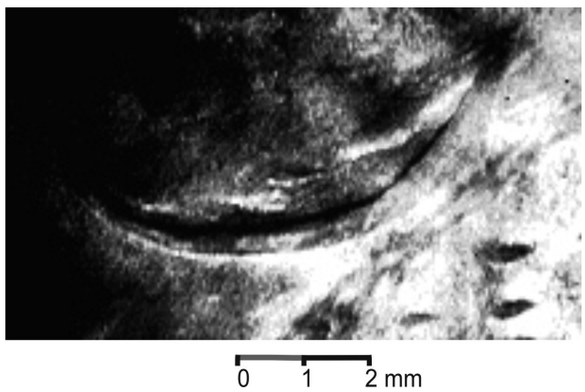


Fig. 2.2.11. (SCY 9).

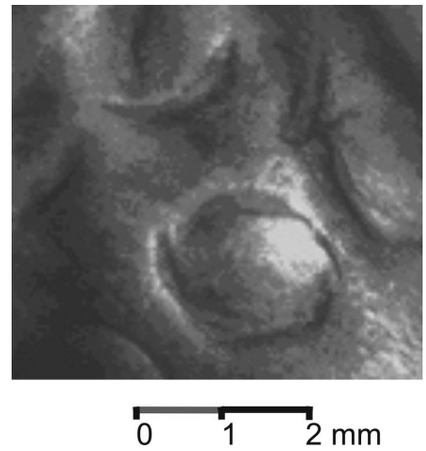


Fig. 2.2.12. (SCY 10).

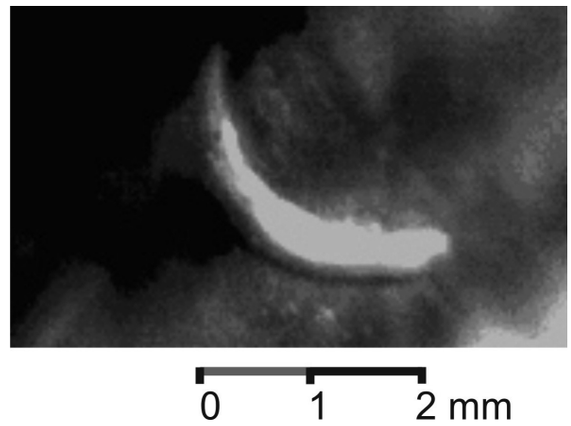


Fig. 2.2.13 (SCY 11).

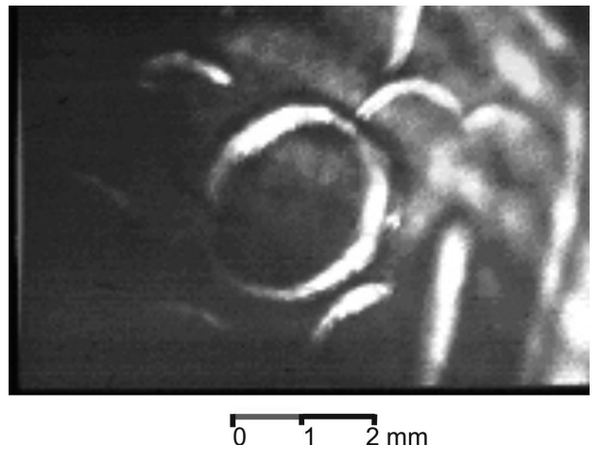


Fig. 2.2.14. (SCY 12).

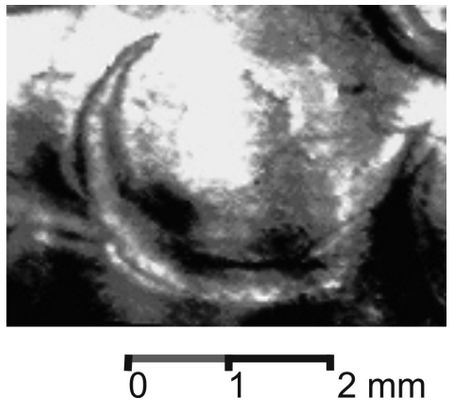


Fig. 2.2.15. (SCY 13).

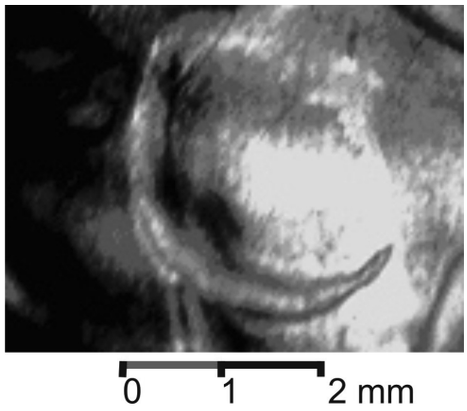


Fig. 2.2.16. (SCY 14).

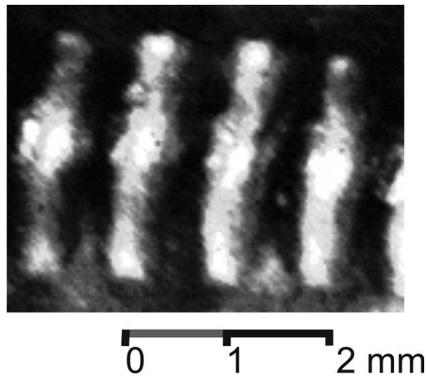


Fig. 2.2.17. (SCY 15).

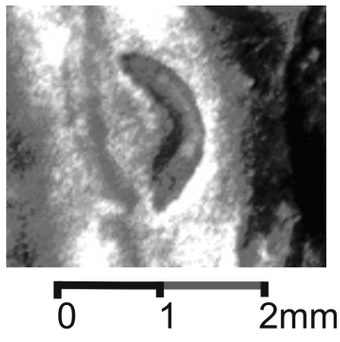


Fig. 2.2.18. (SCY 16).

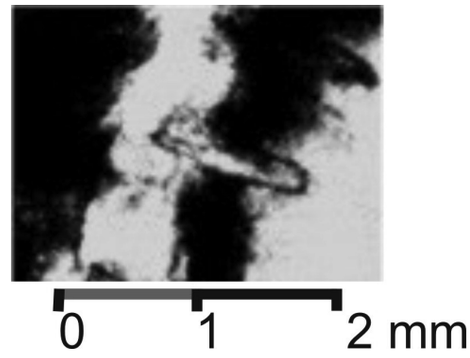


Fig. 2.2.19. (SCY 17).

Not all of the pictures are of the desired quality, due to the equipment sensitivity to vibration caused by vehicles within 50 m of the test area and the fact that the fish has not been cleaned recently, which dictates the amount of light reflected to the equipment. These problems will be overcome in future developments of the equipment, but the basic shape of the tool can be discerned in each of the 16 samples from the fish and can be used for the comparison of the fish with other samples from the same period. Each of the pictures has been scanned and minimal manipulation of the original has taken place. These are available from the author for comparative studies upon request.

On the repoussé decoration of the fish there is evidence of only one circular punch being used (SCY 8) to produce the eye of the bird; all other circular decorations that were studied, were produced by a semicircular tool (SCY 5b, SCY 6, SCY 10 and probably SCY 12). This was a labour-intensive technique to produce this form of decoration on the various figures decorating the fish. There are no complex forms of punches, all being a single form; the bird's feathers (SCY 7) are produced individually using a number of separate tools to produce the desired effect.

There is no evidence that the fish was ever used for any purpose, nor is there evidence of damage other than the fire damage which caused a number of areas to melt. The localised damage to the fish by heating may have been caused by the non-homogeneous mixing of the alloying materials, which resulted in the fish having different melting temperatures in the various regions; the varying thickness of the gold alloy means that less thermal energy was required to melt the alloy at these points or localised heating may have caused the damage to these areas only. It is probably a combination of these factors that caused the damage.

The fish appears to have been heated from the front as some of the melted material from the dorsal fin has solidified on the back of the fish. The damage caused in the vicinity of the eye also corroborates this theory, as there is no gold on the back of the fish and the area of damage is greater on the front of the fish compared to the back.

Sword Sheath (Misc 7842) Fig 2.2.20

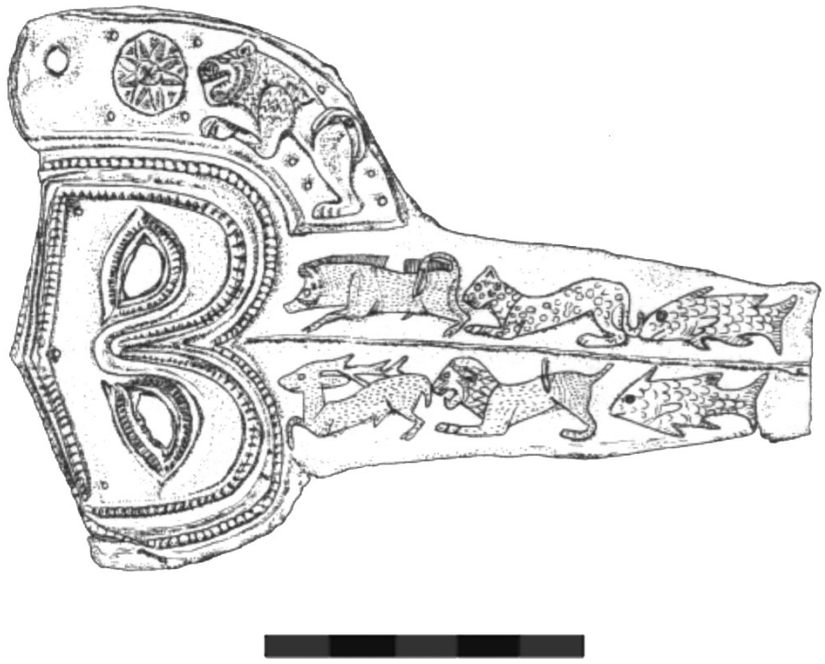


Fig. 2.2.20.

The main part of the sword sheath was produced by the technique known as repoussé. This means it is made from a thin sheet of gold alloy which has been worked by a hammer and punches. The basic form of the decoration was embossed from the back whilst the piece was lying on a yielding material. Wood or lead was used for the shallow relief. However, in this case a softer medium, such as warm pitch, would have been used which is able to support the work but is flexible enough to give way under the force of the hammer blows. In this piece of repoussé work, the complex form of the decoration required the craftsman to have worked from both sides. The animal figures would have first been outlined using a tracer on the front of the piece and then the figure would have been embossed from the back using round punches.[28] The fine decoration was added from the front of the piece to represent the hair on the animals and the scales on the fish.

The holes for fixing can be discerned in a number of places, and a number of the rivets are still in place. The large hole was an attachment to the belt to stabilise the knife in its position on the body of the rider. There is again no evidence of wear on this artefact.

Lozenge	Sword sheath	Misc 7842	Fig. 2.2.21 (SCY 36)
Semi circle	Sword sheath	Misc 7842	Fig. 2.2.22 (SCY 37)
Semi circle	Sword sheath	Misc 7842	Fig. 2.2.23 (SCY 38)
Lozenge	Sword sheath	Misc 7842	Fig. 2.2.24 (SCY 39)
Lozenge	Sword sheath	Misc 7842	Fig. 2.2.25 (SCY 40)
Lozenge	Sword sheath	Misc 7842	Fig. 2.2. 26 (SCY 41)

Table 2.2.3.

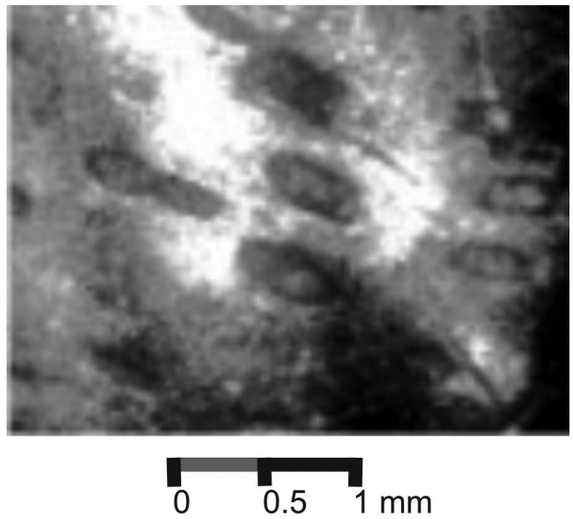


Fig. 2.2.21. (SCY 36).

[28] Higgins 1961, 9.

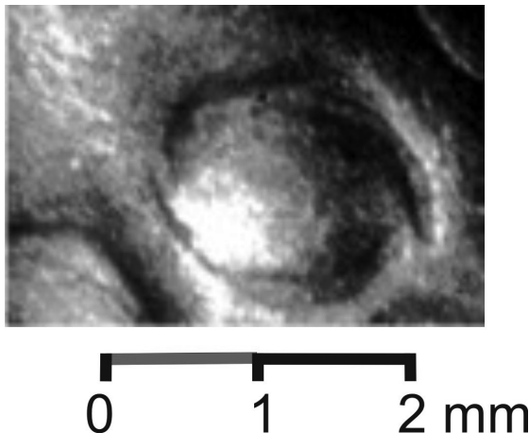


Fig. 2.2.22. (SCY 37).

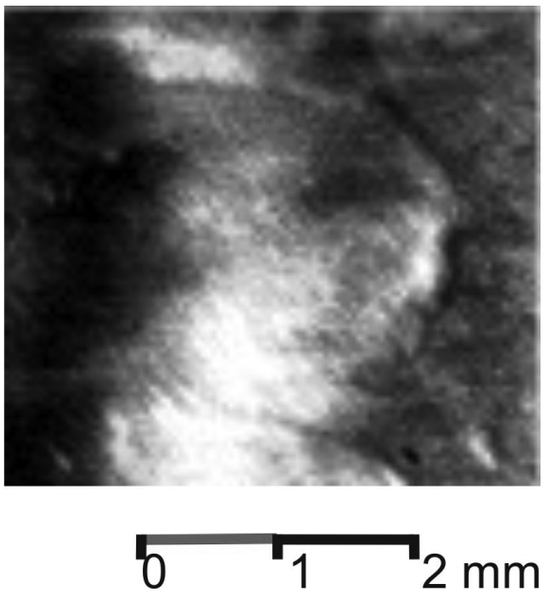


Fig. 2.2.23. (SCY 38).

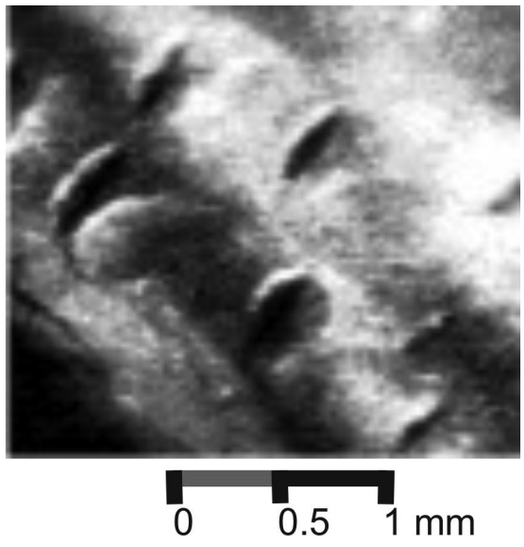


Fig. 2.2.24. (SCY 39).

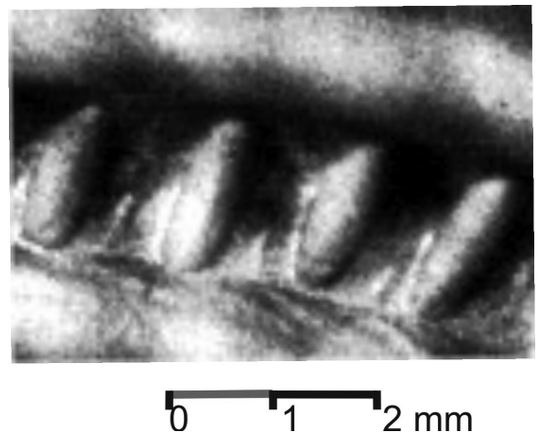


Fig. 2.2.25. SCY 40.

Fig. 2.2.26. (SCY 41).

Ornamental Plaque (Misc 7841) Fig 2.2.27

Fig. 2.2.27.

The ornamental plaque was constructed in the same way as the sword sheath cover except for the semi-circular domes that were fitted after the repoussé work had been finished. Only two of these have survived to the present, but originally there could have been five of these decorative features, one per panel. The central panel is smaller than the rest having no zoomorphic decoration as on the four external panels.

The samples of marks were taken from six positions on the plaque, because on examination of the tools used there was only a limited sample that proved viable since the same tools had been used to decorate the different animals represented here.

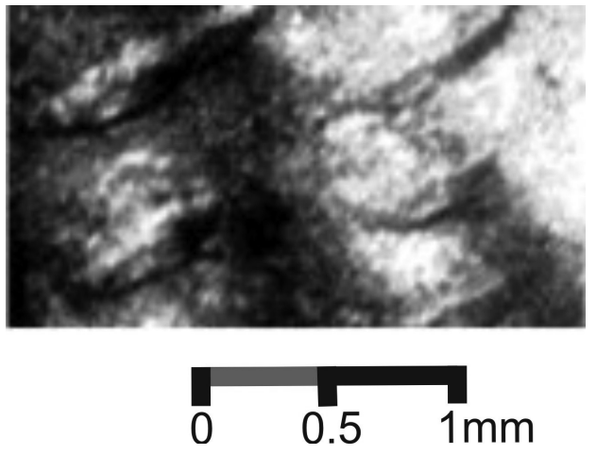


Fig. 2.2.28. (SCY 34).

Lozenge	ornamental plaque	Misc 7841	Fig. 2.2.28 (SCY34)
Lozenge	ornamental plaque	Misc 7841	Fig. 2.2.29 (SCY 35)
Semi circle	ornamental plaque	Misc 7841	Fig. 2.2.30 (SCY 42)
Semi circle	ornamental plaque	Misc 7841	Fig. 2.2.31 (SCY 43)
Lozenge	ornamental plaque	Misc 7841	Fig. 2.2.32 (SCY 44)
Lozenge	ornamental plaque	Misc 7841	Fig. 2.2.33 (SCY 45)

Table 2.2.4.

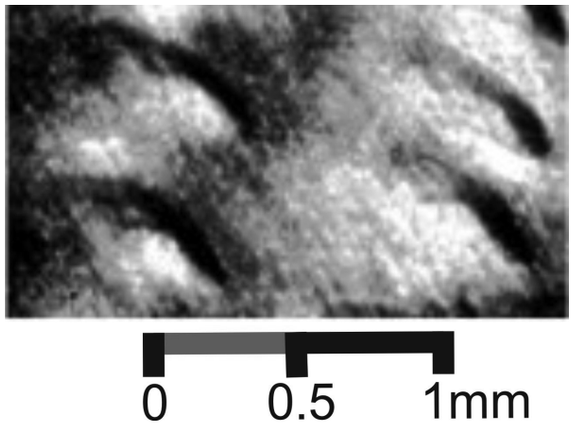


Fig. 2.2.29. (SCY 35).

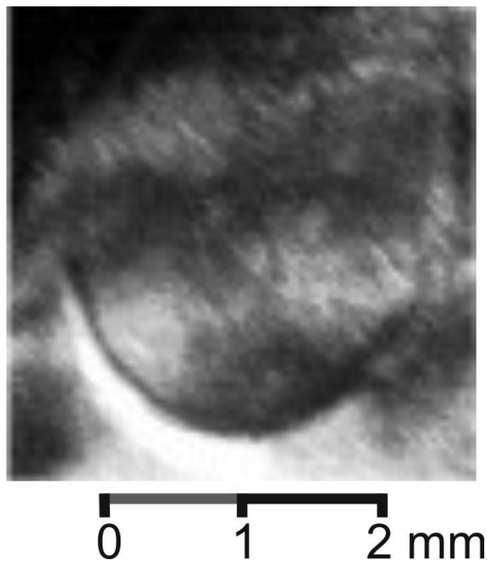


Fig. 2.2.30. (SCY 42).

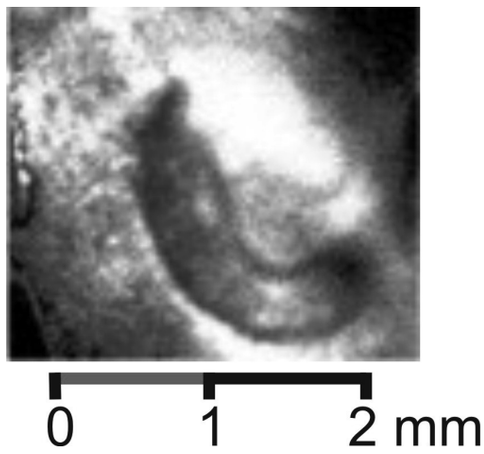


Fig. 2.2.31. (SCY 43).

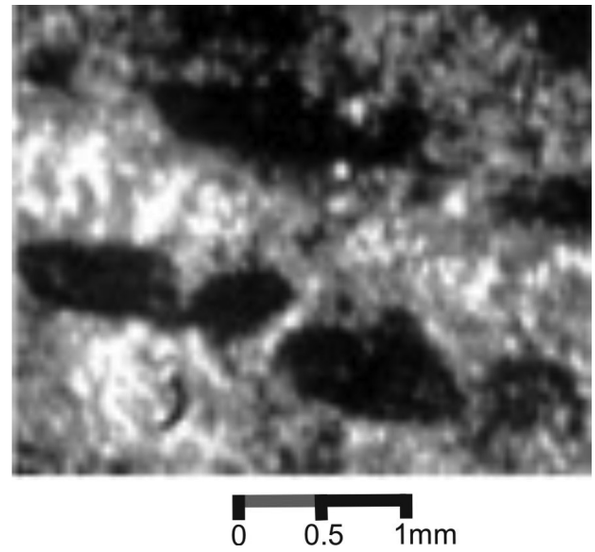


Fig. 2.2.32. (SCY 44).

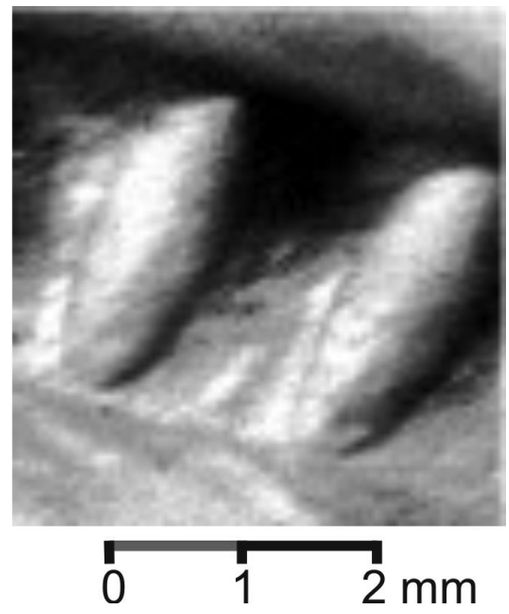


Fig. 2.2.33. (SCY 45).

Once more there is no evidence of wear on this artefact.

Earring (Misc 7853) Fig 2.2.34

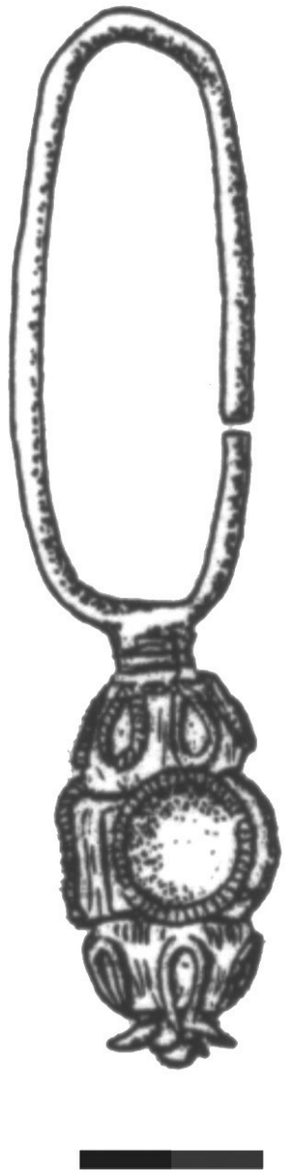


Fig. 2.2.34.

The artefact that has been referred to as an earring is constructed from a hollow central core with two domes fixed to it by soldering. It is decorated with filigree and cloisonné panels. The loop for fixing it to an ear was constructed too flat for this purpose and as there is evidence of wear or damage to this artefact, it could have had another function. In the paper "Centenarium eines Goldfisches", Greifenhagen states that he knew of no similar artefacts to this form of earring;[29] it may have been used as a belt decoration.

Filigree	earring	Misc 7853	Fig. 2.35 (SCY 27)
Cloisonné	earring	Misc 7853	Fig. 2.36 (SCY 28)

Table 2.2.5.

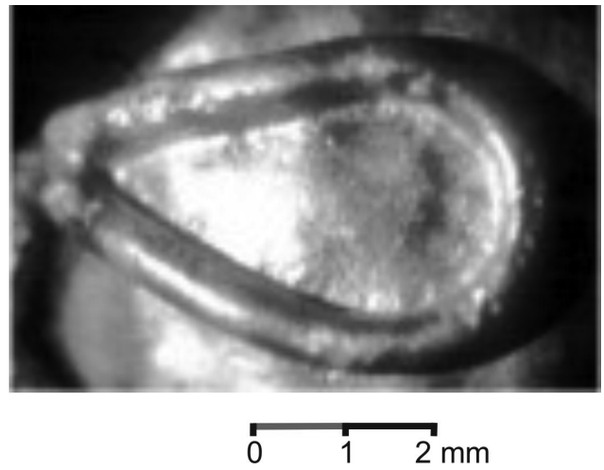


Fig. 2.2.35. (SCY 27).

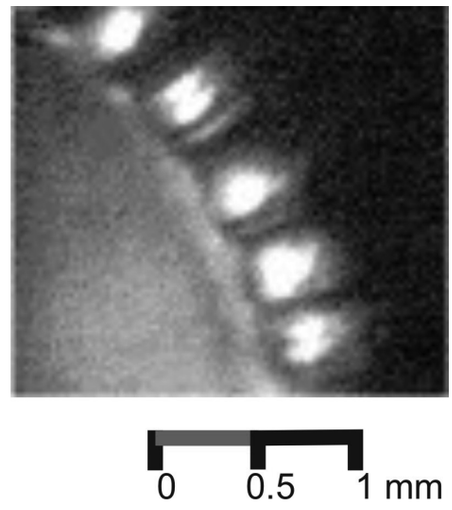


Fig. 2.2.36. (SCY 28).

The central rill of the beads on the filigree indicates that the beading was produced by a rolling swage with only a single tooth because the width of the beads is variable and so are the 'valleys' between them (SCY 27). The cloisonné is a simple panel made from a loop of gold wire which has been formed over a forming tool (SCY 28).

[29] Greifenhagen 1982, 8.

Pendant (Misc 7851) Fig 2.2.37

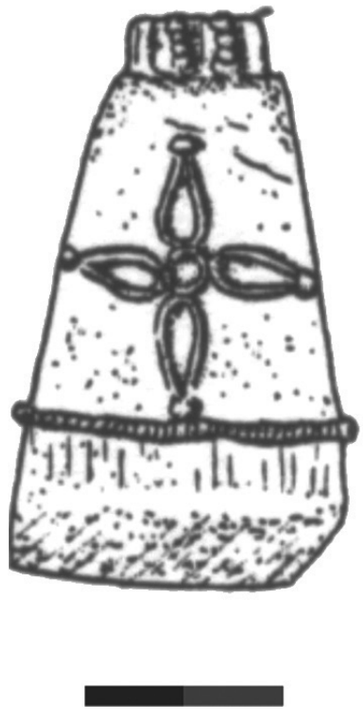


Fig. 2.2.37.

A small gold pendant that includes a worked trapezoidal stone is decorated with filigree and cloisonné. In the filigree border between the stone and the gold there is limited evidence of damage from heating; this could have occurred during the construction of this artefact or at a later date. It is not possible to discern when this occurred at the moment.

Cloisonné	pendant	Misc 7851	Fig. 2.3.38 (SCY 23)
Cloisonné	pendant	Misc 7851	Fig. 2.3.39 (SCY 24)
Cloisonné	pendant	Misc 7851	Fig. 2.3.40 (SCY 25)
Filigree	pendant	Misc 7851	Fig. 2.3.41 (SCY 26)

Table 2.2.6.

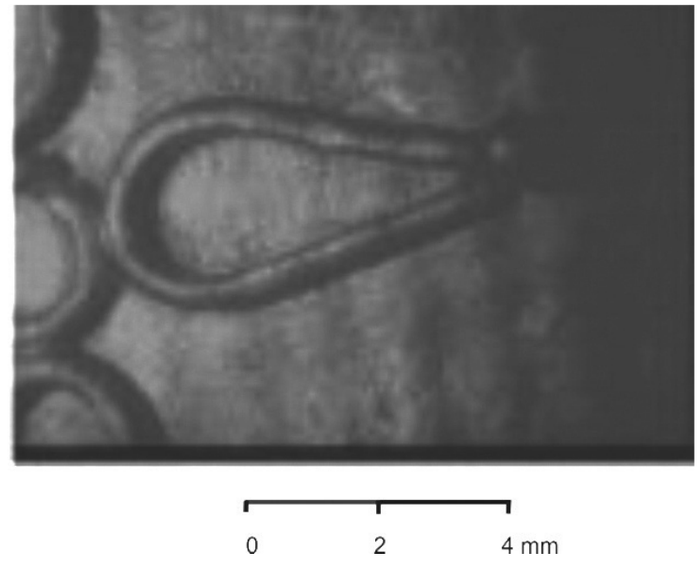


Fig. 2.2.38. (SCY 23).

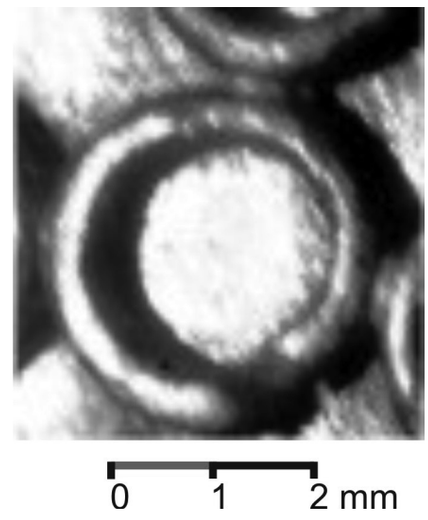


Fig. 2.2.39. (SCY 24).

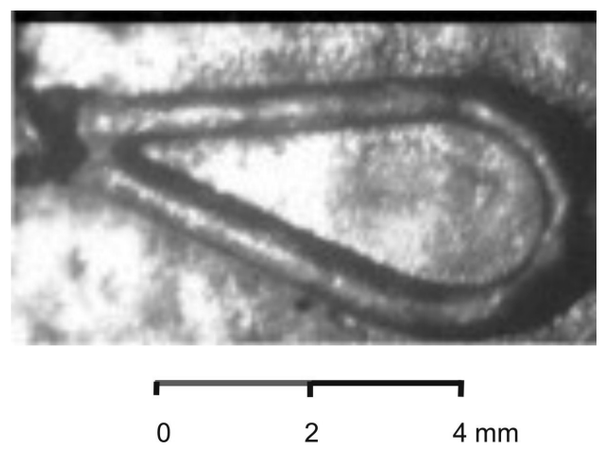


Fig. 2.2.40. (SCY 25).

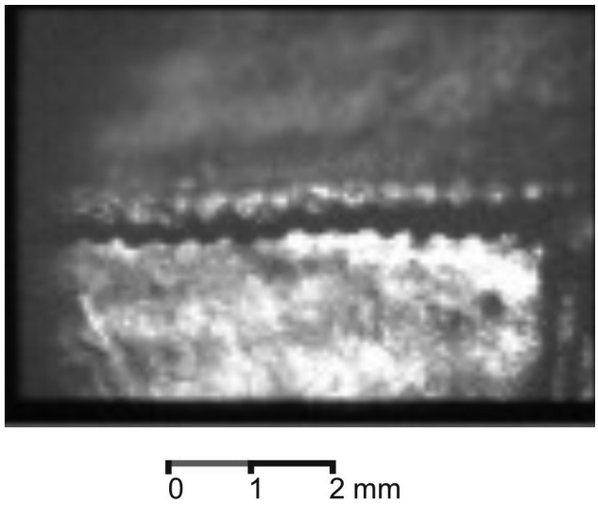


Fig. 2.2.41. (SCY 26).

The irregularity of the pearls indicates that a rolling swage was used to produce the beads (SCY 26). The regularity of the cloisonné panels indicates that a forming tool was used to construct these parts (SCY 23 and SCY 25). There is no indication of wear or abrasion on this artefact which could possibly indicate that it was never worn.

Pendant (Misc 7846) Fig 2.2.42

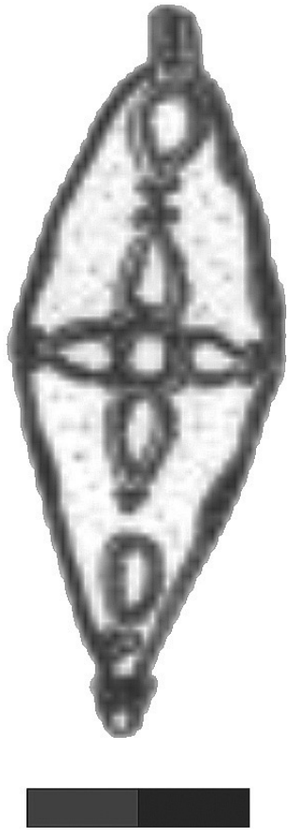


Fig. 2.2.42.

A small pendant constructed from a backing plate that has been decorated with filigree and cloisonné panels.

Cloisonné	pendant	Misc 7846	Fig. 2.2.43 (SCY 29)
Cloisonné	pendant	Misc 7846	Fig. 2.2.44 (SCY 30)
Cloisonné	pendant	Misc 7846	Fig. 2.2.45 (SCY 31)
Filigree	pendant	Misc 7846	Fig. 2.2.46 (SCY 32)
Hourglass	pendant	Misc 7846	Fig. 2.2.47 (SCY 33)

Table 2.2.7.

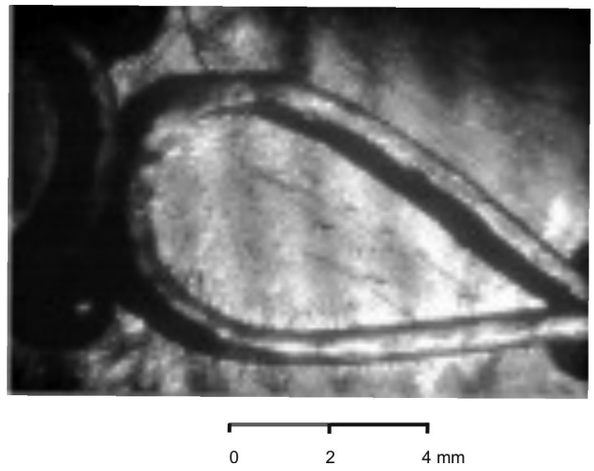


Fig. 2.2.43. (SCY 29).

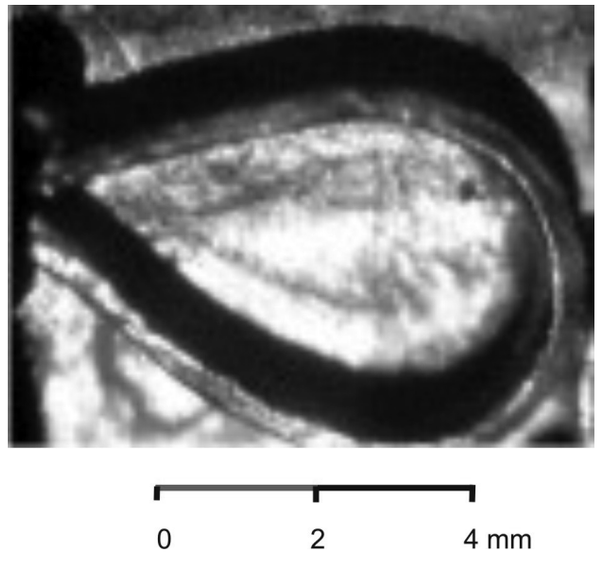


Fig. 2.2.44. (SCY 30).

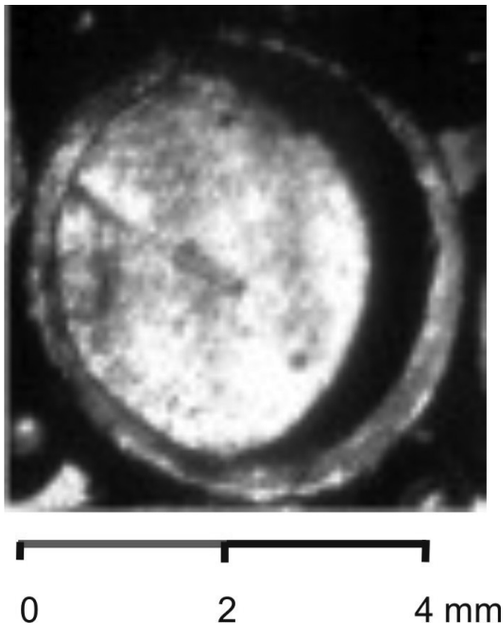


Fig. 2.2.45. (SCY 31).

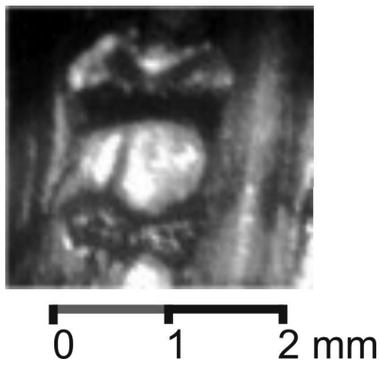


Fig. 2.2.47. (SCY 33).

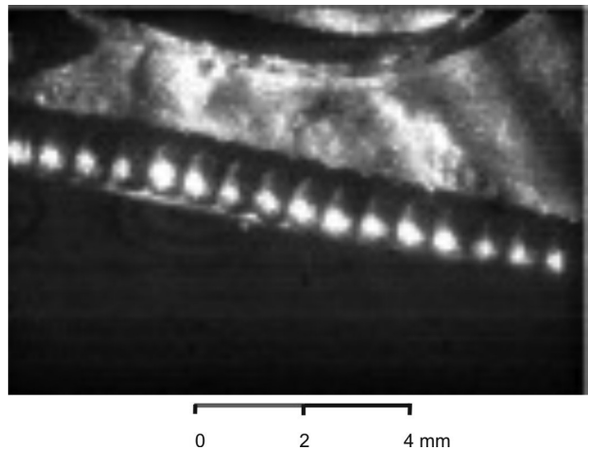


Fig. 2.2.46. (SCY 32).

The cloisonné has been produced with a forming tool; the filigree, although of a higher quality, is still made from a rolling swage. SCY 33 does not compare with any of the other tool marks that have been studied from Vettersfelde/ Witaszkowo. This artefact has no evidence of abrasion caused by wear.

Bracelet (Misc 7845) Fig 2. 2.48

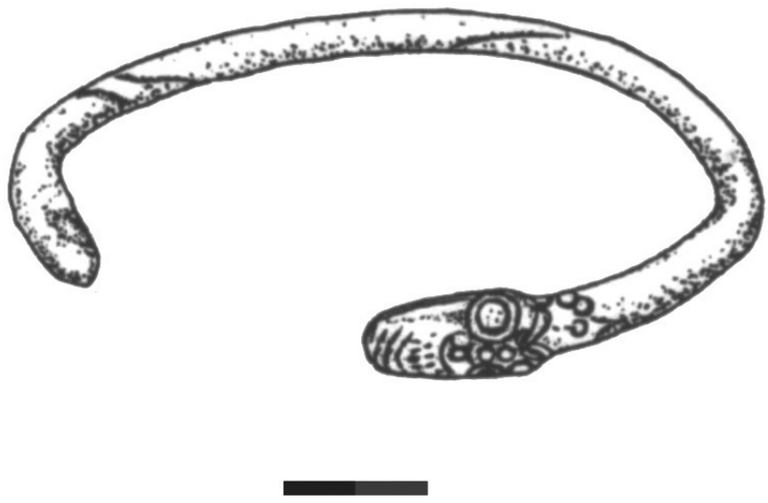


Fig. 2.2.48.

The bracelet has been produced from a square stock bar of gold alloy which has been twisted and then hammered round; this can be discerned from the spirals which are still evident. One of the snake heads still survives (there could have been another opposing it but this has been damaged by exposure to a high temperature which has melted this part of the bracelet). The head of the snake has been decorated with punches.

Semi circular	arm ring	Misc 7845	Fig. 2.2.49 (SCY 18)
Circle	arm ring	Misc 7845	Fig. 2.2.50 (SCY 19)
Triangular	arm ring	Misc 7845	Fig. 2.2.51 (SCY 20)
Semi circle	arm ring	Misc 7845	Fig. 2.2.52 (SCY 21)
Punch	arm ring	Misc 7845	Fig. 2.2.53 (SCY 22)

Table 2.2.8.

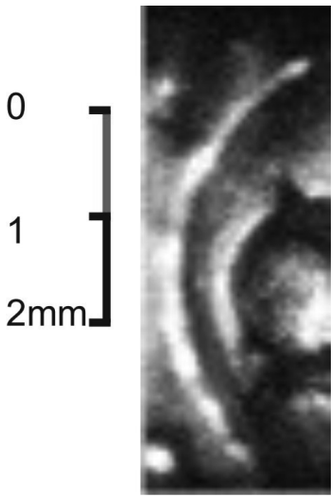


Fig. 2.2.49.(SCY 18).

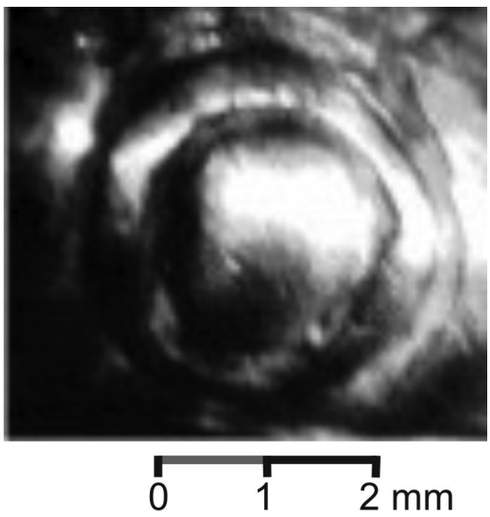


Fig. 2.2.50. (SCY 19).

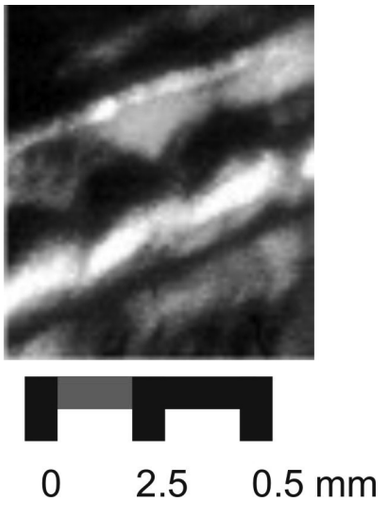


Fig. 2.2.51. (SCY 20).

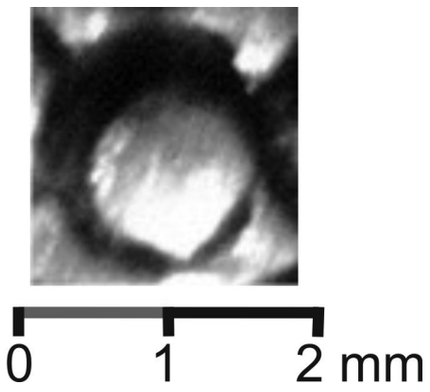


Fig. 2.2.52. (SCY 21).

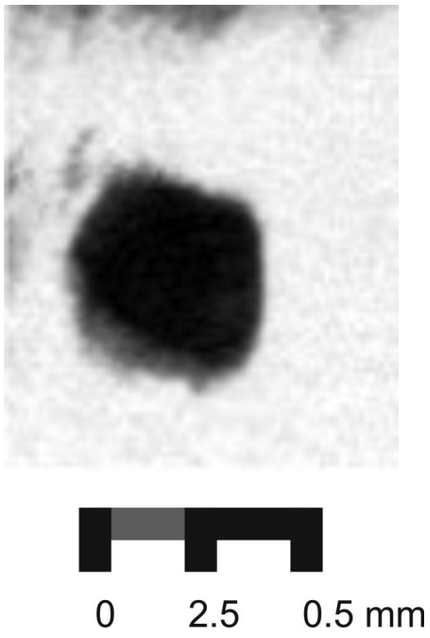


Fig. 2.2.53. (SCY 22).

Five different tool marks could be discerned on this artefact. The innermost side of the lower jaw of the snake head indicates that this piece had not been worn for a long period, if ever.

Result of the comparison of the tool marks

When the tool marks from the seven artefacts that were suitable for this type of examination were compared, it appeared that four of the samples may have been produced in the same workshop, using the same tool. It is possible to construct a relative chronology for the production of the artefacts that were studied from this tool.

When the tool was used to produce the bracelet (Misc 7845) it was a sheet of metal that had been bent around to form a circle: the original sheet was not of a uniform thickness (SCY 21). It was possibly used next on the production of the fish (Misc 7839) where the join between the edges has broken and it is no longer a full circle (SCY 5b). When it was used in the manufacture of the ornamental plaque it shows more evidence of wear (SCY 42). Further on, when this tool was used on the sword sheath one half of the tool has broken away, resulting in the craftsmen having to use it mirrored to produce a circular effect. Another example of a tool mark from the fish and the ornamental plaque supports this hypothesis. SCY 16 is in better condition than the same mark on the ornamental plaque.

This means that from this workshop there is a tool kit of twenty three different examples and another three possible tool marks. The three possible tool marks cannot be fully compared with the other examples due to the aforementioned problems with vibration, but SCY 11 could be the same as SCY 16 and SCY 43, SCY 6 may be the same as SCY 42, SCY 37 and SCY5b, and in the case of SCY 12 it could possibly be the same tool as SCY 8.

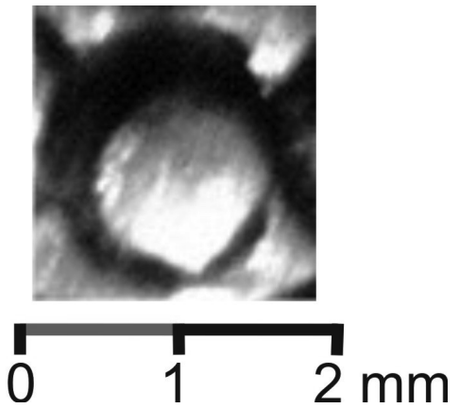
Tool Mark	SCY 21	SCY 5b	SCY 16	SCY 42	SCY 43	SCY 37
SCY 21		*		*		*
SCY 5b	*			*		*
SCY 16					*	
SCY 42	*	*				*
SCY 43			*			
SCY 37	*	*		*		

Table 2.2.9. the links between the tool marks and the artefacts in chronological order of production.

It is therefore possible to reconstruct the chronological order in which the craftsmen decorated some of artefacts from the tool marks and the wear of the tools (see Fig. 2.2.54).

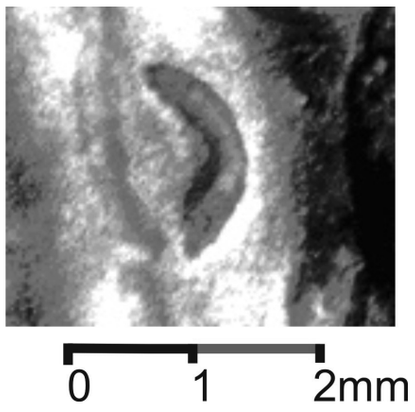
Linked tool marks from Vettersfelde/Witaszkowo

Bracelet

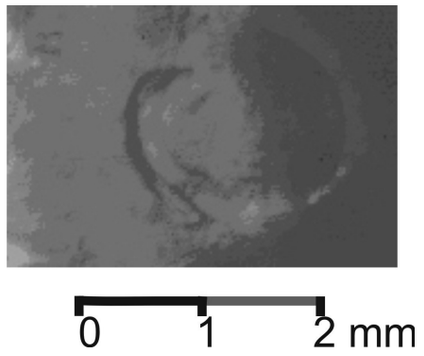


SCY 21

Fish

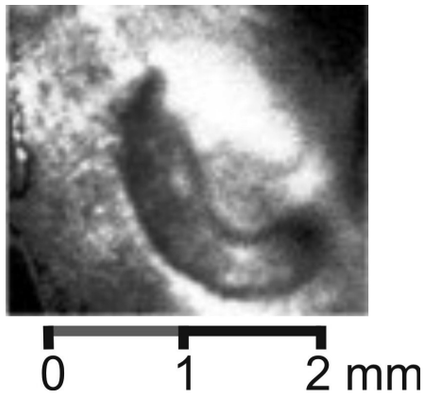


SCY 16

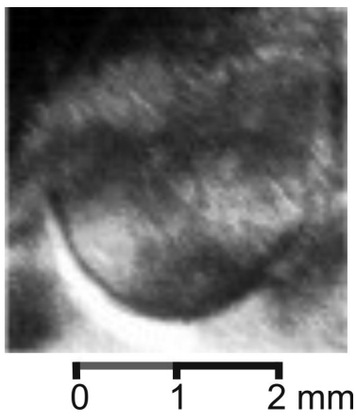


SCY 5b

Ornamental plaque

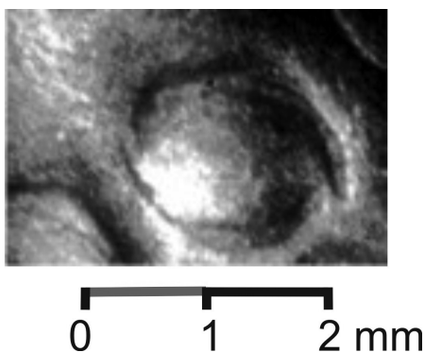


SCY 43



SCY 42

Sword Sheath



SCY 37

Fig. 2.2.54.

Reconstruction

In this study conducted on seven artefacts from Vettersfelde/Witaszkowo, a new interpretation of the objects was produced after studying the tool marks. It was possible to show that four of the seven artefacts sampled were produced in the same workshop and a relative chronology between these artefacts could be constructed. It was found that it was possible to see that one tool was used on the bracelet (Misc 7845); the same tool was then used to decorate the fish (Misc 7839) with the scarf joint broken a little so that the tool mark was no longer a full circle. When this tool was used in the manufacture of the ornamental plaque (Misc 7841), the gap between the two edges had increased. On the sword sheath (Misc 7842) the tool had broken in half at the weak point that was evident before (Fig. 2.2.8). This is evidence that the craftsman who decorated these artefacts was not responsible for the construction of the tool, indicating that there were two separate specialists.

By using these four tool marks as the basis, it was possible to find 19 tool marks that belonged to the craftsmen working on these four artefacts. These artefacts have been dated to the early 5th Century BC ever since this material was procured by the Berlin Museum; it has been dated historically and not archaeologically, always relating to the war with the Persians[30]. This dating relied on the Greek elements in the pictorial representation and the circular argument that the hoard was buried to protect it from Darius who had invaded Scythia at this time. These allegedly Greek elements could have come from the Near East, which is supported by the Ištar, an Assyrian symbol which was used on reliefs from the 9th to 7th centuries BC. The design of the akinakes also supports this earlier dating of the manufacture of the hoard, although this does not mean that it was not placed into the ground at a later date. In the dating of the Vettersfelde/Witaszkowo hoard, a maximum difference of 200 years can be produced using the chronology based on the Ferigile culture. In the case of the Akinakes (Misc 7850) the sword handle has been shown to be type 25 named Orbeasca de Sus, dated to late 8th/early 7th century BC. On the sword sheath cover there is another indicator that the dating of these artefacts is incorrect (see above).[31]

The difference in the dating of the hoard is critical in the understanding of the development of technology because when the filigree was studied on the two pendants and the earring, it was found that the pearls were produced in a technique that was not used in the Greek world; they were produced by a swaging tool and not rolled. The cloisonné fixtures were produced using a forming tool to achieve uniformity. This indicates that our common beliefs about the Greeks as the master craftsmen of the ancient world may be incorrect, for in the examination of the Vettersfelde/Witaszkowo hoard it is apparent that there were different

[30] Greifenhagen 1970, 61.
[31] See also: Kull 1997a, 572.

levels of technology in other areas of the world; even if these craftsmen from the periphery of the Greek world did have contact with Greek artistic forms, they clearly did not use the same technology to produce the same effect.

The fact that none of the samples that were studied from Vettersfelde/Witaszkowo had any evidence of abrasion caused by wear could indicate that they had been packed for transportation from the place of manufacture. Although all of the artefacts were not studied to the same standard, it also appears that they were not used for any length of time, if at all. This could mean that the material was of a ceremonial nature or that it had never been used. The earring is more likely to be a belt hanger, as were the pendants, which suggests that nearly all the artefacts found at Vettersfelde/Witaszkowo belong to a belt set (the bracelet and the torque being the exceptions). It is possible that the hoard from Vettersfelde/Witaszkowo was a negative reciprocal gift[32] which was packed in a wooden box; this was involved in a fire which resulted in some of the artefacts being damaged. The public display of part of the whole assemblage would have resulted in questions being asked over the rest. The artefacts were then removed from the backing material, e.g. bow case, and disposed of, to be re-discovered when a ditch was excavated in 1882.

The complete assemblage from Vettersfelde/Witaszkowo should have consisted of more material, all of which, upon examination of Scythian statues, fits in with a chieftain from the area of the Black Sea in the 7th century BC, as on the statue from Erdelevka. The figure represented is wearing a torque, and hanging from a belt is a knife, bow case, and a possible whetstone.[33]

There is also evidence from the statues that the bow case sometimes had a motive fixed upon the outside[34]. It is possible that the fish (Misc 7839 - Fig. 2.2.1) and the ornamental plaque (Misc 7841 - Fig. 2.2.3) were used for this purpose. There are a limited number of examples where this can be discerned, e.g. Grave 2, Melitopol Kurgan[35], the bow case from Mastjugeno[36], and the bow case from Karagodeuasch.[37]

The interpretation of the fish as a shield motive may not be valid because the Scythian shield was manufactured from thin sheets of iron fixed to a leather backing material, making the shield relatively flexible. The fixing of the fish would result in the shield no longer being so flexible and the fish would be prone to damage even from limited movement. The fish is not curved so it is improbable that it was used for the decoration of a horse.

In the study of the artefacts from Vettersfelde/Witaszkowo it was possible to directly link 6 tool marks used to decorate four of the seven artefacts examined. In total there were 19 different tools used by the craftsmen to produce these artefacts. The damage of one of the tools in the production run indicates a degree of specialisation in the production of jewellery that was not previously suspected: the jeweller was not the tool maker.

The results of the study of this hoard indicate that the artefacts were hardly if ever used because of the lack of wear on them. The re-interpretation of the artefacts has resulted in the conclusion that all belonged to a single male individual and that they are not from two separate and possibly related inhumations.

[32] A negative reciprocal gift is where something of such a high cultural worth is given to the receiver that he can never reciprocate with anything of equal value leaving the receiver in debt for the rest of their lives to the giver.
[33] Ol'kovskiy & Yevdokimov 1994, 130.
[34] Ol'kovskiy & Yevdokimov 1994, 74.
[35] Ol'kovskiy & Yevdokimov 1988, 122.
[36] Chernenko 1981, 66.
[37] Chernenko 1981, 74.

2.3 Maikop Hoard

There has been considerable debate about the origin of the Maikop hoard since it was bought by the Antique Collection of Berlin in 1913. An Armenian dealer stated that the hoard came from the *Tshmyrevshen Kurgan* south of Nikopol.[1] The origin of these artefacts was changed to the Kuban region after the study conducted by Prof. M. Rostovzteff, the results of which were published in 1931. He also linked the material in Berlin to the artefacts in the Metropolitan Museum, New York, and the Ercole Canessa Collection in the Museum of the University of Pennsylvania.[2] His comparison was based on similarities between a number of the artefacts preserved in the three museums, which resulted in the Maikop hoard being dated to the first half of the 5th Century BC on the basis of two dateable artefacts in the University of Pennsylvania: a black-figure *skyphos* and a fragment of red-figured *pelike* of the late 5th Century BC.[3]

Although the majority of the material has been considered genuine, there have been questions over the authenticity of many of the artefacts in the recent past.[4] However, these anomalies were not known when this material, together with the material from Vettersfelde/Witaszkowo was technically analyzed by Macro Laser Imaging Technique (M.L.I.T.). A number of abnormalities in the method of gold production were observed in the Maikop hoard, differing from known Classical gold smithing techniques. It was found that in the case of the Maikop treasure it is possible to link the tool marks over the majority of the artefacts studied.

From these artefacts a complete data bank has been assembled consisting of over 180 photographs of tool marks. As the majority are exactly the same only 37 are discussed here.

[1] Greifenhagen 1970, 55.
[2] Rostovzteff 1931, 368.
[3] Stoddert et al. 1975, 157.
[4] Boardman 1994, footnote 79, 340; Greifenhagen 1970, 58-59.

Artefact	Inventory number	Material	Weight	Dimensions
Drinking horn terminal	MISC 30221 i 1-2	Gold alloy	Not available	L. 3
Plaques	MISC 30221 u 1-218	Gold alloy	Not available	1,2 x 1,2
Stags	MISC 30221 s 1-14	Gold alloy	Not available	H. 3 x W. 2.7
Griffins	MISC 30221 r 1-10	Gold alloy	Not available	2.5 x 2.5
Panther heads	MISC 30221 f 1-4	Gold alloy	Not available	H. 5, W. 3.8
The sea-eagles-hunting-fish	MISC 30221 e 1-4	Gold alloy	Not available	L. 11.2 x W. 7.3
Rams heads	MISC 30221 q 1-14	Gold alloy	Not available	L. 15.7, with chain.
Opposed-lotus-blossom plaques	MISC 30221 t 1-19	Gold alloy	Not available	H 2.5
Drinking horn	MISC 30221 k 1	Gold alloy	Not available	Dia. 6.7, rim H. 5.6
Drinking horn	MISC 30221 k 2	Gold alloy	Not available	Dia. 6.5 rim H. 2.1

Table 2.3.1.

The results of the study of the tool marks on the Maikop Hoard

Drinking horn terminal (MISC 3022i) Fig 2.3.1

Fig. 2.3.1.[5]

The detailed examination of the tool marks from two drinking horn terminals indicated that the basic form of the lion heads had been produced using the same pair of matrixes to press the separate halves of the terminal, then soldered together. This can be discerned from the eyes which have the same defects from the tools that were used to produce them. (See Fig. 2.3.2 - SCY 47 & Fig. 2.3.3 - SCY 51).

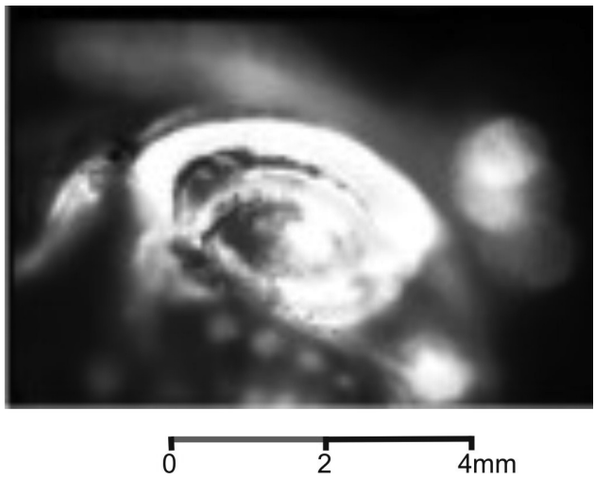


Fig. 2.3.2. (SCY 47).

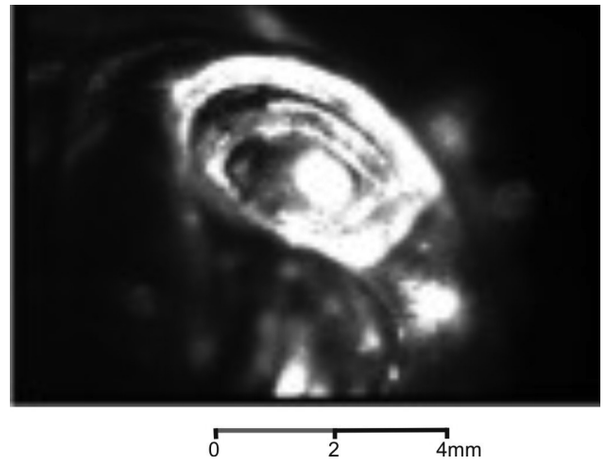


Fig. 2.3.3. (SCY 51).

The differing quality in the decoration of the artefacts indicates that this was done by two individuals, probably the master and his apprentice (Fig. 2.3.4 - SCY 46, and Fig. 2.3.5 - SCY 52). This difference can also be found in the production of the filigree wire which was used to strengthen the neck of the terminals and the quality of the engraving. The filigree wire was produced using a rolling swage (Fig. 2.3.6 - SCY 50 & Fig. 2.3.7 - SCY 54).

[5] By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung. All Scales in cm unless otherwise stated

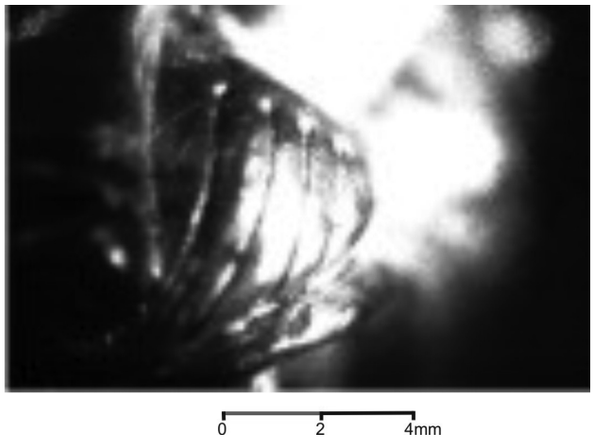


Fig. 2.3.2. (SCY 47).

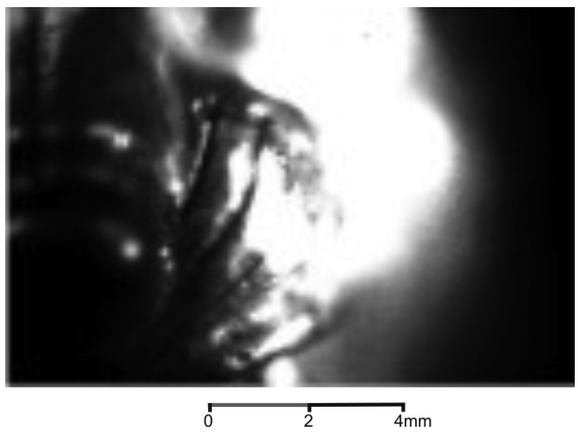


Fig. 2.3.3. (SCY 51).

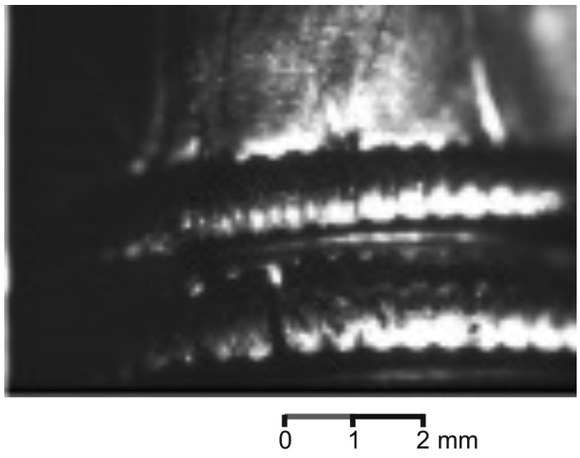


Fig. 2.3.4. (SCY 46).

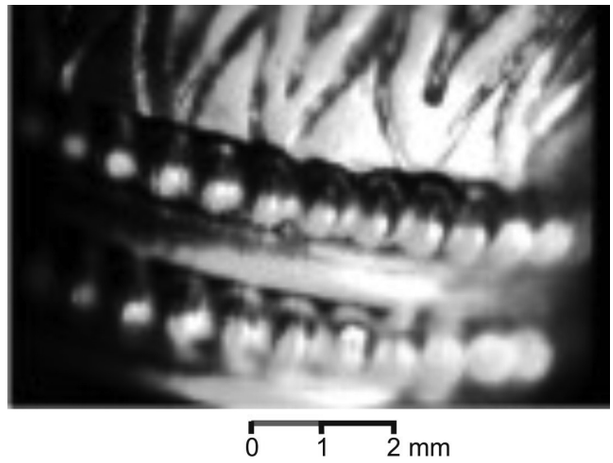


Fig. 2.3.5. (SCY 52).

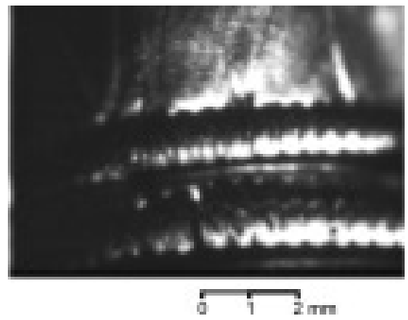


Fig. 2.3.6. (SCY 50).

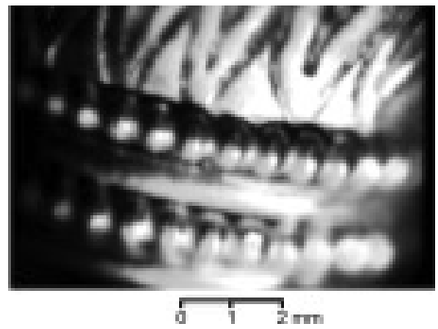


Fig. 2.3.7. (SCY 54).

In Fig 2.3.7 (SCY 54) there is evidence of abrasion on the filigree which could indicate that the artefact had been used.

Punch	Drinking horn terminal	MISC 3022i	Fig. 2.3.2 (SCY 47).
Punch	Drinking horn terminal	MISC 3022i	Fig. 2.3.3 (SCY 51)
Punch and engraving	Drinking horn terminal	MISC 3022i	Fig. 2.3.4 (SCY 46)
Punch and engraving	Drinking horn terminal	MISC 3022i	Fig. 2.3.5 SCY 52
Filigree and engraving	Drinking horn terminal	MISC 3022i	Fig. 2.3.6 (SCY 50)
Filigree and engraving	Drinking horn terminal	MISC 3022i	Fig. 2.3.7 (SCY 54)

Table 2.3.2.

Plaques (MISC 30221 u 1-218) Fig 2.3.8

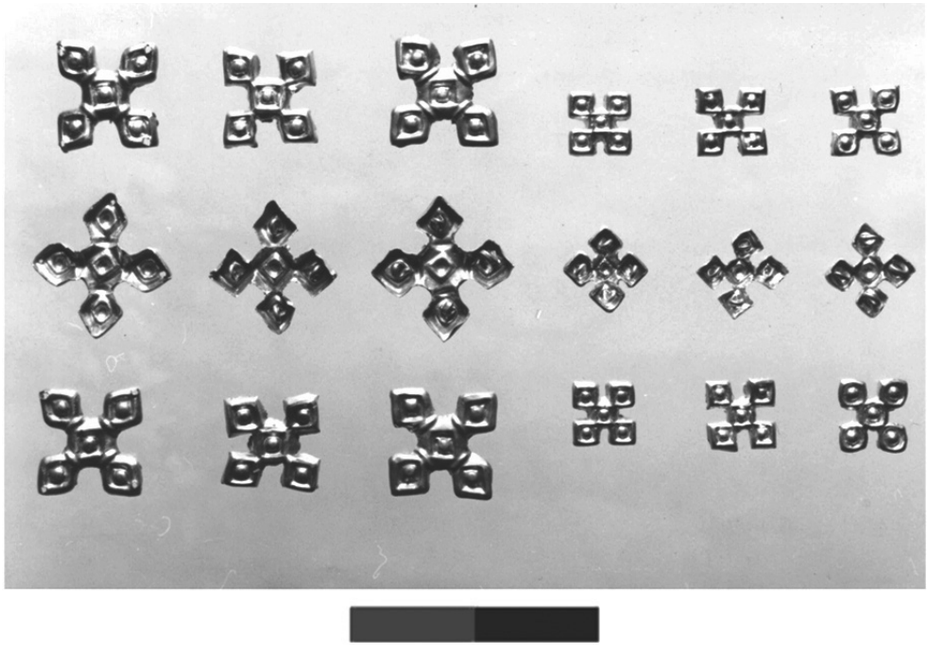


Fig. 2.3.8.[6]

The small square geometric plates would have been stitched to clothing using the 4 small rings mounted on the back or through the holes punched through the plaque (as per the three examples on the left of the picture). There are 4 different types of plaques, all of which are presented in the illustration mentioned; the central three examples are the same style as the plaques with punched holes, except that they have four rings soldered to the back of the plate. These plaques were grouped together in the initial inventory and have not been previously sub-divided.

The nine plaques to the right were all produced by the same matrix and patrix,[7] for, although the outer form can be seen to change, it is only at the areas that were subjected to the most stress when the gold was being pressed. When the central motif is compared with the others, they match in all cases, which indicates that the artefacts were pressed, as does the relative thickness of the gold sheet. The gold wire that was used to attach the plaques was produced by wrapping fine wire around a stock bar and then cutting it with a chisel or knife; they were joined by the technique of colloid hard soldering,[8] which was known to the Greeks as chrysokolla,[9] meaning gold glue. This can be discerned by the way that the edges of the cut are still evident on the wire (Fig. 2.3.9 - SCY 57, Fig. 2.3.10 - SCY 55 and Fig. 2.3.11 - SCY 56).

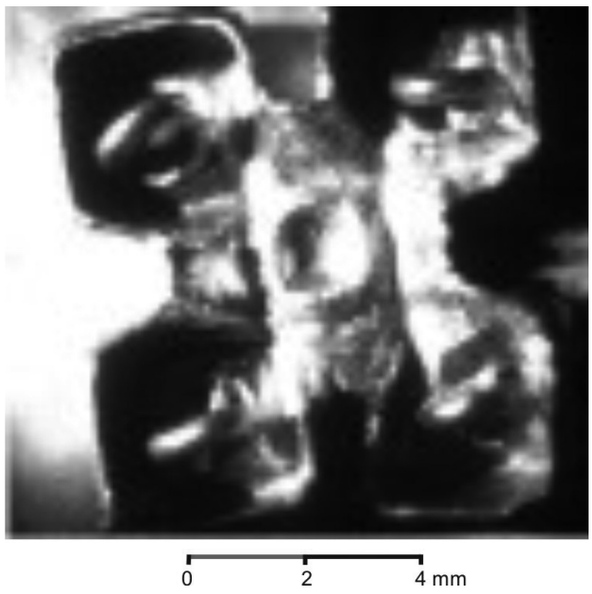


Fig. 2.3.9. (SCY 57).

[6]By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung.
[7] Matrix and patrix are the engineering terms for male and female forming tools.
[8] Littledale British Patent nr.415181 (23.8.1934).
[9] Jüngst 1981, II.

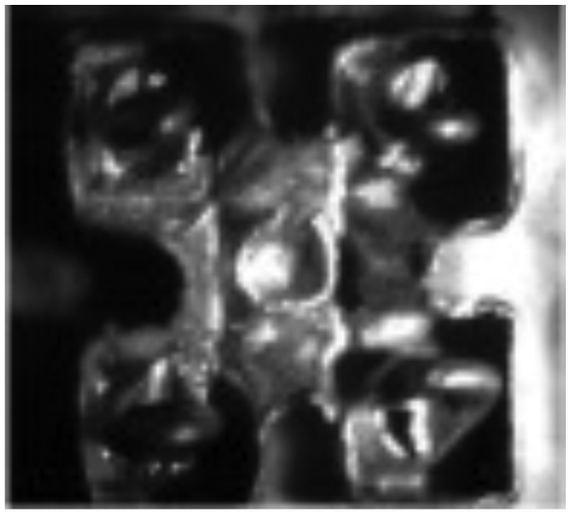


Fig. 2.3.10. (SCY 55).

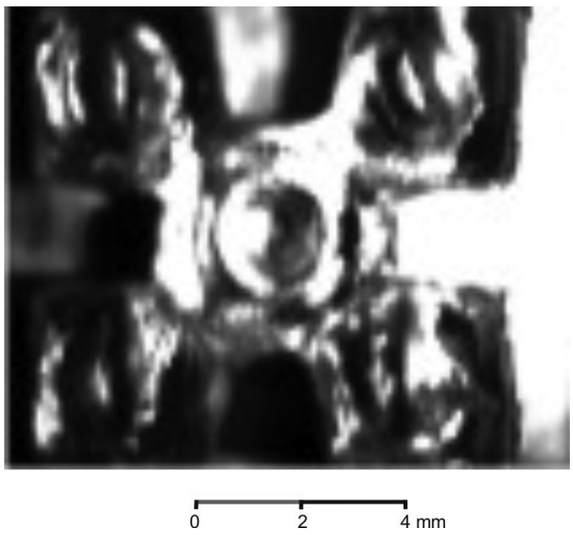


Fig. 2.3.11. (SCY 56).

The edges of the plaque, which can be discerned in SCY 55, indicate that these artefacts were only produced for the inhumation ceremony because there is no evidence of wear on this fragile service. All of the rings are still in situ, which would have been easily damaged when these plaques were placed under stress.

The rest of the plaques studied had a number of abnormalities that may indicate that they were not produced by Greek or Scythian craftsmen. The square ornamental plaques (Fig 2.3.8) were all produced using the same tool to produce the central motif and they appear to be genuine in form. However the square gold wire used to fix the central form in the plate of the complete assemblage of plaques has been drawn (Fig. 2.3.12 - SCY 58), which is not a technique known for this period. At the moment there are no known examples from provenanced materials that have been found to have drawn gold wire before the AD 8th Century.[10] All other earlier examples have come from unprovenanced material and as such are normally considered to be forgeries.[11]

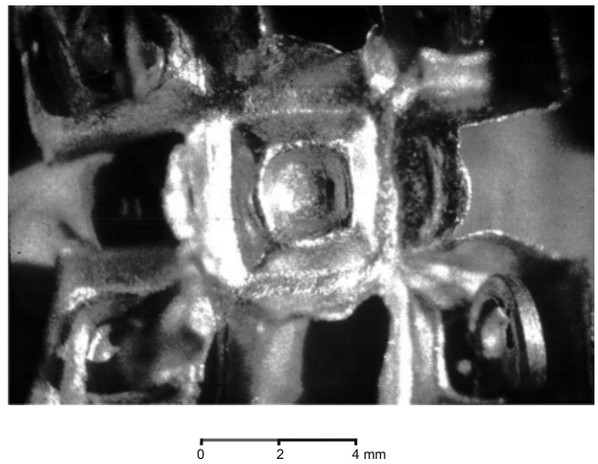


Fig. 2.3.12. (SCY 58).

Stamp	Plaques	MISC 30221 u 1-218	Fig. 2.3.9 (SCY 57)
Stamp	Plaques	MISC 30221 u 1-218	Fig. 2.3.10 (SCY 55)
Stamp	Plaques	MISC 30221 u 1-218	Fig. 2.3.11 (SCY 56)
Stamp	Plaques	MISC 30221 u 1-218	Fig. 2.3.12 (SCY 58)

Table 2.3.3.

The other pieces that are suspect in the Maikop treasure are the stags *(MISC 30221 s 1-14)*, griffins *(MISC 30221 r 1-10)*, ram's heads *(MISC 30221 q 1-14)*, opposed-lotus-blossom plaque *(MISC 30221 t 1-19)*, sea-eagles-hunting-fish *(MISC 30221 e 1-4)*, panther heads *(MISC 30221 f 1-4)*, and drinking horns (*MISC 30221 k 1-2)*. Since the quality of the tool marks and the comparison with the individual photographs has shown that the artefacts were pressed, it is possible to see that mirror images were also produced using dies that had been produced from the opposing dies used to produce the artefacts, e.g. the stags.[12]

[10] Williams & Ogden 1994

[11] The latest research conducted in Brandenburg, Germany, has identified drawn wire dated to the AD 4th Century. (Personal communication Stephan Brather.) The earlier indications for the drawing of wire, as discussed in Chapter 3.6, concern only wire with round section.

[12] This technique would have also have to have been used for the production of the lion head terminals, so it is not proof of forgery on its own.

Stags (MISC 30221 s 1-14) Fig 2.3.13

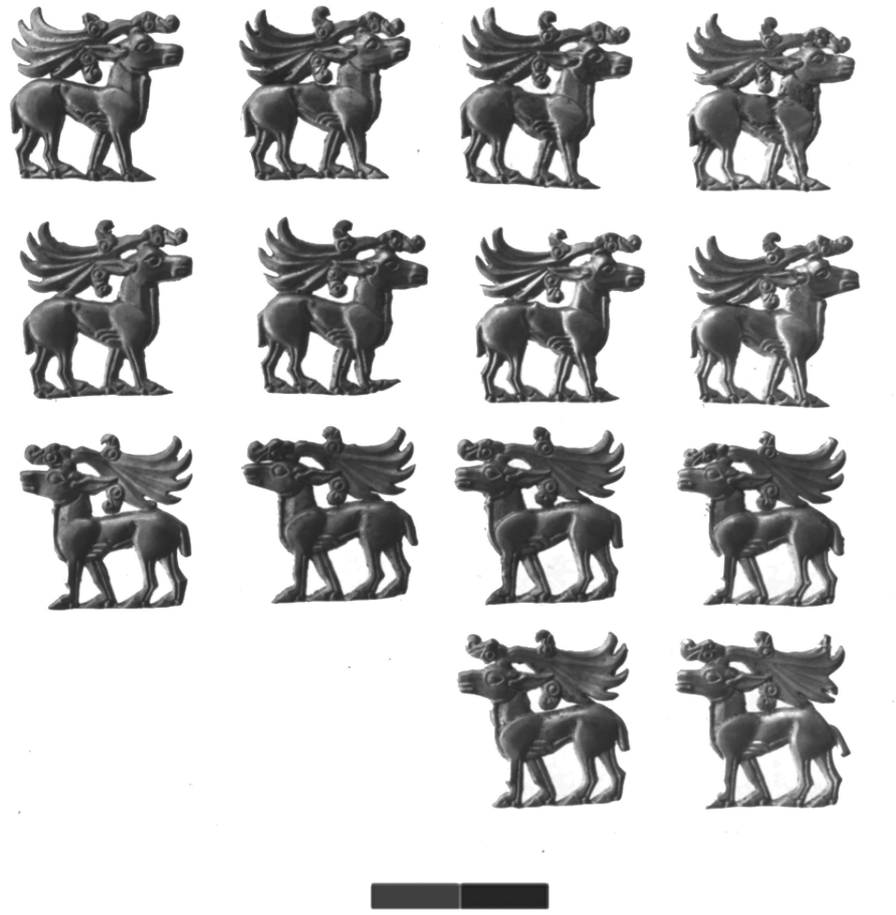


Fig. 2.3.13.

The stags facing right are slightly smaller than the ones facing left, which could mean that the original tool produced right-facing reproductions of the stags and then a positive copy of this tool was used to produce the others (Fig. 2.3.14 - SCY 60, Fig. 2.3.15 - SCY 62, Fig. 2.3.16 - SCY 63 and Fig. 2.3.17 - SCY 64). The original tool was pressed into a sheet of heated metal to produce a mirror image, which the sheet gold was pressed onto to produce the stags facing left. When this negative image had cooled a heated bar was forced into the hollow to produce a new tool. This is apparent from the tool marks on the stags; the right-facing stags have sharper edges than the left-facing ones. This is not a standard practice for the production of Scythian and Greek jewellery. Normally the plaques are all produced facing one direction and although there are a limited number of opposite-facing plaques they are not exact mirror images, e.g. the seven gold plaques of prostrate lions from Kurgan 4 at Aul Ulyap.[13]

Stamp	Stag	MISC 30221 s 1-14	Fig. 2.3.14 (SCY 60)
Stamp	Stag	MISC 30221 s 1-14	Fig. 2.3.15 (SCY 62)
Stamp	Stag	MISC 30221 s 1-14	Fig. 2.3.16 (SCY 63)
Stamp	Stag	MISC 30221 s 1-14	Fig. 2.3.17 (SCY 64)

Table 2.3.4.

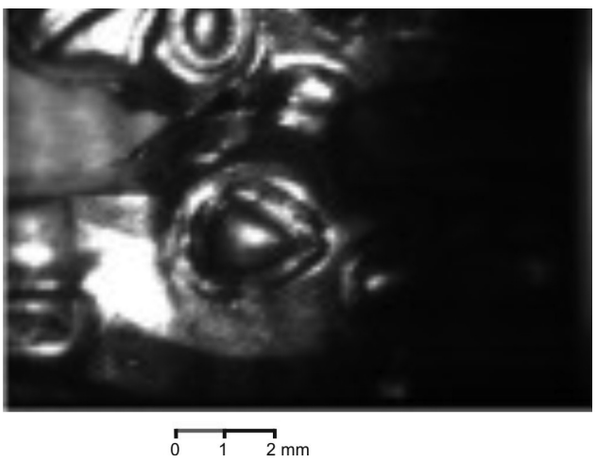


Fig. 2.3.14. (SCY 60).

[13] Leskov & Lapushnian 1987, cat. No. 42, fig. 31.

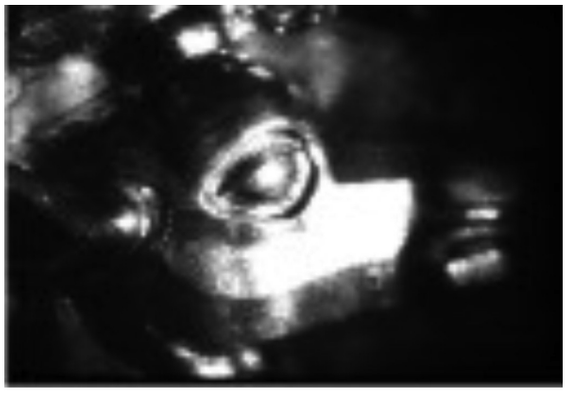


Fig. 2.3.15. (SCY 62).

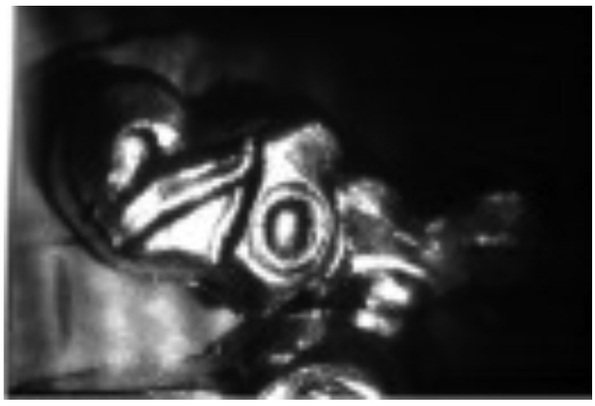


Fig. 2.3.16. (SCY 63).

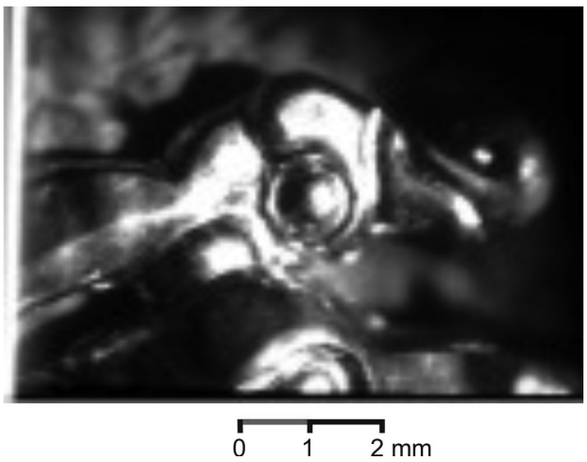


Fig. 2.3.17. (SCY 64).

Following the indications from the technical study that these pieces may not be genuine Greek or Scythian artefacts the stags were considered from an art historical perspective to see if this suspicion could be confirmed. The sharp high relief of the stags with the articulation of the components relative to the total product of the finished image, which converges at the angle of the planes with clear faces, is immediately apparent as normally associated with Scythian art from the European steppe strip.[14] Differences in the criteria, inherent in the formation of the animal style, can be an indicator if the piece was conceived in the east or west of the Scythian sphere of influence. In the case of the stags from Maikop, the western versions have two leading branches compared with one from eastern regions. This factor contradicts the first impression that the stags were produced in western regions. The horns, although correctly fulfilling the form to be Scythian by running over the whole length of the body, are inverted to the standard representation. The degraded horns are stylistically represented and not naturalistically, as is known to occur in the material from the Tatar culture of the Khakass-Minusinsk Basin in southern Siberia. Along with the degradation of the horns, the figure of the animal becomes flatter and dryer which is not the case for these stags.[15] The legs of the stags do not conform to the canons of Scythian art either, because more than two are reproduced and the animal is walking, while normally, for a herbivore, they are in a position of rest, except when the animal is being attacked by a predator. There is at least one other example of this type of stag from Kurgan 5, Aul Ulyap, except for the round eyes and the quality of the pressing.

It is apparent that the stags are produced from a mixture of western and eastern Scythian influences and do not conform to the known rules for the representation of these animals, which along with the method of production indicates that these artefacts may not be genuine Greek or Scythian manufactured objects.

[14] Perevodchikova 1994, 89.
[15] Perevodchikova 1994, 107.

Griffins (MISC 30221 r 1-10) Fig 2.3.18

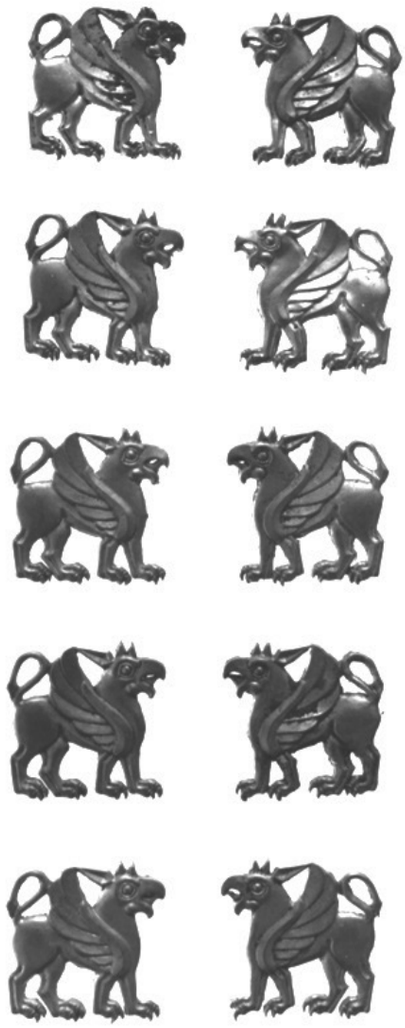


Fig. 2.3.18.[16]

The griffins are manufactured in the same way as the aforementioned stags, being pressed without any reworking to clarify the decorative features. Once again a mirror image of the original tool was produced, except that the griffins facing left were produced before the right-facing griffin (Fig. 2.3.19 - SCY 65). This is shown by the quality of reproduction, especially in the tongues which are sharper on the left-facing griffins (Fig. 2.3.20 - SCY 66).

Stamp	Griffin	MISC 30221 r 1-10	Fig. 2.3.19 (Scy 65)
Stamp	Griffin	MISC 30221 r 1-10	Fig. 2.3.20 (Scy 66)

Table 2.3.5.

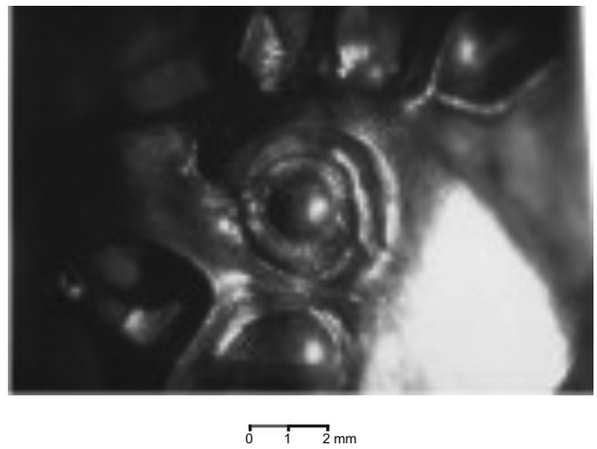


Fig. 2.3.19. (Scy 65).

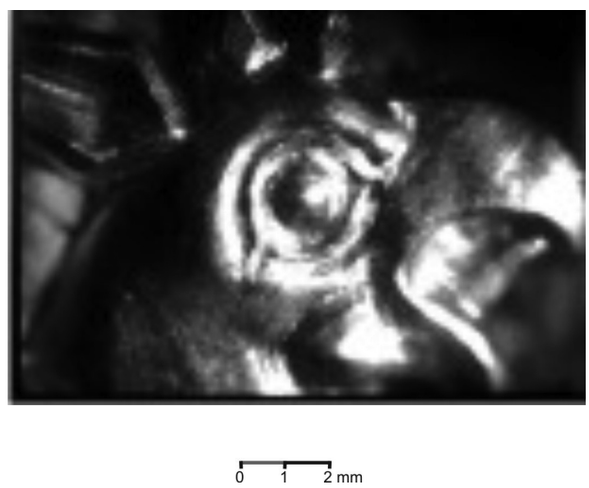


Fig. 2.3.20. (Scy 66).

An art historical study of these artefacts to clarify if they are of Scythian or Greek manufacture once again indicates that they may be not genuine because they are produced from conflicting styles. They are produced in a Greek style with a comb for a crest, and crescent wings (which are dated from the 8th - 6th Century BC); the ear design can be dated to the 6th century BC, and the four legs which are represented can normally be found on plaques from the 4th Century BC onwards. The apparent differences in the dating of the different styles that are used to produce these artefacts, along with the discrepancies from the technical study of tool marks, leads one to draw the conclusion that the griffins are not genuine antique objects of art, but rather that they are relatively modern reproductions.

[16]By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung.

Panther heads (MISC 30221 f 1-4). Fig 2.3.21

Fig. 2.3.21.[17]

The technical analysis of the panther heads showed that they had been stamped with the punched indentations on the cheeks for decoration added separately. There is no evidence for reworking to sharpen the relief or that they were polished to remove marks from the manufacturing process. The inscribed lines for the orientation of the punch can still be discerned in Fig. 2.3.22 (Scy 67), Fig. 2.3.23 (SCY68) and Fig. 2.3.24 (SCY69).

Punch and engraver	Panther	MISC 30221 f 1-4	Fig. 2.3.22 (Scy 67)
Punch and engraver	Panther	MISC 30221 f 1-4	Fig. 2.3.23 (SCY68)
Punch and engraver	Panther	MISC 30221 f 1-4	Fig. 2.3.24 (Scy 69)

Table 2.3.6.

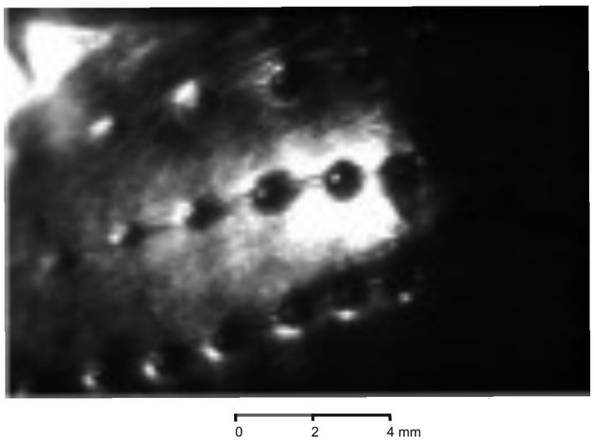


Fig. 2.3.22. (SCY 67).

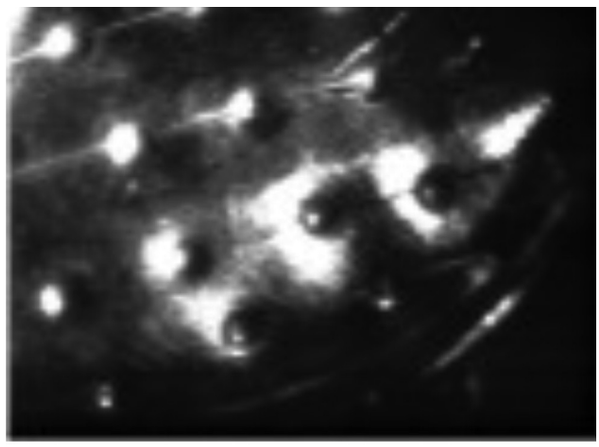


Fig. 2.3.23. (SCY68).

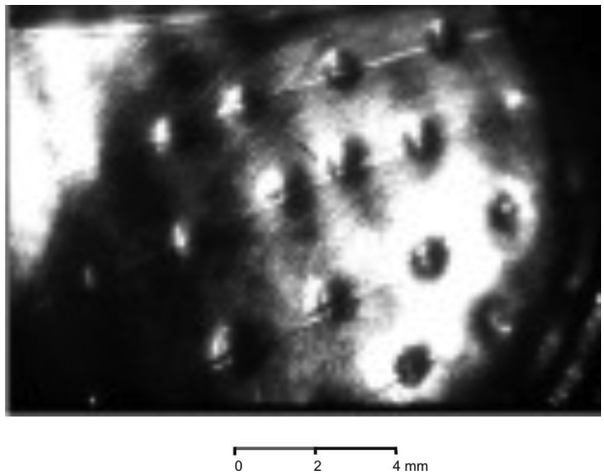


Fig. 2.3.24. (SCY69).

[17] By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung.

A historical study of these artefacts indicates that they may not be Scythian or Greek because the ears and eyes are not produced in the correct style; normally in the North Pontic region the ears were produced in the form of a heart and the eyes are round,[18] e.g. three copper alloy plaques from Kurgan 2, Aul Ulyap[19] and the predatory beasts on the carved wooden artefact from Bashadarskogo Kurgan.[20].

The sea-eagles-hunting-fish (MISC 30221 e 1-4) Fig 2.3.25

Fig. 2.3.25.[21]

For the four trapezoidal plaques decorated with a sea eagle in the foreground with a fish in the background, it has normally been assumed that the eagle has caught the fish, but the claws appear to be superimposed on the fish indicating that the fish is not captive of the sea eagle but rather that the eagle is standing on the fish. The head of the eagle is bent downwards with the beak touching the fish's head; the demarcation of the head from the neck is the large eye and the small ear. The claws and wings are naturalistically represented.

The fish is also naturally represented; the triangular head is separated from the body of the fish which is covered in semi-circle scales by the gills. The tail could be a lotus blossom.

Stamp	sea-eagles-hunting-fish	MISC 30221 e 1-4	Fig. 2.3.26 (SCY 70)
Stamp	sea-eagles-hunting-fish	MISC 30221 e 1-4	Fig. 2.3.27 (SCY 71)
Stamp	sea-eagles-hunting-fish	MISC 30221 e 1-4	Fig. 2.3.28 (SCY 72)
Stamp	sea-eagles-hunting-fish	MISC 30221 e 1-4	Fig. 2.3.29 (SCY 73)
Semi circle	sea-eagles-hunting-fish	MISC 30221 e 1-4	Fig. 2.3.30 (SCY 74)
Semi circle	sea-eagles-hunting-fish	MISC 30221 e 1-4	Fig. 2.3.31 (SCY 75)

Table 2.3.7.

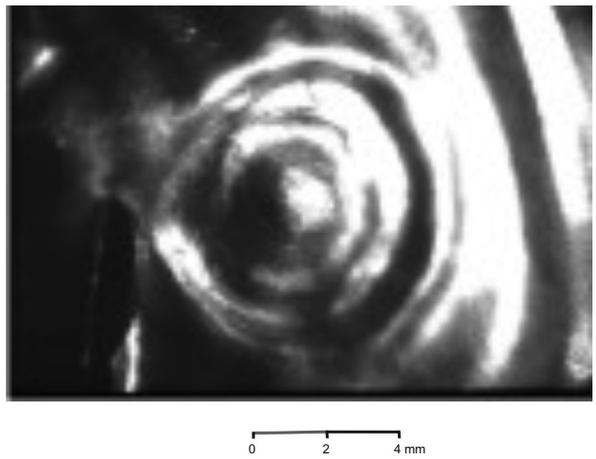


Fig. 2.3.26. (SCY 70).

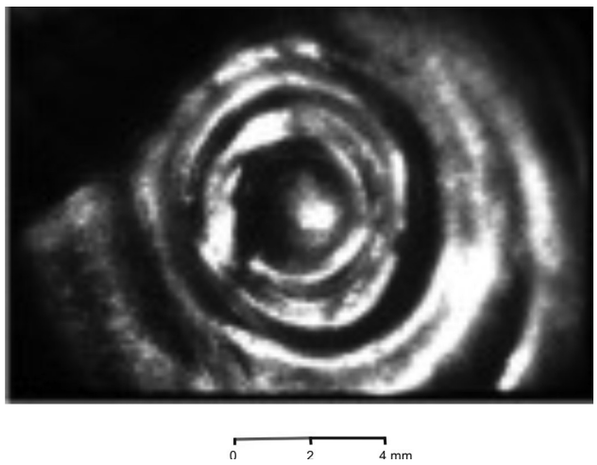


Fig. 2.3.27. (SCY 71).

[18] Perevodchikova 1994, 34.
[19] Leskov & Lapushnian 1987, 81.
[20] Perevodchikova 1994, 35.
[21] By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung.

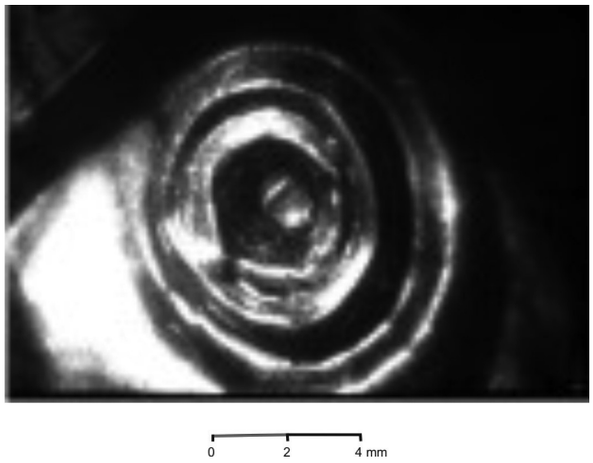


Fig. 2.3.28. (SCY 72).

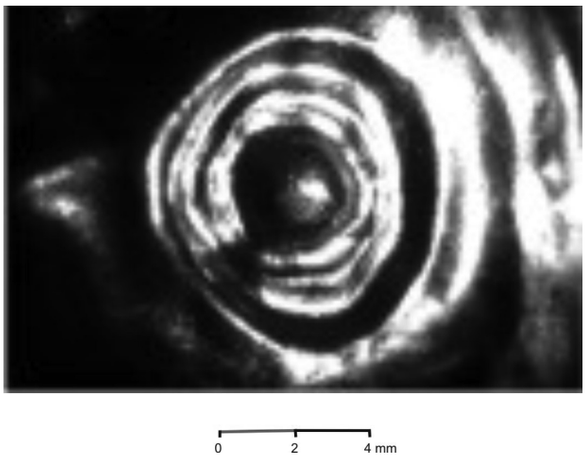


Fig. 2.3.29. (SCY 73).

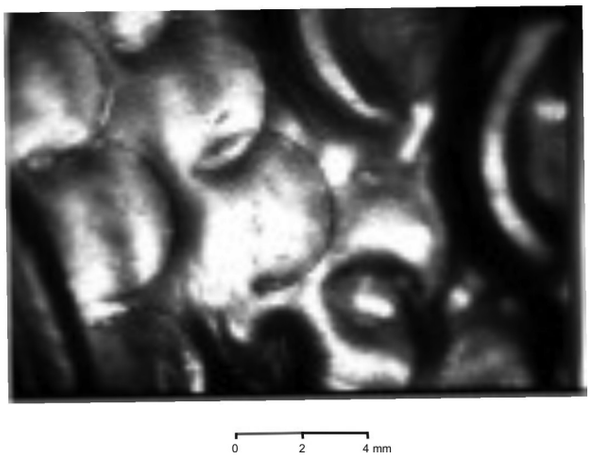


Fig. 2.3.30. (SCY 74).

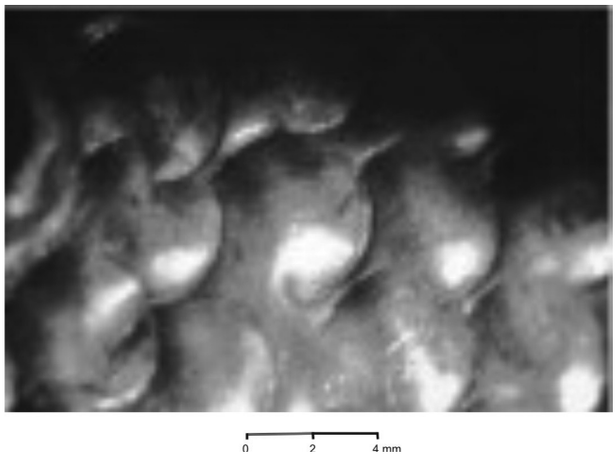


Fig. 2.3.31. (SCY 75).

The pictures of the eyes of the fish show that, although the plaques had been stamped (see Fig. 2.3.26 to Fig 2.3.29), the details had not been reworked to sharpen the image. The scales of the fish were applied by a semi-circular punch. There is no evidence that these artefacts were polished, as can be seen in Fig 2.3.30 (SCY 74) where the damage from an overstrike of the punch is still apparent. This type of punch, which is the standard equipment of a modern gold smith, has not been archaeologically proven as existing in the 5th Century BC.

Ram's heads (MISC 30221 q 1-14) Fig 2.3.32

Fig. 2.3.32.[22]

There are 13 hollow ram's heads which hang from a single loop in loop chain joined to the head by a ring which passes through the chain and eye. In the collection in Berlin there is one chain without a head.[23] These artefacts were suspected as forgeries or as having been repaired at a later date by Greifenhagen because of the inclusion of quadric links in the chains.[24]

Stamp	Ram's head	MISC 30221 q 1-14	Fig. 2.3.33 (SCY 76)
Stamp	Ram's head	MISC 30221 q 1-14	Fig. 2.3.34 (SCY 92)
Semi circle	Ram's head	MISC 30221 q 1-14	Fig. 2.3.35 (SCY 77)
Semi circle	Ram's head	MISC 30221 q 1-14	Fig. 2.3.36 (SCY 78)

Table 2.3.7.

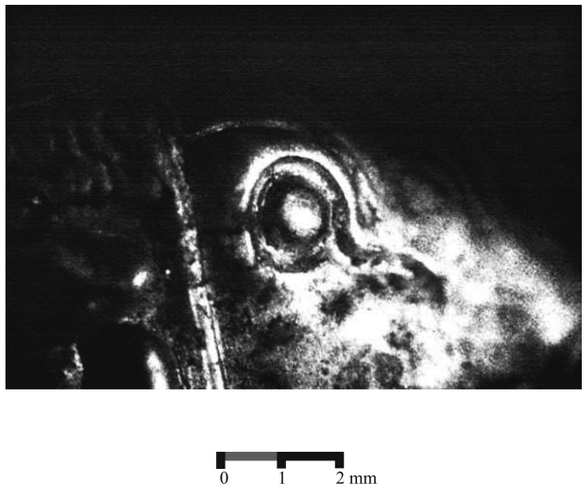


Fig. 2.3.33. (SCY 76).

Fig. 2.3.34. (SCY 92).

Fig. 2.3.35. (SCY 77).

[22] By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung.
[23] Greifenhagen 1970, 58.
[24] Greifenhagen, 58-59.

Fig. 2.3.36. (SCY 78).

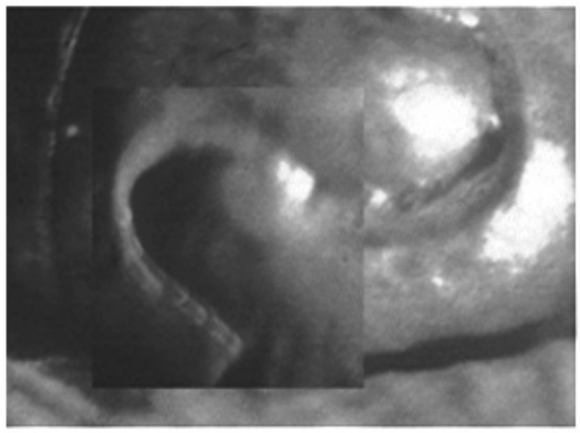


Fig. 2.3.37.

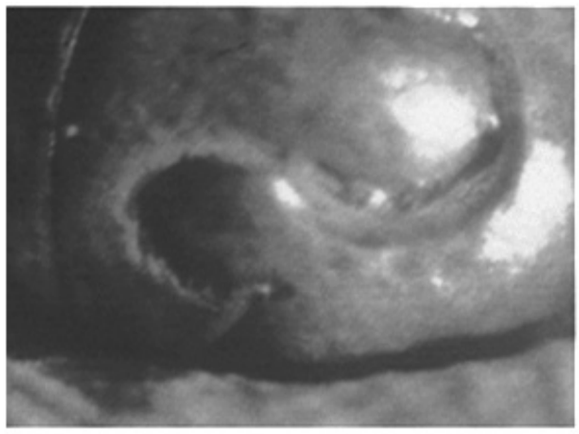


Fig. 2.3.38

The results of the technical study show that the heads were pressed in 2 separate halves with most of the decorative features being included in the matrixes; there is a limited amount of reworking of the heads with the punching of the nostrils and possibly the eyes. If the ram's heads were genuine then the nostrils had to be punched in after the heads had been pressed because the undercutting caused by these would not have permitted the removal of the finished head from the tool without damaging it. However, the comparison of the tool marks indicates that this was not the case, as they are exactly the same showing that the same amount of pressure was used to produce them and that the tool marks from the semi-circular punches are in the same place (Fig. 2.3.37, which is the composite of Fig. 2.3.35 and Fig. 2.3.36). The variations in the form are caused by the difference in the angle of the photographs and Fig. 2.3.38 shows the true form of the tool mark.

The tool marks indicate that the head was withdrawn backwards from the matrix and the neck was already cut to the correct size in the pressing to allow this to occur avoiding the problem of the undercut, thus indicating that these pieces are, as Greifenhagen suspected, forgeries.

Opposed-lotus-blossom plaques (MISC 30221 t 1-19)
Fig 2.3.39

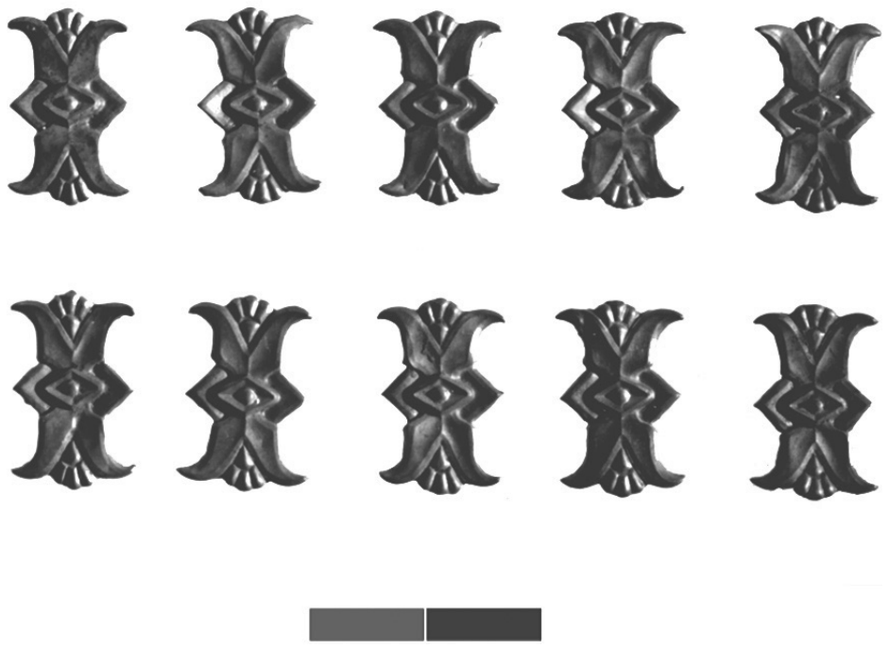


Fig. 2.3.39.[25]

The technical analysis of the opposed-lotus-blossom plaques showed that, once again, these artefacts were pressed with no reworking on the images. This can be discerned from the tool marks on the central rhomboid which are the same and the exact reproduction of the form in each case (Fig. 2.3.40 - SCY 79 and Fig. 2.3.41 - SCY80). The comparison build (Fig. 2.3.42) proves this to be the case, indicating that these pieces are probably forgeries and pressed using a hard material such as a steel matrix which did not wear.

Stamp	Opposed-lotus-blossom plaques	MISC 30221 t 1-19	Fig. 2.3.40 (SCY 79)
Stamp	Opposed-lotus-blossom plaques	MISC 30221 t 1-19	Fig. 2.3.41 (SCY80)

Table 2.3.8.

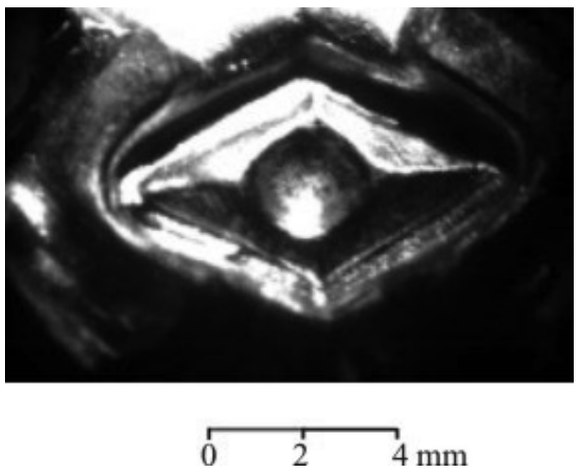


Fig.2.3.40.SCY79).

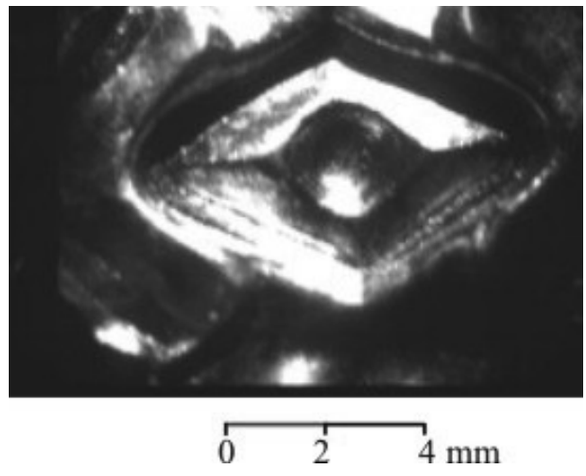


Fig. 2.3.41. (SCY80).

[25] By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung .

The tool used for the production of the central boss is the same as the tool used to produce the pupil of the fish in the aforementioned plaques (see above).

The double-ended lotus-blossom plaques were believed to have to been Ionic in origin, since there were similar artefacts from the Hogarth excavation.[26] However, the linking of the tool marks with the tool marks used in the production of the eye of the sea-eagle-hunting-fish plaques does not support this hypothesis (see Fig. 2.3.43).

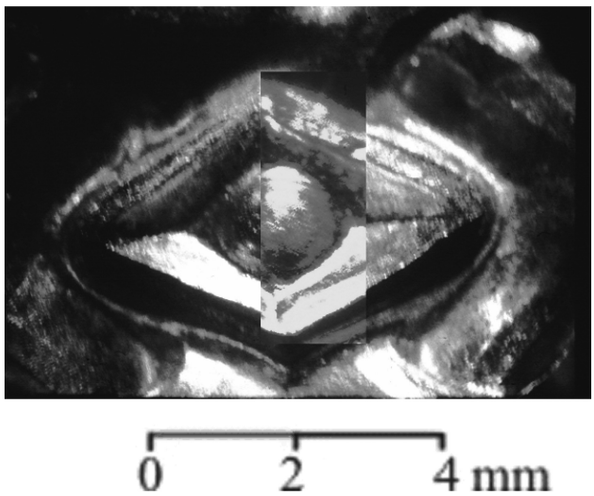


Fig. 2.3.42.

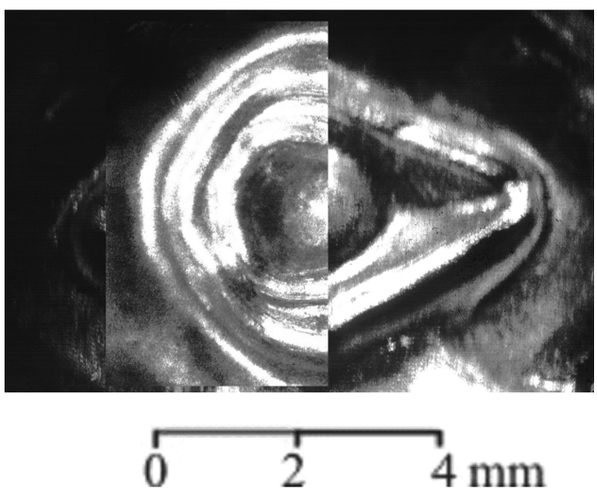


Fig. 2.3.43.

Drinking horns (MISC 30221 k 1-2) Fig 2.3.44

Fig. 2.3.44.[27]

The drinking horns are a complex problem because they appear to have been constructed from genuine parts which have been added together at a later date. This conclusion was drawn because the filigree wire that has been used to edge the rim of the drinking horn MISC 30221 K2 was not produced in the correct technique (Fig. 2.3.45 SCY 89). The indentation of the rim occurred after the wire had been soldered onto the rim. Another indication that they are not totally genuine is the damage that has occurred to the horn where the stags are soldered onto it, because there are signs of localised heating. The horns may be the possible source of the raw material for the production of the rest of the aforementioned artefacts; only the analysis of the gold alloy may confirm this idea.

The quality and regularity of the beading indicates that it was made with the application of high pressure to force the gold wire into the beading.

The horns themselves may be genuine, but this can not be ascertained by this type of study; it could possibly be achieved by the examination of the gold alloy of the object and the solder which could then be compared with other artefacts.

The plaques that are joined onto the horns are produced in the Scythian art style by stamping thin gold sheet with the animal motif which was then bent to form a round ring; the filigree wire was then added. The filigree wire from MISC 30221 K1 has been produced by the use of a rolling swage. The difference in the forms of the beads (Fig 2.3.46 - SCY 87 and Fig. 2.3.47 - SCY 88) indicates that the same tool was not used to construct the beading on these two wires used to edge the decorative panel on MISC 30221 K1.

[26] Greifenhagen 1970, 58.

[27] By permission of the Staatliche Museen zu Berlin, Preussischer Kulturbesitz, Antikensammlung.

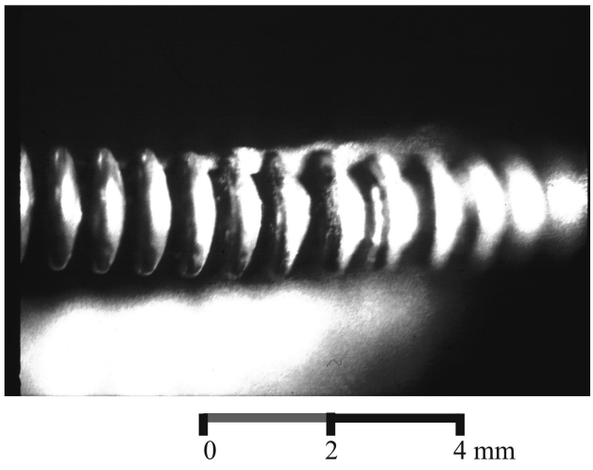


Fig. 2.3.45. (SCY 89).

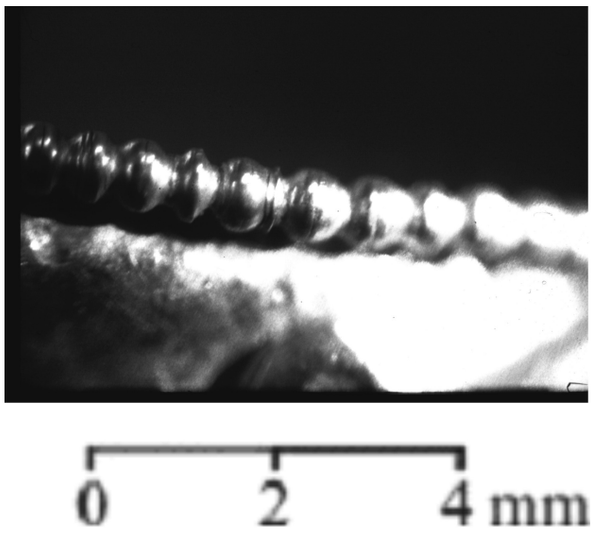


Fig. 2.3.46. (SCY 87).

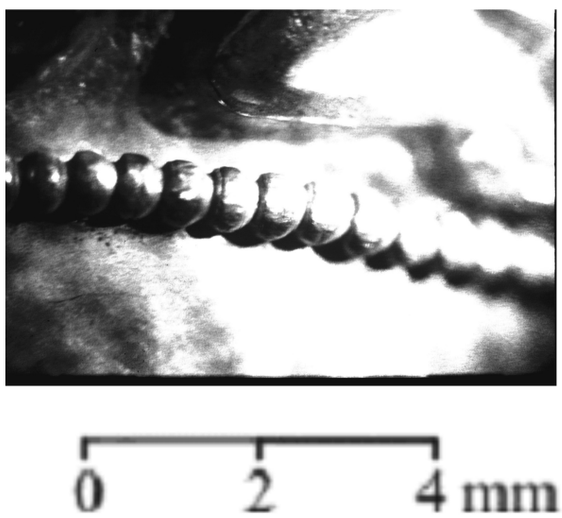


Fig. 2.3.47. (SCY 88).

It was also possible to link the ram's heads with the stags used to decorate the rims of the two drinking horns (Fig. 2.3.48 - SCY 90 and Fig. 2.3.49 - SCY 91).Except for the case of the former of the drinking horns, the tool marks are positive, which can be compared with the negative on the ram's heads. In the case of the latter of the drinking horns, the tail that was characteristic when used on the other two artefacts is no longer there but it can still be matched with the other two artefacts (Figs. 2.3.50, 2.3.51 and 2.3.52).

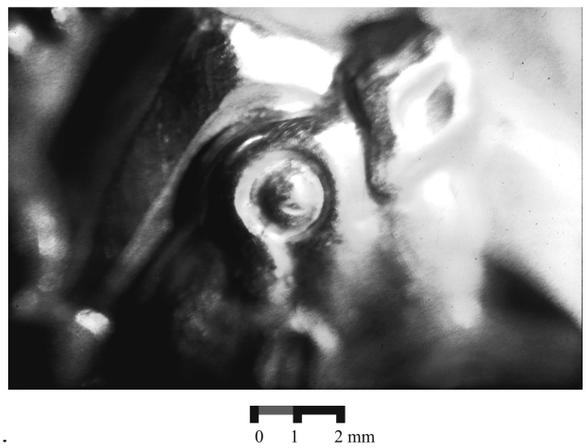


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Fig. 2.3.48. (SCY 90).

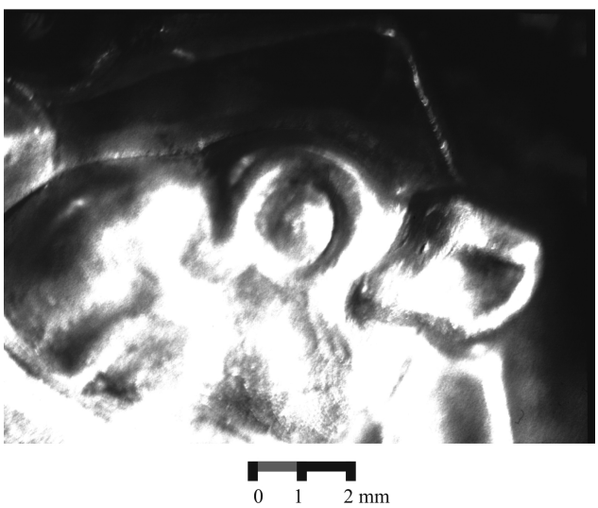


Fig. 2.3.49. (SCY 91).

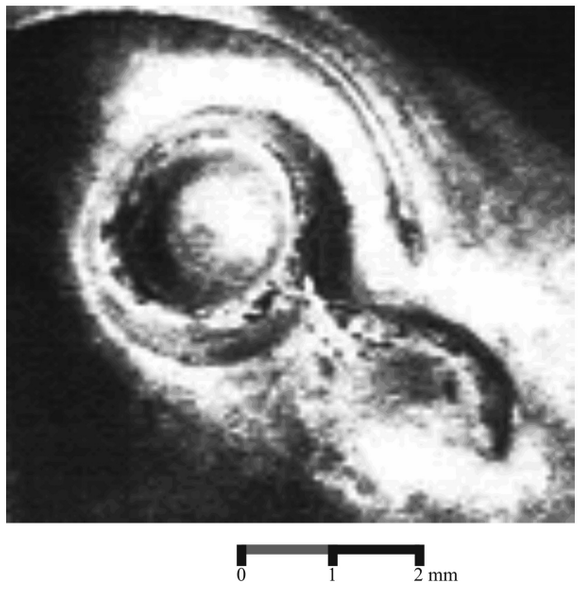


Fig. 2.3.50

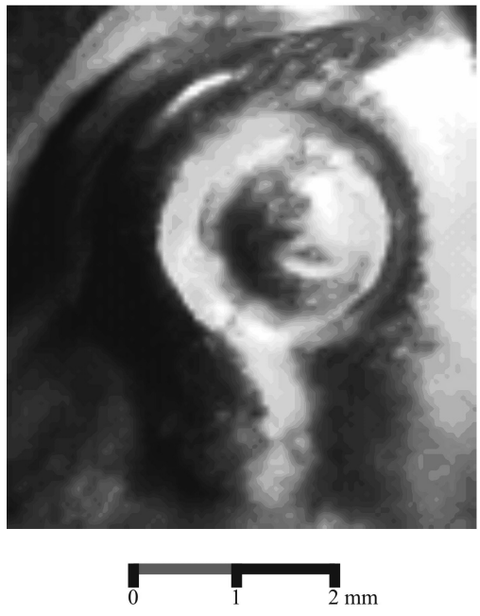


Fig. 2.3.51

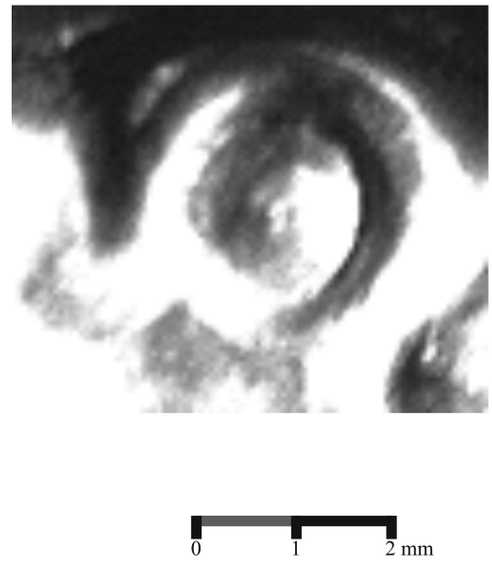


Fig. 2.3.52

Filigree	Drinking horns	MISC 30221 k 1	Fig. 2.3.45 (SCY 87)
Filigree	Drinking horns	MISC 30221 k 1	Fig. 2.3.46 (SCY 88)
Filigree	Drinking horns	MISC 30221 k 2	Fig. 2.3.47 (SCY 89)
Stamp	Drinking horns	MISC 30221 k 1	Fig. 2.3.48 (SCY 90)
Stamp	Drinking horns	MISC 30221 k 2	Fig. 2.3.49 (SCY 91).

Table 2.3.9.

Results of the comparison of the tool marks in the Maikop Hoard.

All of the tool marks that were studied from the Maikop hoard were compared with one another to attempt to link the artefacts; this included all of the suspected forgeries, because it is as important to identify modern tools that have been used to reproduce ancient artefacts in order to help other researchers in this field, as it is to identify ancient workshops.

Tool marks	SCY 47	SCY 51	SCY 46	SCY 52
SCY 47		*		
SCY 51	*			
SCY 46				*
SCY 52			*	

Table 2.3.10. Linked tool Marks from the Drinking Horn Terminals MISC 30221 I1 and MISC 30221 I2

Tool marks	SCY 55	SCY 56	SCY 57
SCY 55		*	*
SCY 56	*		*
SCY 57	*	*	

Table 2.3.11. Linked tool Marks from the Plaques MISC 30221 u 1-218

Tool Marks	SCY 60	SCY 62	SCY 63	SCY 64
SCY 60		*	*	*
SCY 62	*		*	*
SCY 63	*	*		*
SCY 64	*	*	*	

Table 2.3.12. Linked tool Marks from the Stag Plaques MISC 30221 S 1-14

Tool marks	SCY 65	SCY 66
SCY 65		*
SCY 66	*	

Table 2.3.13. Linked tool Marks from the Griffin plaques MISC 30221 r 1-10

Tool marks	SCY 67	SCY 68	SCY 69
SCY 67		*	*
SCY 68	*		*
SCY 69	*	*	

Table 2.2.14. Linked tool Marks from the Griffin plaques MISC 20221 f 1-4

The round punch was compared with the tool that was used to produce the eyes of the fish in the sea-eagle-hunting-fish plaques (which were linked by Rostovtzeff to the Seven Brothers Kurgans and thus provenanced the Maikop Hoard to the Maikop region).[28] In the composite picture (Fig. 2.3.40) produced from one of the eyes of the fish and one of the central motifs of the double ended lotus-blossoms, they match; the same tools were used to produce the dies. This means that these artefacts were produced in the same production centre at the same time.

It was also possible to link, through the tool that produced the eyes, the ram's heads (SCY 92 and SCY 76) with the elks that were used to decorate the rims of the two drinking horns. However, in the case of the drinking horn (SCY 90 and SCY 91) the tool mark is a positive, when compared with the negative on the ram's heads, indicating that the tool was used to produce the composite tool. In the case of one drinking horn (MISC 30221 k 2) (SCY 91), the tail that was characteristic when used on the other two artefacts is no longer there, but it can still be matched with the other two artefacts. The break point can be discerned in SCY 90 as the small triangular cuts. These faults can not be seen in SCY 92, indicating that the tool used to produce the ram's heads (MISC30221 q 1-14) was produced before the tool used for the elks on MISC 30221 K1, then used on MISC 30221 K 2 (See SCY 92, SCY 90 and SCY 91 in Volume 2).

Tool Marks	SCY 70	SCY 71	SCY 72	SCY 72	SCY 74	SCY 75	SCY 79	SCY 80
SCY 70		*	*	*	*	*	*	*
SCY 71	*		*	*	*	*	*	*
SCY 72	*	*		*	*	*	*	*
SCY 72	*	*	*		*	*	*	*
SCY 74	*	*	*	*		*	*	*
SCY 75	*	*	*	*	*		*	*
SCY 79	*	*	*	*	*	*		*
SCY 80	*	*	*	*	*	*	*	

Table 2.3.15. Linked tool Marks from the Sea-Eagle-hunting-Fish plaques MISC 30221 e 1-4 and Opposed-lotus-blossom MISC t 1-19

Tool Marks	SCY 76	SCY 92	SCY 78	SCY 90	SCY 91
SCY 76		*	*	*	*
SCY 92	*		*	*	*
SCY 78	*	*		*	*
SCY 90	*	*	*		*
SCY 91	*	*	*	*	

Table 2.3.16. Linked tool Marks from the Ram MISC 30221 q 1-4 and Drinking horn MISC K2

[28] Rostovtzeff 1931, 367.

A comparison of the known ancient goldsmith techniques with the results of the study of the tool marks from the Maikop hoard

In all studies that have been conducted on ancient gold artefacts it has been found that the working of gold sheet into a decorative form was by the use of dies, punches or formers of which there are a number of examples from this period.

With all of these techniques producing a required form, the pressure used to force the gold sheet to the end shape cannot be constant, resulting in slight differences; it is also very difficult to produce the same angle between the various pieces being used, again resulting in the end product being dissimilar from others produced using the same tools. In the case of the unfinished lion head terminal from the Burton Y. Berry Collection, it can be seen that only the basic form of the half lion's head was produced and it had to be worked further to produce the desired end result.[29]

However, in Eastern Europe, and as far as Zhou China, there is evidence that a metal patrix and wooden or bone matrix may have been used, although rarely. A number of patrixes have been found in excavations. The patrix from Opişor, Romania, was originally dated by the excavator as being 3rd Century BC, but this has now been dated to the late 6th/early 5th Century BC because of stratigraphic association with other artefacts.[30] This artefact could have been a die or force used with pitch to form the required shape in the gold. However, as the artefact[31] is well finished with all the required details to produce half of a bead, it may have been a patrix that was used with a wooden or bone matrix, meaning that the half bead only required the excess material to be removed before the two halves of the beads were joined together.

The cultural importance of these patrixes can be exemplified by the two that were found in the excavation of Kurgan 5 from the Aul Ulsk group, near Koban in the northern Caucasus. A rich secondary burial containing black-figured ceramics as well as a Corinthian amphora has dated the inhumation to the 5th Century BC. In the south-eastern corner of this grave, two patrixes were discovered, to the east of which two small bronze wheels were found which may have belonged to a cult wagon.[32] There are no published examples of the tool having been used to produce any of the artefacts from the kurgan; however, as has previously been stated not all of the excavated material has been published adequately.

There had been an attempt to rob the Chertomlyk Kurgan in antiquity, which was unsuccessful due to the collapse of the roof of chamber V and the tunnel, killing one person, who was probably one of a group of an unknown number.[33] A large quantity of artefacts, which had been disturbed by the robbers, and which dated to the 4th Century BC, were found in this kurgan in the original excavation of 1862/63 and in the later excavations between 1981 and 1986 conducted by an international team made up of Germans, Russians and Ukrainians. In the central burial complex of chamber V there are two plaques that R. S. Minasjan[34] states are produced by pressing, using matrixes and patrixes; although he concludes that this technology was introduced by the Greeks,[35] there is no proof that this was particularly the case, since there has been no evidence of pressing found in Greece. The technique appears to have been used in other regions.

Further evidence may come from Kazakhstan, although the material has not yet been examined first hand.[36] Only published photographs of the artefacts have been studied and a number of the artefacts indicate that they have been pressed using a matrix and patrix. These are the cover plaques portraying a recumbent deer[37] and cover plaques reproducing a deer's head from Issyk.[38] This material has been dated to the 5th Century BC.

The study of the Maikop hoard indicates that the majority of this material was constructed at a later date. The technological level represented by this material does not conform to the known ancient techniques of manufacture. It appears that these artefacts were produced using a heavy press with steel tools. This conclusion is based on the fact that there is only a very limited number of matching tools and that there is no evidence of the artefacts having been reworked with engravers. The limited number of tool marks which could be found on artefacts also produced contradictions insofar as artistically different artefacts of various stylistic regions had the same tool mark, e.g. the sea-eagles-hunting-fish plaques and the opposed-lotus-blossom plaques. The genuine artefacts from this hoard were the drinking horn terminals which had differing qualities of workmanship. The production of these artefacts indicates that, although they come from the same workshop (the same dies were used to produce the heads), they may not belong to the same complex or they were made by different people. The small plaques were found to have been produced with the use of a press tool which had rapidly worn out, producing variations that can be discerned in a short production run. This shows that the patrix was produced from a relatively hard material, such as bronze, whilst the matrix was produced from a softer material which wore rapidly; possibly this matrix was made from bone.

[29] Rudolph 1991, 6.
[30] Kull 1997a, 567.
[31] Kull 1997a, 567.
[32] Kull 1997a, 581.
[33] Minns 1913, 155.
[34] Dr R. S. Minasjan is a senior researcher and curator in the Hermitage Museum and the Russian expert on ancient technology.
[35] Rolle, Murzin and Alekseev 1997, 182.
[36] Verbal invitation to study the material from the Issyk Kurgan has been received by the author and this is hoped to be undertaken in the future.
[37] Akishev 1978, pl. 20.
[38] Akishev 1978, pl. 21.

For the Maikop hoard it may no longer be valid to link the material that is in Germany with the artefacts in America. We can no longer date the genuine artefacts that are in the various collections or provenance them to the Maikop region, even though it has been shown that the technology to press sheet gold was known in Eastern Europe at the presumed date of the Maikop hoard. There is a major difference between most of the materials studied and a number of genuine materials that have been found in excavations. The gold sheet is normally thinner than forced gold artefacts, which is not the case in the majority of the Maikop hoard; this is due to the stresses involved in producing the object. The fact that the gold was thinner may have deterred the Greek craftsmen from using this technique because they were probably paid on a commission basis with a percentage of the gold used. The discovery of artefacts which have not been produced by the known techniques for the period under study is important for future research conducted in this field. They should not be used in art historical studies which then produce invalid results and do not further research in these fascinating cultures and their development.

2.4 Nymphaeum

Some material that is now displayed at the Ashmolean Museum, Oxford, originates from an illegal excavation conducted in 1868 by Franz Biller, an agent of Sir William Siemens, who displayed this material in the University museum from 1880 until 1885 when it was transferred to the Ashmolean. There is some confusion as to the number of kurgans that were excavated by Biller. In Gardner's account, published in 1884, there were five graves with one male and four female burials, a conclusion drawn from the information supplied by Biller himself.[1] These results, however, are not compatible with the report supplied by A. Lyutsensko, the Director of the Museum of Antiquities at Kerch, who submitted a report to the Imperial Archaeological Commission in St. Petersburg, when he had been offered the material for 3000 roubles, which was considered to be too much.[2] In the first excavation report published in 1870 only two kurgans are mentioned which contained three inhumations.[3] These two kurgans must have been excavated before April 1869 and further excavations were conducted later in that year by Biller, when another three inhumations were excavated. A total of five kurgans were probably excavated, all situated on the property of Madame Gur'eva near to the settlement of Eltegen.

Not all of the artefacts in the Ashmolean were studied for their tool marks.

Artefact	Inv. no.	Material	Weight	Dimensions
Necklace	1885.502	Electrum	Not available	L. 25 cm
Necklace	1885.482	Gold	Not available	L. 31 cm
Hare plaques	1884.469	Gold	Not available	L. 1.1 cm
Lion plaques	1885.483	Gold	Not available	L. 1.3 cm
Boat-shaped earnings	1885.468	Gold	Not available	H. 6 cm
Hair ornaments	1885.483	Gold	Not available	H. 3.5 cm
Lion-headed bracelets	1885.503	Silver and electrum	Not available	D. 7.4 cm

Table 2.3.1.

Necklace 1885.502 - Fig. 2.4.1

Fig. 3.4.1. (adapted from Vickers 1979)[4]

[1] Gardner 1905.
[2] Vickers 1979, Appendix III; Archive LOIIMK, Archaeological commission, files 1867g No.11, 101.
[3] Vickers 1979, Appendix II; Lyutsenko, 1870, 54-55.
[4] All Scales in cm unless otherwise stated

This necklace has been reconstructed from the 25 rectangular plaques from each of which a bead is suspended. Eight of the plaques are larger, six of which have two beads suspended from them and a six petalled rosette edged in filigree wire. One end of the *lina* has survived in the form of a trapezoidal plate of sheet metal which was folded over on the long edges to form a mooring for a pair of threads[5] (Fig. 2.4.2 - SCY 93 and Fig. 2.4.3 - SCY 94).

Fig. 2.4.2. (SCY 93).

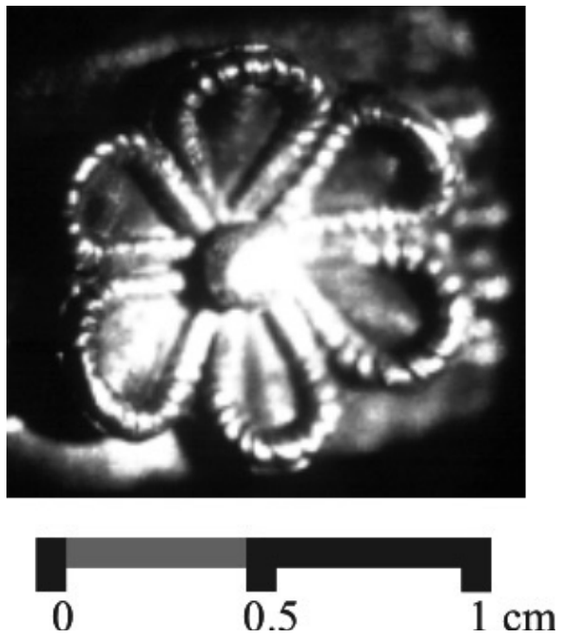


Fig. 2.4.3. (SCY 94).

The rosettes were constructed from sheet metal which has been formed probably after it had been cut to the correct shape; the convex tear drops which can be discerned in each of the petals are individually placed in the petal, indicating that a complex tool was not used to produce these decorative features. The cloisonné has only partial beading produced by a rolling swage and has been hand formed to the required shape. The central bead is most probably a mechanical fixing to hold the rosette to the backing plate in the form of a rivet before the piece was soldered on (this can not be proved without the destruction of the artefact). The beaded wire was produced as spiral bead by using a sharp cutting tool to apply pressure whilst rotating the wire.

[5] Vickers 1979, 41.

Necklace 1885.482 - Fig. 2.4.4

Fig. 2.4.4. (adapted from Vickers 1979)

This necklace consists of 22 rosettes which have acorns suspended from them alternating with 20 stylised opposed lotus blossoms with small beads hanging from them. Set in the centre of these sheet metal plaques there is a six-petalled rosette. The components of the necklace were strung together using two rings soldered to the back of the plaques. The terminals have not survived.

The rosettes (Fig. 2.4.5 - SCY 95 and Fig. 2.4.6 - SCY 96) on this necklace are produced in the same way as the aforementioned necklace except that they are of simpler construction with less attention paid to the details; a disc was produced from which the petals are designated by the cloisonné which is a plain rolled wire. The chain has been constructed by loops which have been soldered together after being fitted, instead of being constructed as a single loop in loop chain (Fig. 2.4.7 - SCY 97). This method of construction is more complex because the temperature for the soldering has to be controlled, so that the previously soldered links are not damaged. The mechanical fixing rivet used to fix the petals to the backing plate has a collar behind the bead, which appears to have been constructed from rolled wire, but it is probably a single rivet produced by forging a metal rod in a die (see Fig. 2.4.8).

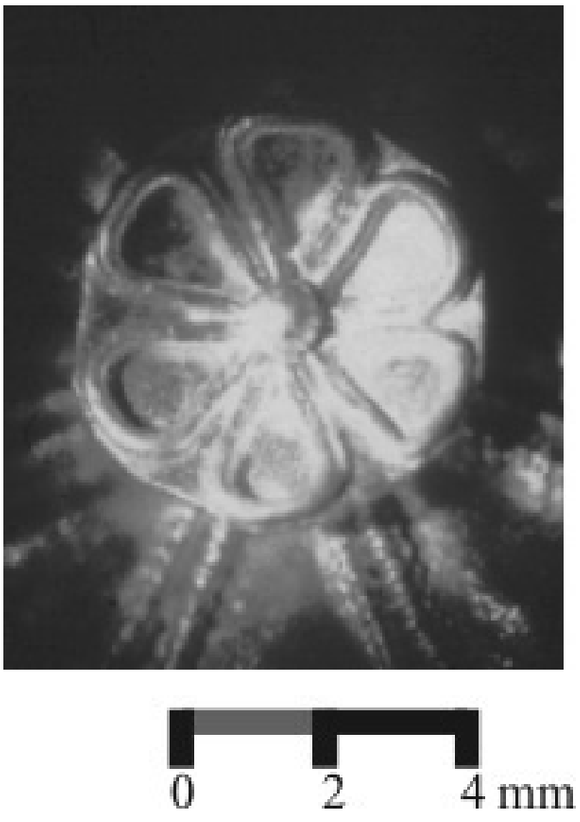
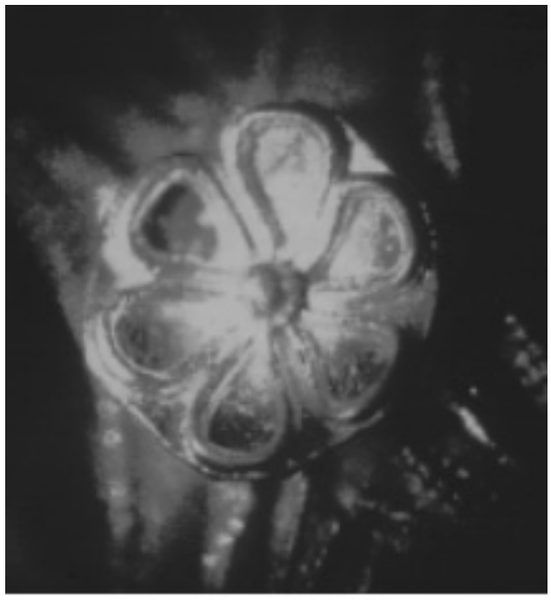


Fig. 2.4.5. (SCY 95)



. Fig. 2.4.6. (SCY 96).

Fig. 2.4.7. (SCY 97).

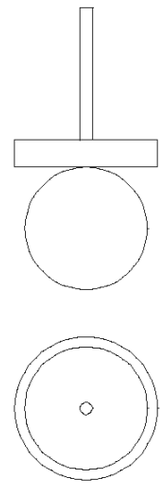


Fig. 2.4.8. Reconstruction of the rivet.

The eyelets to link the necklace together have bevelled edges (Fig. 2.4.9 - SCY 98), indicating that the necklace was constructed to be worn and not just for the inhumation, which is not always the case in Scythian burials. From this it may be possible to discern the social status of the individual because the burial customs of the royal Scythians were probably different to those of the rest of the population.[6] It may be a valid hypothesis that the jewellery was produced for the social elite after they were dead, the goldsmith having a minimum of 40 days to produce the artefacts, if Herodotus' description is accurate.[7] This could be the reason why there is often limited damage to fragile objects which have been discovered in the suspected royal inhumations, such as Issyk.

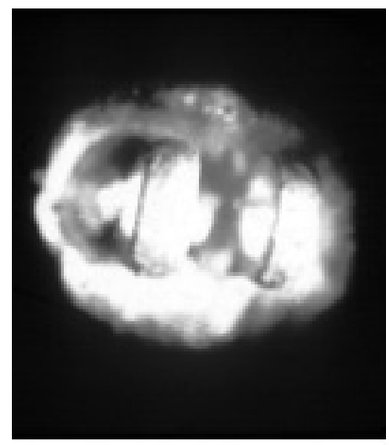


Fig. 2.4.9. (SCY 98).

[6] Herodotus, Book IV, 71-73.
[7] Herodotus, Book IV, 73.

Hare plaques 1884.469 - Fig. 2.4.10

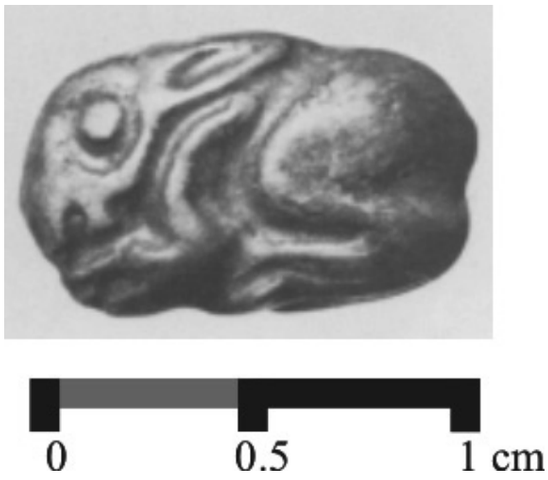


Fig. 2.4.10. (adapted from Vickers 1979)

There are 84 gold hare plaques, which were originally attached to cloth by the eyelets soldered onto the back of the plaques, none of which have survived.[8] These plaques were constructed using a stamp which forced the gold into the desired form. The legs of the rabbits are in the position which denotes the animal as being prey. The importance of the hare in Scythian culture can be remarked by the story that the Scythians, when they were finally offering to battle against the invading army of Darius, abandoned the thought of battle giving chase to a hare which had appeared between the opposing armies.[9] In Fig. 2.4.11 (SCY 99) the stretching of the gold sheet can be discerned around the leg. The lack of fine detail indicates that these plaques were pressed with a relatively low pressure using a patrix into a soft backing matrix which was not worked to produce any fine details.

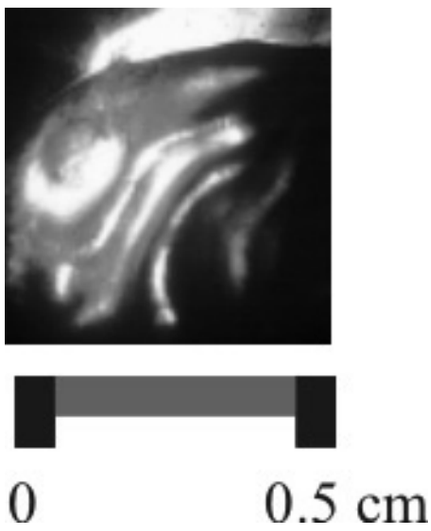


Fig. 2.4.11. (SCY 99).

Lion plaques 1885.483 - Fig. 2.4.12

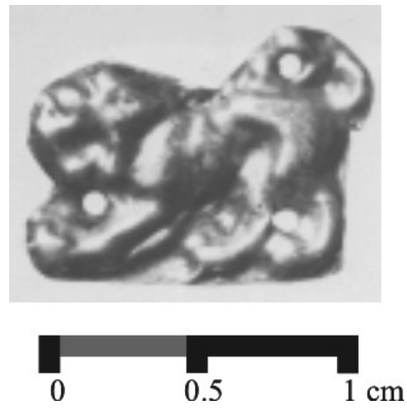


Fig. 2.4.12. (adapted from Vickers 1979)

There are 49 of these plaques which were sewn directly on the clothes through the holes which were pierced in the gold sheet. They are reproduced in a naturalistic style with none of the influences of the Scythian animal style. They were produced from a matrix which was driven into the gold sheet and do not show any fine detailing indicating that they had been reworked or that a matrix had been used (Fig. 2.4.13 - SCY 100).

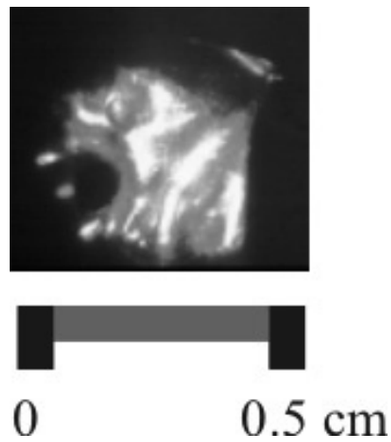


Fig. 2.4.13. (SCY 100).

[8] Vickers 1979, 36-37.
[9] Herodotus, IV, 134.

Boat-shaped earrings 1885.468 - Fig. 2.4.14

Fig. 2.4.14. (adapted from Vickers 1979)

The boat-shaped earrings terminate with the head of a griffin which has no cockscombs, not allowing a determination as Greek or Scythian style. They were produced from a stamped blank in two halves which were soldered together. The ears, the tongues and the protrusions from the heads have been added afterwards. The join to the boat, which was also produced in two halves, has been decorated with granulation in the form of triangles and filigree wire, disguised by beaded wire. The same technique was used on the cylinder which joins the rosette and the hanger to the body (Fig. 2.4.15 - SCY 101, Fig. 2.4.16 - SCY 102, Fig. 2.4.17 - SCY 103 and Fig. 2.4.18 - SCY 104).

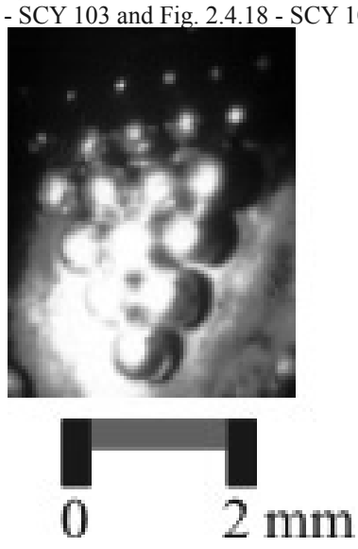


Fig. 2.4.15. (SCY 101).

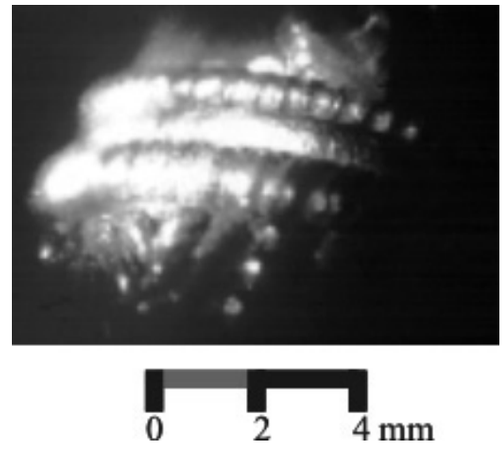


Fig. 2.4.16. (SCY 102).

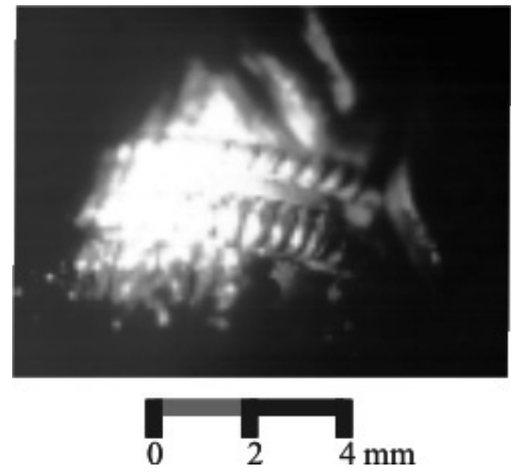


Fig. 2.4.17. (SCY 103).

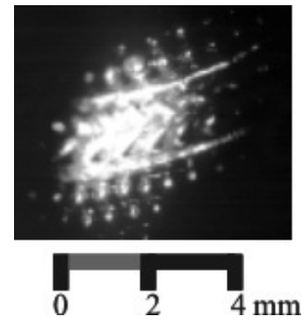


Fig. 2.4.18. (SCY 104).

This artefact was produced from sheet gold which had been pressed into the required shape by patrixes; the granulation was produced either by cutting up small pieces of gold sheet which was melted to form the granules or by cutting the beads from beaded wire. The round wire was produced by twisting a square wire and then rolling it to produce a uniform round wire. The beaded gold wire was produced by rolling the gold wire with an organarium.

Hair ornaments 1885.483 - Fig. 2.4.19

Fig. 2.4.19. (adapted from Vickers 1979)

The two hair rings are made with a copper alloy core which has an electrum covering. The terminals, which are also produced from electrum, consist of pyramids which have been produced from granules; the collars which join the terminals to the ring are decorated with filigree wire in the form of figures of 8 with a granule within the loop.[10] These granules were either produced by the aforementioned techniques or by dropping molten gold droplets into water to form the beads. The wire used in the filigree was produced by the same technique that has been mentioned above (Fig. 2.4.20 - SCY 105).

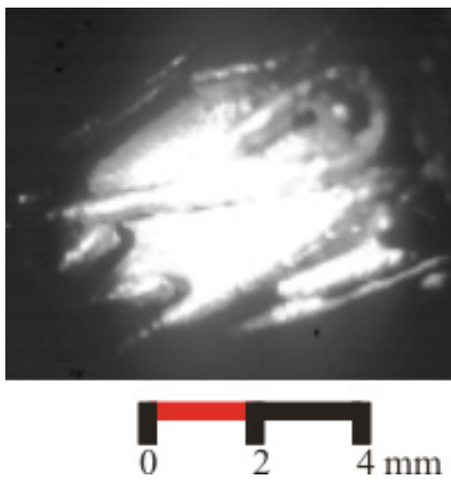


Fig. 2.4.20. (SCY 105).

Lion-headed Bracelets 1885.503 - Fig. 2.4.21

Fig. 2.4.21. (adapted from Vickers 1979)

These fragile bracelets are made from silver and electrum; the ends in the form of Achaemenid lion-heads are made from electrum.[11] The heads were stamped from a sheet of electrum using a die; the opposing halves were produced using a different tool, and the details were added separately. The collars, which join the heads to the bracelet ring, were produced from a flat sheet which was formed and stabilised by filigree wire in the form of a cable pattern. The heads were mechanically fixed to the collars before they were soldered on by the spreading of the metal hidden within the head (Fig. 2.4.22 -SCY 106).

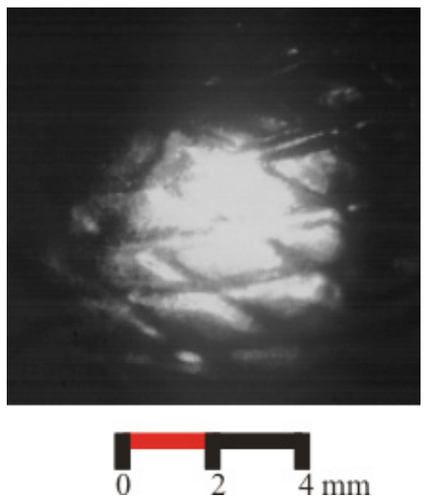


Fig. 2.4.22. (SCY 106).

[10] Vickers 1979, 42.

[11] Vickers 1979, 41.

Conclusions

In the Nymphaeum collection at the Ashmolean Museum there are two types of manufacturing styles apparently: Scytho-Greek (Necklace 1885.482), with evidence that a press tool was used for the rivets, and, possibly, the petalled flower heads were produced using a shearing tool to cut them out of the gold sheet. Although there is no evidence that the acorn beads were produced using a press tool they probably were made this way because of the uniformity in the shape and decoration. The chain, although it appears to be simpler than loop in loop, is actually more complicated to produce in this technique because each link has to be soldered together during the construction of the chain, indicating that the craftsmen had knowledge of the gold alloy and the melting temperatures that would destroy his work.

The rest of the artefacts from Nymphaeum are constructed in the standard labour-intensive techniques used by the Greek craftsmen. The hares and lion plaques could have been produced through a pressing tool, which could have been made from bone or a hard wood as no decorative features were added other than the basic shape.

The beaded wire was produced as spiral beaded wire; the wire itself was produced by twisting square wire and then rolling to produce a uniform gold wire. The cloisonné was made by ending each piece of wire in a tool similar to a round nosed pliers because of the difference in the form.

2.5 Gold strap necklace with seed-like pendants

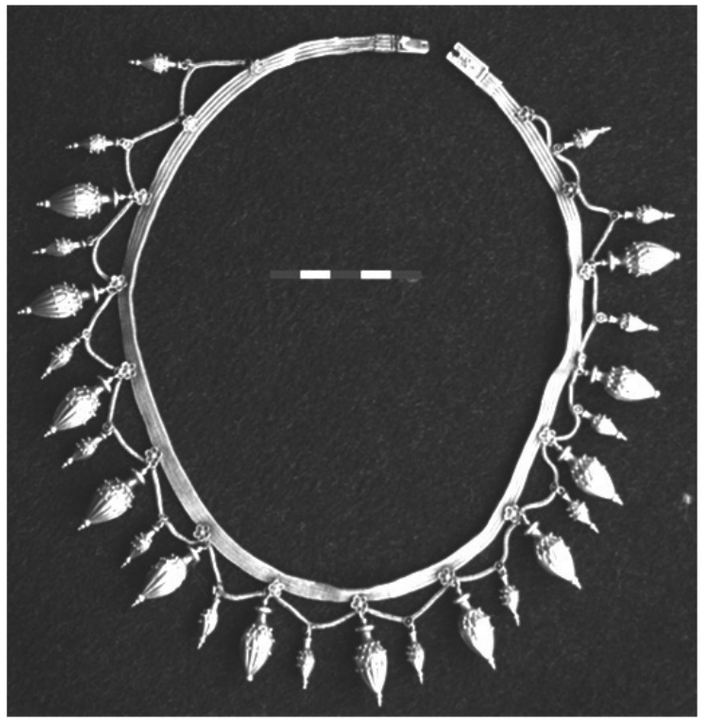


Fig. 2.5 1. Necklace bought in 1916 in Nikolaev, presently in Berlin.[1]

A privately owned golden necklace in Berlin (Fig. 2.5.1) was brought to my notice by a friend, who also suggested to the owner that it could be studied technologically in order to check its authenticity.[2] The piece in question has belonged to the family of the present owner since 1916 (Fig 2.5.2), when it was bought from a small jeweller's shop in Nikolaev, Russia. The grandmother of the present owner paid the princely sum of 20 roubles for the necklace, which had been offered as being in "the Greek style" with new clasps. It was destined for her 16-year-old daughter, who wore the necklace throughout her life. Later, it became a wedding gift for her daughter-in-law, who in turn wore it quite regularly until the 1970´s, when two of the larger pendants where lost. With the repairs that were conducted at this time (the replacement of the two outer seed-like pendants for the missing central ones), it was decided that the piece was too fragile to be worn except for special occasions, e.g. the weddings of the next generation. As the necklace was bought in 1916 as an artefact constructed in the Greek style it was not thought to be covered by the Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property because it was not thought to have come from an archaeological excavation and thus did not contradict article 1 C 'products of archaeological excavations (including regular and clandestine) or of archaeological discoveries', article 4C 'cultural property acquired by archaeological, ethnological or natural science missions, with the consent of the competent authorities of the country of origin of such property', or article 1 E 'antiquities more than one hundred years old, such as inscriptions, coins and engraved seals'.[3] It was then thought to be legal to bring the necklace from Russia to Germany when the family emigrated after the dissolution of the Soviet Union into independent states had started in the 1980´s.

The golden necklace is 43 cm long (not including the clasps) and weighs 33.325 g.[4] The strap consists of two doubled loop in loop chains with doubled interlocking links. The end clasps are no longer the originals, having been fitted in 1916 when the piece was sold. The original end terminals cannot be reconstructed from the information that is known about this piece. Attached to the main strap there are 16 preserved rosettes, each with 5 concave petals bordered by spiral beaded wire and with a granulated bead at the centre. The present owner of the jewellery has stated that the rosettes originally contained enamel of the same green colour as that which was used in the rosettes on the disc and boat gold earrings from Kul Oba.[5] Hanging from the rosettes there are now 12 large

[1] All scales in cm unless otherwise stated.
[2] I would like to thank the owner, Pavel Feinstein, for his cooperation and the permission to publish the piece.
[3] www.un-documents.net/cppiiecp.htm 28/08/2010.
[4] Measured with a Kern Precision balance, produced by Gottl. Kern & Sohn.
[5] Artamonov 1970, 146, pl. 221,2.

Fig 2.5.2 Photograph of Bertha Samojlova wearing the necklace in the 1920's

seed-shaped pendants, although originally there may have been five more, making a total of 17. Two of these were lost by the present owner. The large seed-like pendants are decorated with granulation and are a development of the ribbed fennel seeds into a dog tooth calyx.[6] In between the large pendants, there are 15 smaller ones, hanging from a narrow double loop in loop chain which is fixed to the rosettes on the main strap. These small pendants are fixed to the chain by a shield boss, decorated with spiral beading and a single grain. There are two holes on the back of each pendant, near the ends, and it is likely that they were originally filled with a substance which was similar to the material filling the seed-like pendants from the gold strap necklace with three rows of pendants and lion head terminals from Great Blizniza.[7]

Regarding the entire composition, an imbalance can be discerned in the form, when compared with other Greek necklaces from this period. Besides the missing large beads, the rosettes are nearer to the terminals than usual, which could indicate that two are missing, and in order to preserve the symmetry of the construction one more was possibly removed from the left side of the necklace. This form of necklace construction does not appear before the 4th century BC in Greece although the style was known earlier in Asia Minor. It is referred to in Greek literature as a *plokion* (a necklace that is woven).[8] The necklace can easily be dated by analogies to the 4th century BC. The clasps could have been either *lina* or hook and eye terminals; however, the lack of these attachments means that exact dating cannot be carried out, the former being earlier than the latter.[9]

Although a number of necklaces which have been constructed with straps have been discovered in Greece and Thrace, only the 12 artefacts constructed with a strap which have a direct relationship in the style will be discussed here (Fig. 2.5.3 and Table 2.5.1), of which only the four from the Crimea and the Taman peninsula can be provenanced with certainty, because they come from archaeological excavations and were not bought on the art market as is the case with the others. This means that it appears that these necklaces with straps were more common in the Black Sea region, although it need not be the case in fact.

[6] Williams & Ogden 1994, 43.
[7] Williams & Ogden 1994, 188-189; Williams 1998, 102.
[8] Williams & Ogden 1994, 34-35.
[9] Williams & Ogden 1994, 188-189; Williams 1998, 102.

1	Chersoneses[1]	Gold strap diadem
2	Great Blizniza[2]	Gold strap necklace with three rows of pendants
3	Kyme[3]	Gold strap necklace with beech nut pendants
4	Madytos[4]	Gold strap necklace with seed-like pendants
5	Melos: sea[5]	Gold strap necklace with seed-like pendants
6	Mytilene[6]	Gold strap necklace with seed-like pendants
7	Pavlovsky Kurgan[7]	Gold strap necklace with beech nut pendants
8	Thessaloníki[8]	Gold strap necklace with beech nut pendants
9	Great Blizniza[9]	Gold strap necklace with beech nut pendants
10	Fessallii[10]	Gold strap necklace with beech nut pendants
11	Karagodeuashkha Kurgan[11]	Gold strap necklace with beech nut pendants
12	Kiev[12]	Gold strap necklace with beech nut pendants

1 Williams and Ogden 1994, 196
2 Williams and Ogden 1994, 188
3 Williams and Ogden 1994, 99
4 Williams and Ogden 1994, 113
5 Williams and Ogden 1994, 69
6 Williams and Ogden 1994, 117
7 Williams and Ogden 1994, 168
8 Williams and Ogden 1994, 74
9 Williams and Ogden 1994, 191
10 Amandry 1954.
11 Lappo-Danilevskiĭ, & Mal´mberg 1894, table IV 3.
12 Saverkina 2001, 95.

Table 2.5.1. List of provenanced necklaces with double loop in loop strap and seed-shaped pendants.

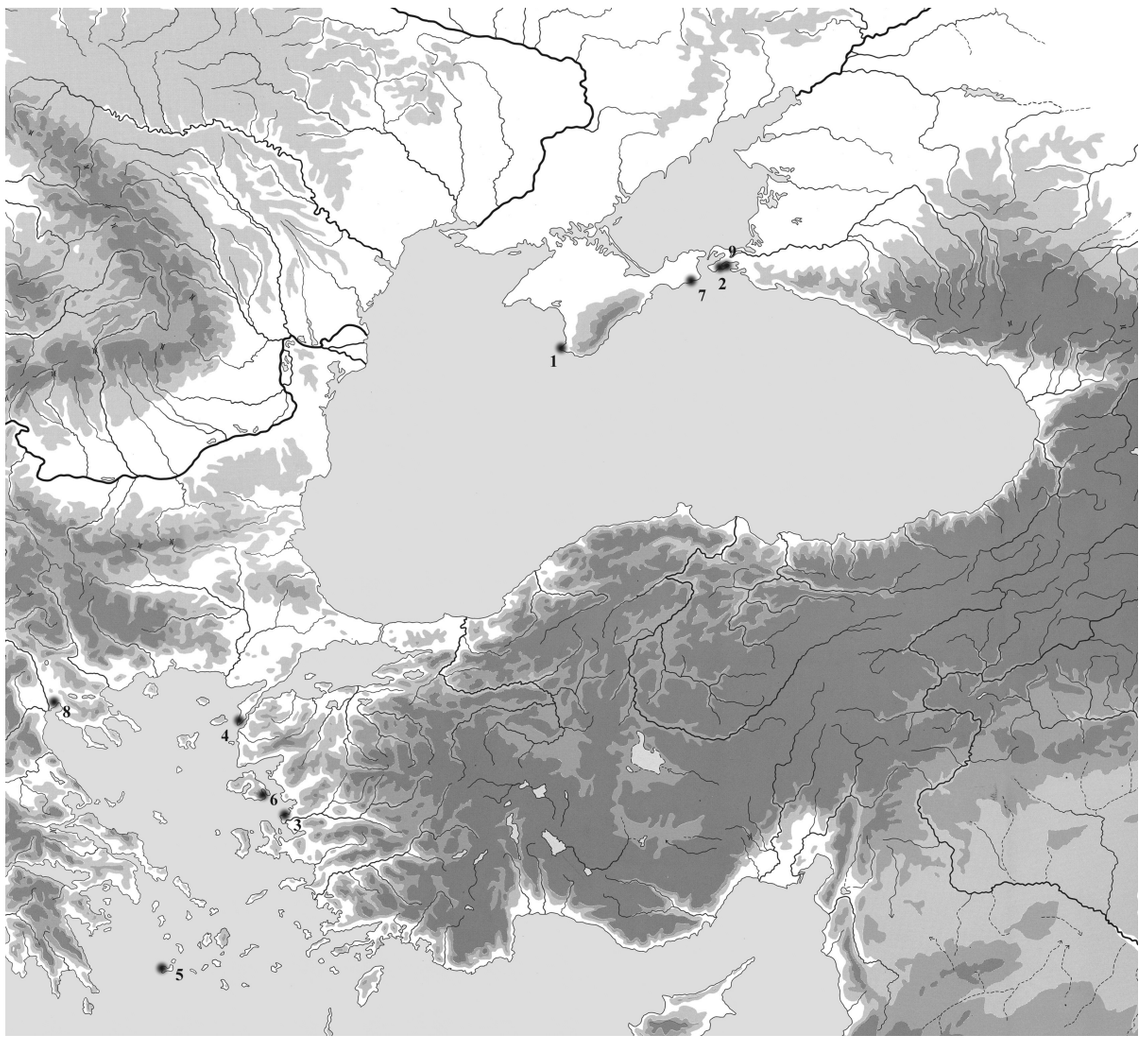


Fig. 2.5.3. Distribution map of provenanced necklaces comparable to the one discussed here.

There has been a tendency to assume that the masterpieces of jewellery found in the North Pontic region are products of Greek craftsmen and not of the indigenous craftsmen. It was considered that the indigenous people did not have access to the techniques of manufacture necessary for this type of necklace, either from the Greeks or from their contacts with Asia Minor. Yet Greek art, literature, science and religion were inspired through their contacts with this region.[10] The Near Eastern influence on Scythian art is hardly taken into account for the 4th century BC, although this is an accepted idea for the middle of the 7th century BC.[11] Traditionally it has been thought that the finest examples of Greek art have survived in the Northern Pontic region due to the Scythian practice of placing these artefacts in graves as offerings. This idea ignores the fact that there is a difference of 250–300 years between the Scythian artefacts of Kelermes and those of the 4th century BC.[12]

Technical analysis

The strap is constructed from four rows of double loop in loop chain joined together by a long link which passes though the strap linking the construction into a single entity which is flexible and strong. The individual loops were probably formed by wrapping the thin wire around a round bar.[13] The wire was then cut and the ends joined by colloid cold soldering because the hour glass reduction in the diameter at the join indicates that the join was not soldered.[14] The modern practice is to heat the loops fusing them together either by the use of a blow torch or in a kiln.[15] The regularity of the strap indicates that a jig (Fig. 2.5.4) may have been used to form the links with the wire loop being gently pushed between the cones to produce the desired shape, although this is now commonly done by using two round nosed pliers.[16] In this necklace there are approximately 3,000 links and the wire has a diameter of 0.3 mm, which means that around 30 m of gold wire was used to produce the chain and the strap. This craftsmanship is similar to that from the gold strap necklace with three rows of pendants and lion head terminals from Great Blizniza, where approximately 50 m of gold wire was used.[17]

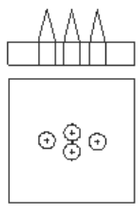


Fig. 2.5.4. Jig for the construction of the wire loops.

Although the wire loops could then be bent to form a "U" by hand before they were fixed together in the chain, the regularity of the chain suggests that another jig (Fig. 2.5.5) was used to form the links. The jigs would have been most probably constructed from wood and bone. For a tool constructed from these materials the chances of survival in the archaeological record are exceedingly small.

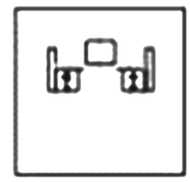


Fig. 2.5.5. Jig for the forming of the gold wire loops

The quality of the chain shows that the craftsman was practiced in working with this technique because the most common errors that occur are not evident in this piece. The slightest variation in a link would destroy the overall effect. These errors are variations in the link size due to careless wrapping, cutting and stretching. Malformed links are due to overfiring, separating links because of poorly butted links, and thinned out joints because the flame was held too long (see Fig. 2.5.6 - SCY 107).[18]

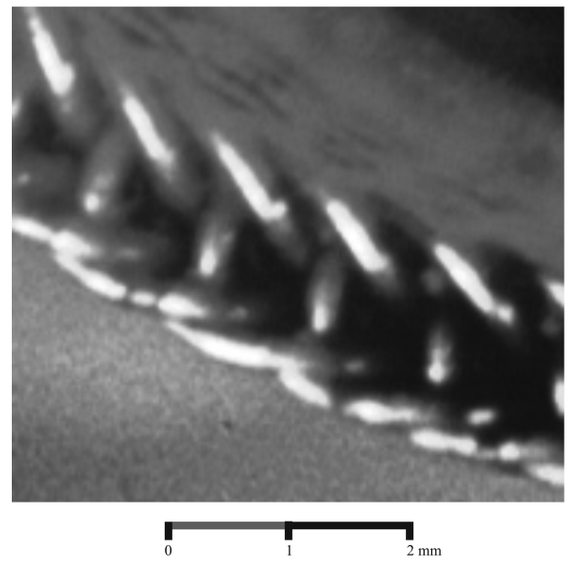


Fig. 2.5.6. (SCY 107).

The wire was joined together by colloid cold soldering to form the links and at the centre of the links, where the greatest strain was expected. The uniformity of the wire was discernable during the examination, as was the seam from the rolling of the gold wire. The latter was originally thought to indicate that drawn wire was not used for the production of the chain. However further examination through an SEM showed this not to be the case (see below).

[10] Boardman 1999, 54.
[11] Kossack 1987, 84.
[12] Jacobson 1995, 7.
[13] Stark & Smith 2000, 14; Codina 2000, 60.
[14] Cf. Littledale British Pattern nr. 415181 (23.8.1934).
[15] Stark & Smith 2000, 16-17.
[16] Stark & Smith 2000, 19-20.
[17] Williams & Ogden 1994, 26.
[18] Stark & Smith 2000, 21.

The construction of the chain is a complex operation which would have required the utmost concentration and skill. To produce this chain a starter link would have to have been produced by soldering the long "dog bone" cross link to the "bowtie" links (Fig. 2.5.7). Next the bowtie links would be bent up to the required angle to form a "U" shape (Fig. 2.5.8). Once this had been done the first set of pre-formed links could be added to the chain (Fig. 2.5.9). Once all of the bowtie links had been added, then both sets of links would have to be re-opened to allow the dog bone link to be passed through. This is done today by inserting a thin round metal scriber but this could have been done by using a wooden or bone needle (Fig. 2.5.10). The long dog bone link would then be threaded through the two sets of links (Fig. 2.5.11). The second row of bowtie links would then have been opened by the needle to allow the next set of bowtie links to be threaded through (Fig. 2.5.12). Once all of the bowtie links had been added, a channel would have been made through to add in the next dog bone link (Fig. 2.5.13). The procedure would then be continued until the chain had reached the desired length.

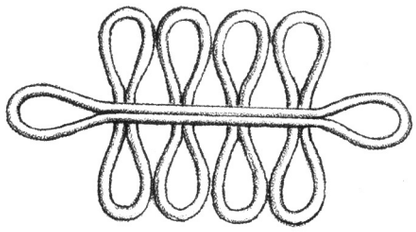


Fig. 2.5.7. (adapted from Stark & Smith 2000)

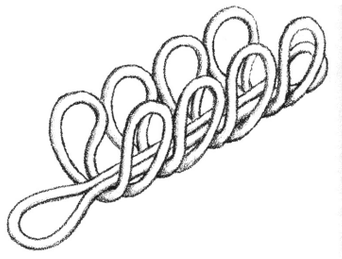


Fig. 2.5.8. (adapted from Stark & Smith 2000)

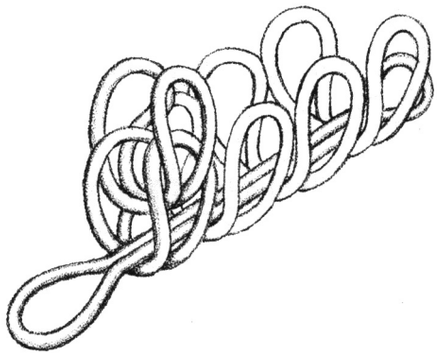


Fig. 2.5.9. (adapted from Stark & Smith 2000)

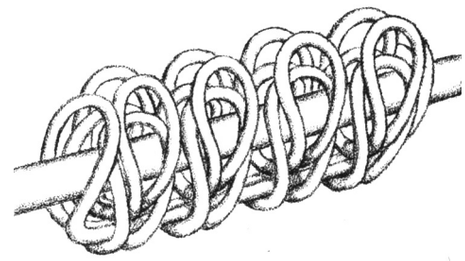


Fig. 2.5.10. (adapted from Stark & Smith 2000)

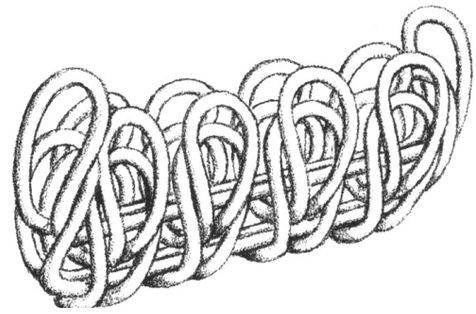


Fig. 2.5.11. (adapted from Stark & Smith 2000)

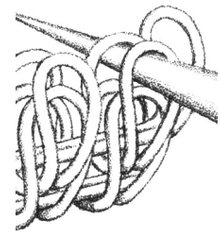


Fig .2.5.12. (adapted from Stark & Smith 2000)

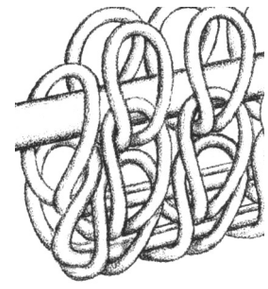


Fig. 2.5.13. (adapted from Stark & Smith 2000)

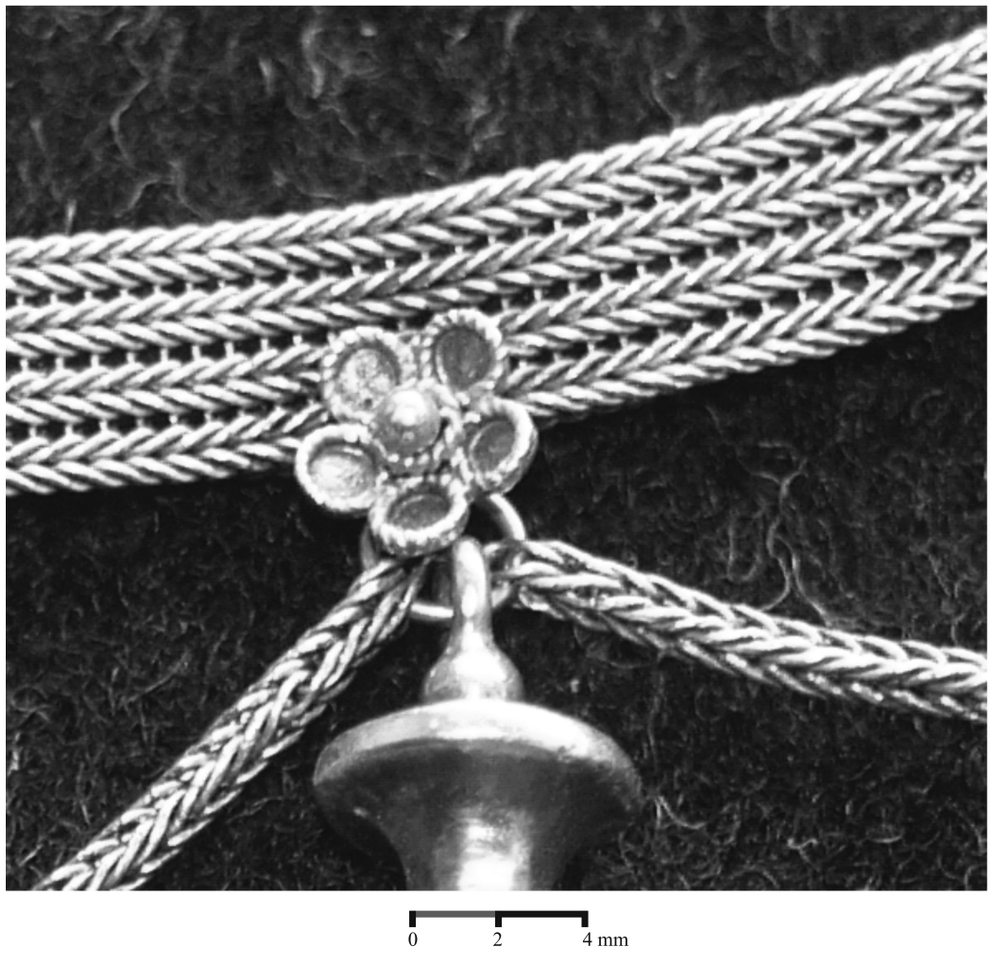


Fig. 2.5.14. Picture of chain.

In Fig. 2.5.14 it can be seen how fine the individual links of the chain are and how tightly it is woven. To produce such a chain would have taken a highly skilled craftsman and a great deal of time, because a single difference in one of the links would have destroyed the desired effect which the craftsman was aiming to achieve.

The reuse of beaded wire within the construction of the chain (Fig 2.5.15 - SCY 108) is an indicator that the piece is genuine because a modern goldsmith would have a ready source of gold wire for the production of a new link, without using this weak variation which is unable to take the same amount of stress and strain as the other links before it would break.

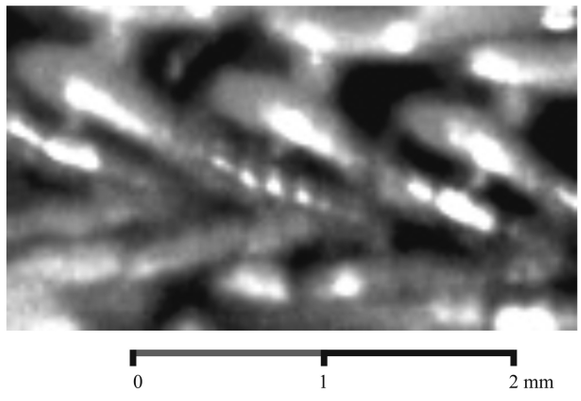


Fig. 2.5.15. (SCY 108).

Pendants - Figs. 2.5.16 and 2.5.17

Fig. 2.5.16. Large bead pendant.

Fig. 2.5.17. Small bead pendant.

The large seed-like pendants were constructed from 10 separate components (not including all the granulation) which were soldered together (Fig. 2.5.18). The body had been pressed or forced using a patrix, where a constant force had been applied. This produced a uniform finished product which could be joined to its other half with a minimum of cold working. A number of these punches or formers have been discovered in archaeological excavations, e.g. the lotus-blossom stamp from Opişor,[19] and from the art market. The latter are often unprovenanced. In the Lydian Treasure there is one former that was used for the production of the bead blanks but this tool is unprovenanced.[20]

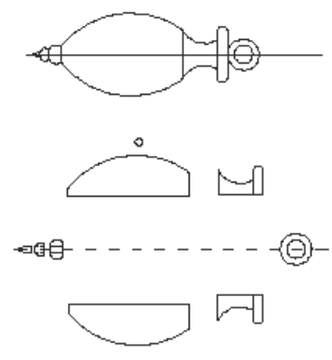


Fig. 2.5.18. Construction principle of the seed-like beads.

The small holes at the back of the pendant are possibly a construction feature and not for the filling of the pendant with a substance to weigh them down (Fig 2.5.19 and 2.5.20). When the separate parts were being joined together they needed to be held stable. The inclusion of

[19] Kull 1997a.
[20] Özgen & Öztürk 1996, 226.

a compound within the central void of the pendant means that they cannot be crushed or deformed by the forces that are involved. The compound would ensure a uniform heating of the pieces and reduces the risk of melting at the edges by increasing the mass effect. The holes would make sure that the pendant body is not placed under internal pressure from the evaporation of this material. The solder splatter that could be discerned in Fig. 2.5.21 (Nik 12 SE) indicates that the beads were held with the holes uppermost when the beads were soldered together.

Fig. 2.5.19. Large pendant, back.

Fig. 2.5.20. Small pendant, back

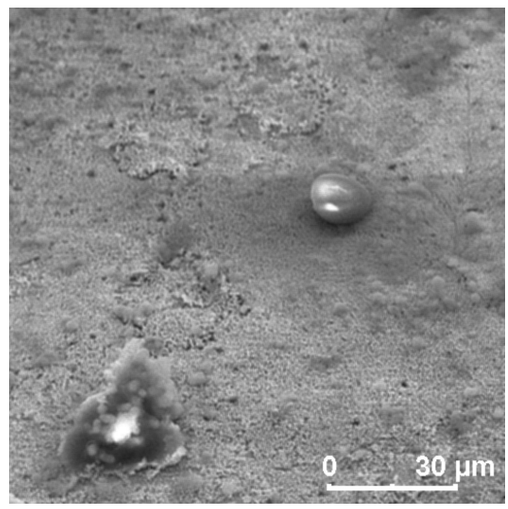


Fig. 2.5.21. (NIK 12 SE).

The small pendants were constructed in the same way, except that there were fewer parts involved in the construction, because the bead was produced using only two parts instead of four.

The rosettes (Fig. 2.5.22 - SCY 109) and the shield motifs (Fig. 2.5.23 - SCY 111) were constructed using a backing plate which had been cut from sheet metal and was then decorated with filigree and a single granulation pearl. The filigree was produced from a thin spiral beaded gold wire which had been fixed to the backing plate by colloid cold soldering and resulted in a sharp clean join without any of the flooding of the motif which can occur when the filigree is soldered on. The hoop on the back of the rosettes which passes through the gold strap and bears most of the strain is constructed in the form of a double ring which is soldered together (Fig. 2.5.24 - SCY 110).

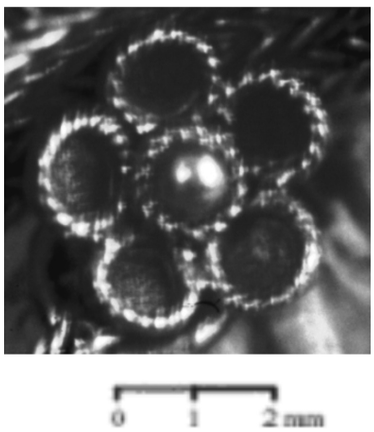


Fig. 2.5.22. (SCY 109)

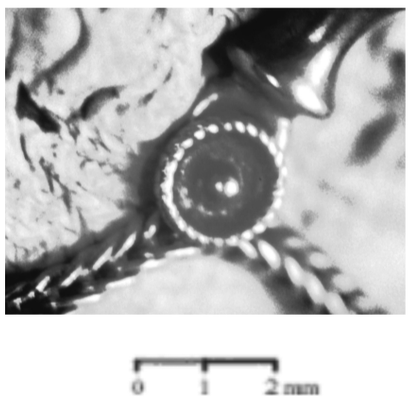


Fig. 2.5.23. (SCY 111).

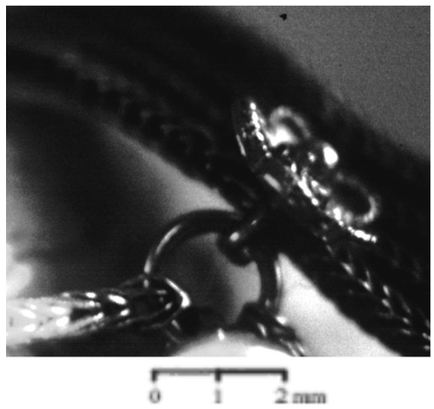


Fig. 2.5.24. (SCY 110).

On the granulation beads there is evidence that they were produced using a stamp and not rolled. This is due to consistency of size and the spur which is evident on the pearls (Fig. 2.5.22 - SCY 109). This appears to have been a standard technique that was used in the North Pontic region to manufacture the granulation balls (see below). Another way to produce the granulation balls of the same size without using cupellation and sieves would be to use small loops of gold similar to those used to produce the links and to melt them in a charcoal block.[21]

On this necklace there is evidence that drawn wire was used to produce the links for the chain and strap. The conformity that would be required in the links to produce the strap may have been the reason why this technological leap had developed. The principle behind the technique of drawing wire is that a twisted piece of wire is placed through the conical opening of the drawing plate, which has to be made from a harder material than the wire, and then the wire is pulled through the opening. This results in a uniform diameter and form of the wire, which is dictated by the size and shape of the opening in the drawing plate.[22] The parallel scratches which may be produced here are not visible to the eye and may possibly only be discerned through the use of a S.E.M., not available for the majority of objects in this study, except for the necklace from Nikolaev.[23]

Drawn wire has not yet been discovered in provenanced material studied; this, however, could be due to the fact that not enough material has been studied or that archaeologists are prejudiced against this and it is immediately accepted as evidence of forgery. In the study of the gold strap necklace with seed-like pendants from Nikolaev evidence was discovered by the use of S.E.M. because the wire is so fine that it is not possible to use a microscope to achieve the necessary magnification. In Fig. 2.5.25 (NIK 20_SE) the parallel scratches which were produced by the use of

[21] Codina 2000, 70-71.
[22] Brepohl 1994, 181; Codina 2000, 29
[23] I would like to thank Prof. E. Pernicka and R. Schwab from the Technische Universität Bergakademie Freiberg for undertaking the study of this necklace with a S.E.M.

a drawing plate can be discerned; this was covered by a 5 mm thick layer of gold which has the characteristic spiral which has been used to identify fine gold wire from this period (see Fig. 2.5.26 - NIK 22_SE).

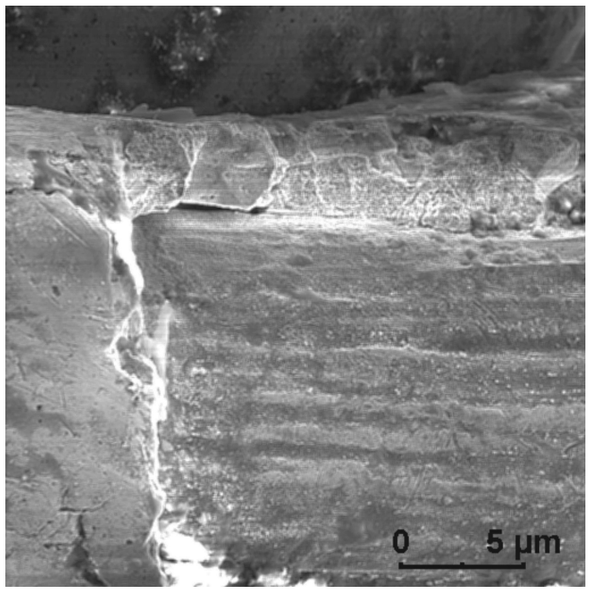


Fig. 2.5.25. (NIK 20_SE).

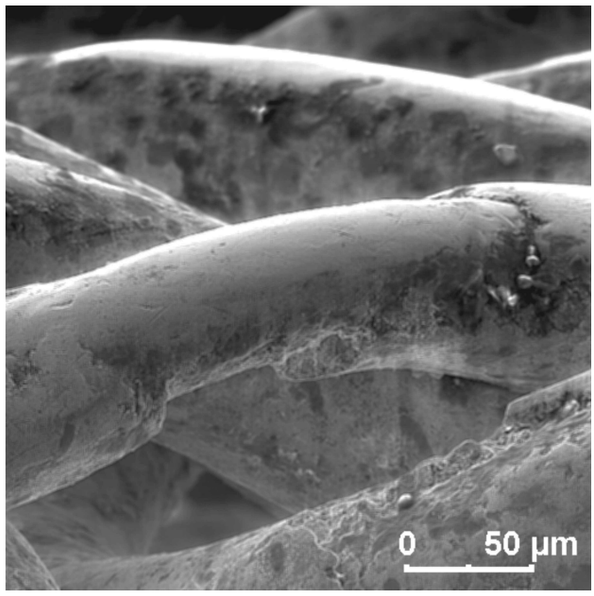


Fig. 2.5.26. (NIK 22_SE).

These parallel scratches, which are beneath the surface layer (which is breaking away), indicate that the wire was produced from a gold alloy with a higher percentage of silver and copper and that it has undergone surface enrichment. The lack of porosity in the gold indicates that it was then burnished to produce a high quality finish. The wire, approximately 50 mm thick, would probably have been burnished using a simple tool which is similar to the lathe used for the production of the spirals (Fig. 2.6.4) except that a knife would not have been used, but rather a flat plate would have run over the gold wire to burnish it. This is potentially a Graeco-Scythian manufacturing technique which is a combination of the two cultures' manufacturing techniques.

In Fig. 2.5.27 the seam can be discerned, suggesting the wire to fix the beads and the shields or rosettes to the chain was produced using the technique that is traditionally identified with ancient gold wire, indicating that it was only the fine wire that was drawn which was used to produce the chain.

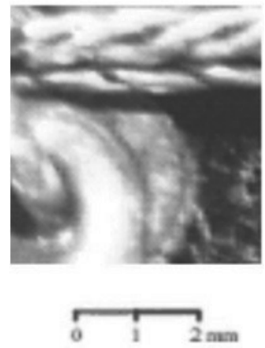


Fig. 2.5.27.

Conclusions

Although this necklace was bought as a copy of a Greek necklace in 1916, the techniques that were used by the master craftsperson to produce it indicate that it was originally manufactured by a Scytho-Greek goldsmith and can be dated to the 4th century BC.

In spite of the damage and repair in recent times, the importance of this necklace cannot be ignored. The early history of this necklace is now impossible to recover. The history of this piece, before it came into the hands of the family of the present owners, is unknown. It could have been in the hands of others before it was sold to the jeweller. It is suspected that it originates from a legal excavation conducted on private land and was later sold; however, it is not possible at this time to reconstruct from which kurgan this artefact originally came. It is only through the study of the technological bases and the tool marks that further insight could be produced and this type of study is still in its infancy.

The necklace from Nikolaev also has all the indicators that it was produced by a Scytho-Greek craftsman. The use of presses to stamp and sheer thin gold sheet to produce a standardised form rather than forcing the gold sheet through the use of dies or cutting by hand is one such aspect. Jigs achieve the same effect of improving the production of complex forms and enhancing the quality of the finished artefacts, as in the production of the strap used on the necklace from Nikolaev. This is critical because slight variations in the loops would produce ugly discrepancies in the finished product. The technology that

was used in the production of this necklace was highly developed, indicating a standardizing in the manufacture of the components.

The use of a press has been shown for the North Pontic Region at this period, as has the use of the stamp for the production of the granulation. The use of colloid cold soldering, which was rediscovered only in the late 1930´s by Littledale, indicates that this piece is genuine. It could have been manufactured by the "Great Blizniza Master" who has been identified by Dyfri Williams.[24] The necklace, although it has been damaged and repaired over the years, is a masterpiece of the Scytho-Greek world. The standardisation of the components used to produce this artefact means that it may become possible, through further studies of the gold and silver jewellery from this region, to eventually even identify the probable source of this necklace.

[24] Williams and Ogden 1994, 127,186- 197

2.6. PRODUCTION TECHNOLOGY

From the results of this study it is possible to affirm that the manufacturing technology was dependant on the culture which produced the artefact: Scythian, Scytho-Greek or Greek. This chapter surveys and discusses the possible techniques that were used by the craftsmen to produce the artefacts which were studied for this thesis.

Wire

The production techniques which could be discerned from the study of some pieces of jewellery show that the standard techniques of the known production methods were: for wire over 1 mm, by hammering and then burnishing a thin rod of gold.[1] Wires less than 1 mm thick were usually made from narrow strips of gold sheet which was twisted and then rolled between two flat surfaces to compress it, producing a wire with uniform diameter with a spiral seam which can still be discerned. (Fig. 2.6.1).[2]

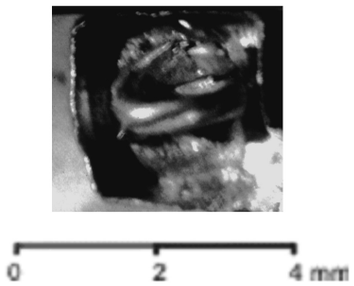


Fig. 2.6.1.

However, this may be incorrect because there is evidence from archaeological material to indicate that drawing of wire was taking place in other cultures which the Scythians and the Greeks would have had contact with in the 4th century BC. From the 4th century BC eight drawing plates have been discovered from Staré Hradisko[3] (Fig. 2.6.2) and Grădiştea de Munte.[4] Both of these sites, where drawing plates have been identified, are in the Carpathian region, where contact had been established between Scythians and Thracians from the 7th century BC.

Modern wire is produced by reducing a stock bar in a rolling mill until it is thin enough to be pulled through a drawing plate resulting in an even wire of the desired thickness. Due to abnormalities in the drawing plate there are often characteristic grooves formed on the wire. This test is often performed when examining jewellery to see if it is a forgery, as it is believed by a number of experts working in this field that the technique of drawing wire was not discovered before the AD 8th century (Fig. 2.6.3 - NIK11_RE). [5]

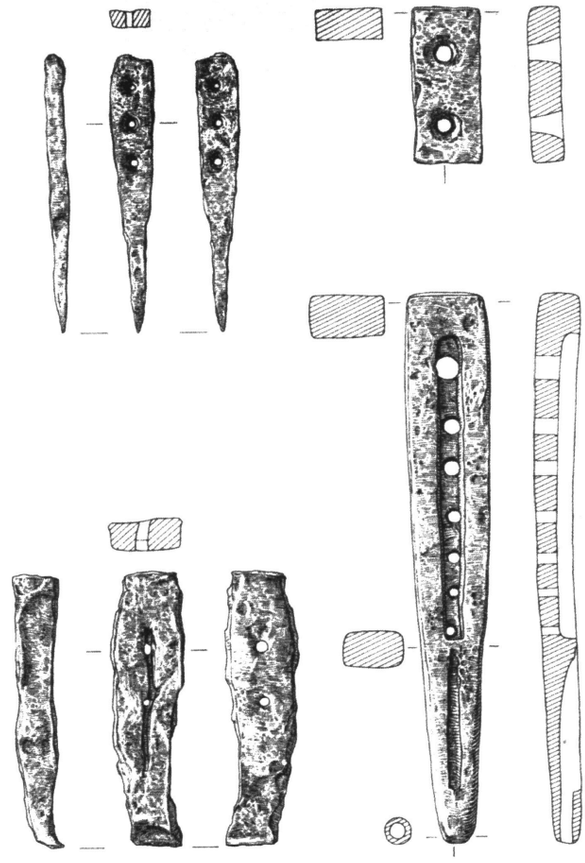


Fig. 2.6.2. (adapted from Jacobi 1979)

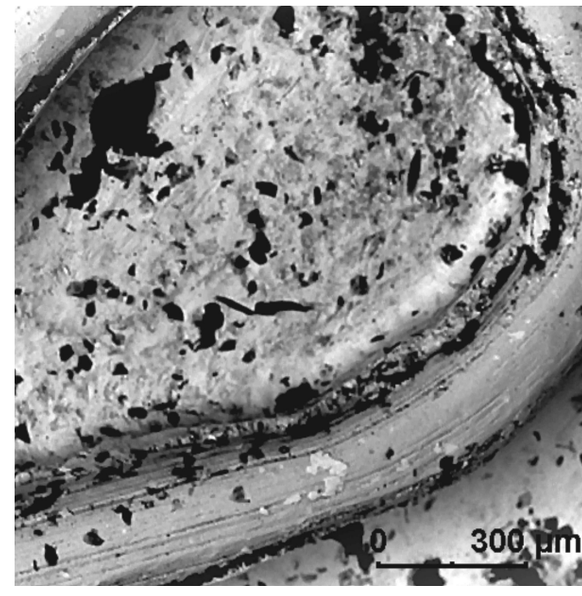


Fig. 2.6.3. (NIK11_RE).

[1] Rudolph 1995, 7; Williams & Ogden 1994, 23.
[2] Rudolph, 1995, 7; Williams & Ogden 1994, 23; Ogden 1982, 51.
[3] Jacob 1979, 113.
[4] Rustoiu, 1996, fig. 24,6-8.12; Glodariu 1979, fig. 54,5-8.
[5] Williams & Ogden 1994, 23; Hoffman, 1969, 447; Higgins 1961, 15.

The drawing of gold wire under 2 mm diameter can be done by hand; modern goldsmiths use drawing pliers to achieve this, but in the Third World it is still common practice to use a piece of round wood around which the formed gold wire is wrapped to produce a stable hand piece which allows enough force to be applied.[6]

Wire can be used for many decorative and constructional purposes within the production of jewellery, depending on the purposes of the goldsmith. It can be used in its plain form or decorated with beads. The wire can be bent to form decorative scrolls, borders for cloisonné decoration and chains.

Construction of beaded wire

The beaded wire that was used to decorate artefacts could have been made by two techniques: firstly various tools were rolled over the wire to produce the grooves and hence the beads; the second technique that could have been used is the so-called *organarium* where two dies are used to produce the beads. The former can be referred to as rolling swages and the latter as opposed swage blocks (see fig. 2.6.4). The use of these techniques leaves evidence on the beads so that the method used can be identified.

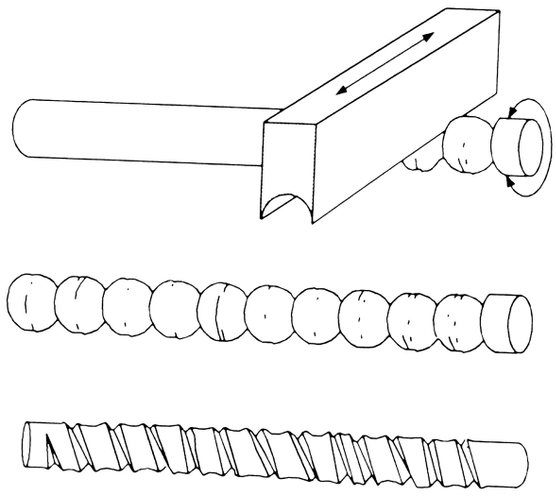


Fig. 2.6.4 Rolling Swage and spiral beaded wire (adapted from Williams & Odgen 1994).

When a rolling swage was used the characteristics are:

a) the beads and furrows are not evenly spaced,
b) the seam at the equator of the beads is not the same in appearance,
c) variation in pressure results in irregularities.

To reduce the variation in the production of spiral beaded wire a simple lathe bank could be used to cut the beads (Fig. 2.6.5). The opposed swages produce more uniform beading but require more experience and care to produce good results[7] (Fig. 2.6.6).

The beaded wire from Vettersfelde was produced using an *organarium* which has not been discovered among Greek artefacts.[8] The use of an opposed swage dictates that the wire is unlikely to be a rolled wire, since the amount of force that is applied using this technique is liable to damage the wire at the seam.

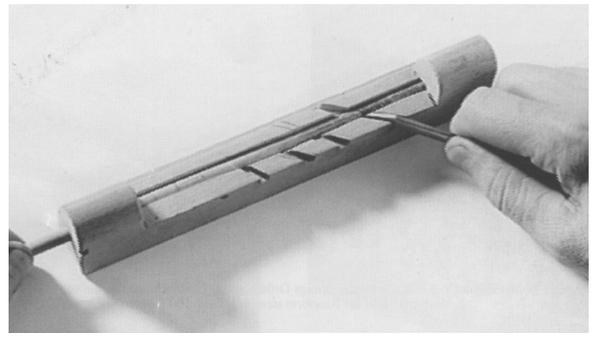


Fig. 2.6.5.Lathe Bank for the production of spiral beaded wire (adapted from Born 1992).

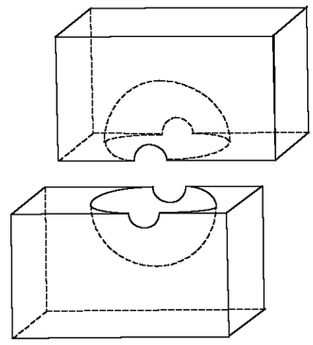


Fig. 2.6.6. Opposed swage.

In the three examples, each using a different technique to produce the beaded wire, there is a depreciation in the quality of the wire that is produced. The wire that was produced by the opposed swage technique (Fig. 2.6.7) has the most uniform appearance, not only in the quality of the beads themselves but also in the size and spacing of the beads. The rolling swage produces beads with a regular spacing and form; this is due to the placing of the tool and the amount of pressure used (Fig. 2.6.8). When spiral beaded wire (Fig. 2.6.9) is produced it should no longer be referred to as beaded wire, since the original cross-section remains while the valleys are produced by the tool deforming the wire only at the point of contact, thus producing an effect that is similar to a bead but not as pleasing to the eye.

[6] Dr. N. Boroffka, personal communication.

[7] Whitfield 1985, 5.
[8] Williams & Ogden 1994, 24.

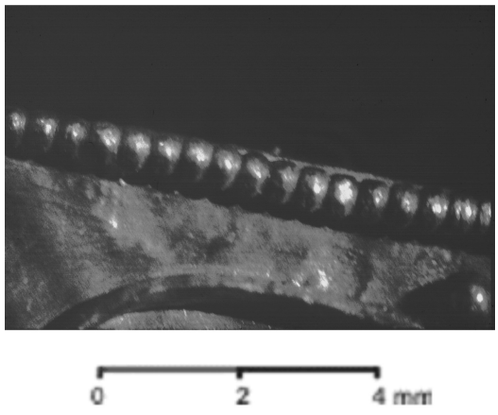


Fig. 2.6.7 Detail of opposed swage formed wire from Vettersfelde/Witazkowo, Pendant.

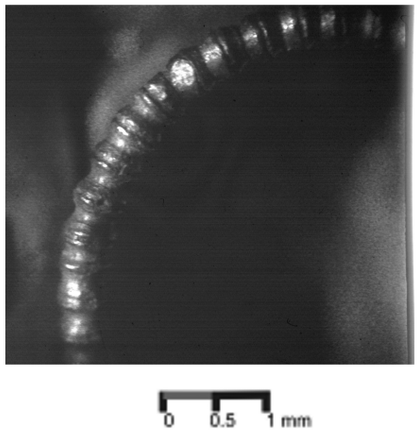


Fig. 2.6.8 Detail of rolling swage wire from Vettersfelde/Witazkowo, earring.

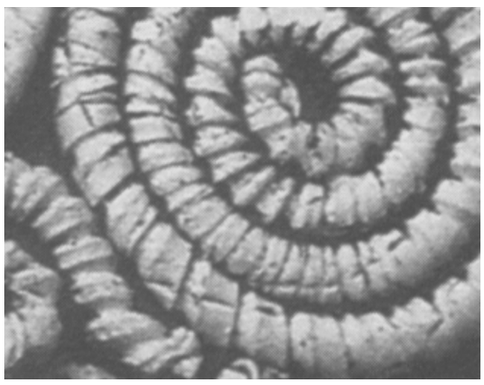


Fig. 2.6.9 Detail of spiral beaded wire (adapted from Williams & Odgen 1994).

The use of these various techniques may be an indicator of the social standing of craftsmen within a society, since the use of opposed swages is highly skilled and time-consuming. The use of a rolling swage again requires skilled personnel to produce the wire because the use of too much pressure would result in the wire breaking at various points. Spiral beaded wire does not require the same amount of skill and time to be produced. It is in the production of wire and of beaded wire that we find our first indication of different technological bases within Scythian and Greek society. The possible use of drawn wire by the Scythian craftsmen, as well as the use of the opposed swages, indicates that the time taken to produce such work was not as important as under the Greeks. In Greek society gold was considered a valuable commodity to be reused and not buried with the owner, while in Scythian society gold may have had another meaning not based upon its value, but rather as an indicator of the individual's status within society, thus resulting in a practice of producing high quality artefacts where the time factor was not considered important. It is known that in classical Greece the common practice was to pay a craftsman a percentage of the amount of gold that was used to produce the artefacts. The Scythian practice is unknown but it does not seem to correspond to the Greek model.

Cloisonné is a technique where a cell is formed using either round or rectangular wire on a backing. The wire can be formed either by pliers - henceforth referred to asfreehand-formed cloisonné – or by the use of a jig, consequently referred to as tool-formed cloisonné. Freehand-formed cloisonné can be recognized by the variations in the form because it is very difficult to produce exactly the same sizes and shapes. Tool-formed cloisonné can be recognized by the constant form and shape; this technique can be referred to as a mass production method and is very important for the recognition of the products from a workshop, since it is inconceivable that an individual would use such a tool only once.

In the case of freehand-formed cloisonné, the shapes that can be produced are dictated by the types of tools that are available. A modern goldsmith usually has nine special pliers to facilitate this work. The original tool for this work was probably the human hand; even to this day goldsmiths still use their hands when forming thin metal. The limitations of using the hand lie in the relatively low pressure that can be achieved by the fingers which means that short and thick material is difficult to bend by hand; small fiddly motifs cannot be produced using the fingers.[9] For thicker material the pliers are used because the resistance to bending of a wire increases with the thickness and the strength (which is dependent upon the alloy). This indicates that the ancient goldsmiths understood these limitations whenever they were producing cloisonné. The shapes that can be produced using the above mentioned techniques are limited in their complexity and uniformity.

For more complex and uniform production it is possible to use a jig, around which the gold wire is formed. When the cloisonné has been produced using a jig it is possible to recognize this because of the standardization in the dimensions and the possible complexity of the form (Figs. 2.6.10 and 2.6.11).

[9] Brepohl 1994, 240.

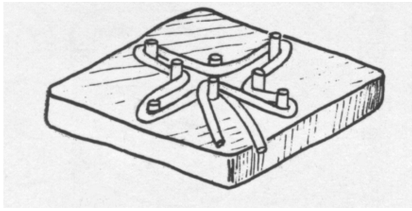


Fig. 2.6.10. Jig.

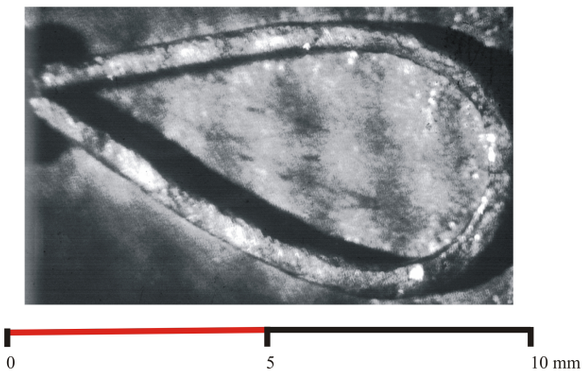


Fig. 2.6.11. Tool formed cloisonné from Vettersfelde/ Witazkowo, pendant.

The majority of the rest of the artefacts studied showed evidence that they were pressed and not stamped as was the norm for this period; there was no evidence of finishing the artefacts with engravers and gravers. However there has never been a study conducted of the majority of the gold plaques excavated; consequently it is not possible to state when, how and where this technique was developed. The Scythians may have developed this for themselves or learnt this method of production from one of the other cultures with whom they were in contact. In the 3rd century BC there is evidence that this technology had been introduced into Zhou China, where 118 artefacts were found in an excavation at Aluchaideng, which included 21 tiger plaques, 12 bird plaques, 2 of rams and 45 geometrical plaques.[10]

Matrix and Stamps

As gold is a soft material and easily formed, this means that the matrix or stamps also had to be produced from material that would not wear rapidly. In the archaeological world there are many examples of copper alloy stamps that have been found in excavations both legal and illegal. However there are no matrixes found in any excavations that match a patrix from this period. This has led technologists to believe that all archaeological artefacts of this type were produced by forces, stamps and punches. As most technological studies published for this period (7th–5th centuries BC) deal with classical Greek gold-working technology, there is still a tendency to believe that the Greeks were the most civilized and technologically advanced culture of this period. This is also due to the exceedingly good Greek propaganda by the ancient authors, whose writings have been a foundation of classical studies for so long.

There have only been 16 provenanced punches and matrixes discovered in excavations from the Aegean and the North Pontic which are dated to 7th to 5th centuries BC. The importance of these artefacts becomes clear through their association to the elite burial at Ul'skiy Aul.[11] The patrixes and matrixes that are provenanced come from Arbanasi,[12] Berezan,[13] Chersoneses,[14] Dragoevo,[15] Kamenskoye,[16] Oprişor,[17] Panticapaeum,[18] Pîoaia,[19] Radovanu,[20] Ruen,[21] Thessaly,[22] Garcsinovoi,[23] and Nymphaeum[24] (Fig. 2.6.12).

The largest collection of patrixes recovered is unprovenanced because they were sold to dealers at the same time as the Lydian treasure was sold to the Metropolitan Museum. It is possible that these 32 patrixes[25] may have come from tombs in the area of Güre, Yoncali Mevkisi, Ikiztepe or from an unknown tomb which could have been looted at the same time as the others.[26]

There are countless examples of artefacts, produced by the Scythians from bone, which have been carved in a highly skilled manner,[27] indicating that it was possible to produce a matrix from bone. It is easier to carve bone which is in a soft state, as has been found to be possible by archaeological experiments. When the bone is submerged in a natural organic acid such as sour milk, buttermilk, fruit acid or stomach acids for approximately one week then a reversible reaction takes place:

$$2(Ca_3(PO_4)_2)\cdot CaCO_3 \rightarrow CaHPO_4\cdot 2H_2O \xrightarrow{\uparrow CO_2} 2(Ca_3(PO_4)_2)\cdot CaCO_3 + CO_2$$

Acid — From the air

The bone can then be carved, drilled, punched and generally worked to produce the desired form up to a depth of approximately 5 mm.[28] This is also the usual depth of the gold plaques that are so common in Scythian burials.

Although there is no direct evidence, there are more than enough secondary indications that plaques were being pressed and not forced. An indicator of the origin of this technology could be the punches themselves, the type of

[10] Personal communications, Professor M. Wagner.

[11] Leskov 1990, fig. 92-95.
[12] Kull 1997a, fig. 15.
[13] Domanskii, Vinogradov & Soloy`ev 1989, fig. 14,6.
[14] Kadeev 1970, 49.
[15] Kull 1997b, 109. ff.
[16] Kull 1997a, fig 15.
[17] Kull 1997a, 551-84.
[18] Kull 1997a, fig. 15.
[19] Kull 1997b, fig. 29.
[20] Morintz & Şerbănescu 1985, fig. 3,1.
[21] Kull 1997a, fig. 15.
[22] Kull 1997a, fig. 15.
[23] Fettich 1934, 15.
[24] Treister & Vickers 2001, 134-135.
[25] Özgen & Öztürk 1996, 211-229.
[26] Özgen & Öztürk 1996, 168.
[27] Galanina 1997, pl. 16.
[28] Zurowski 1973, 486

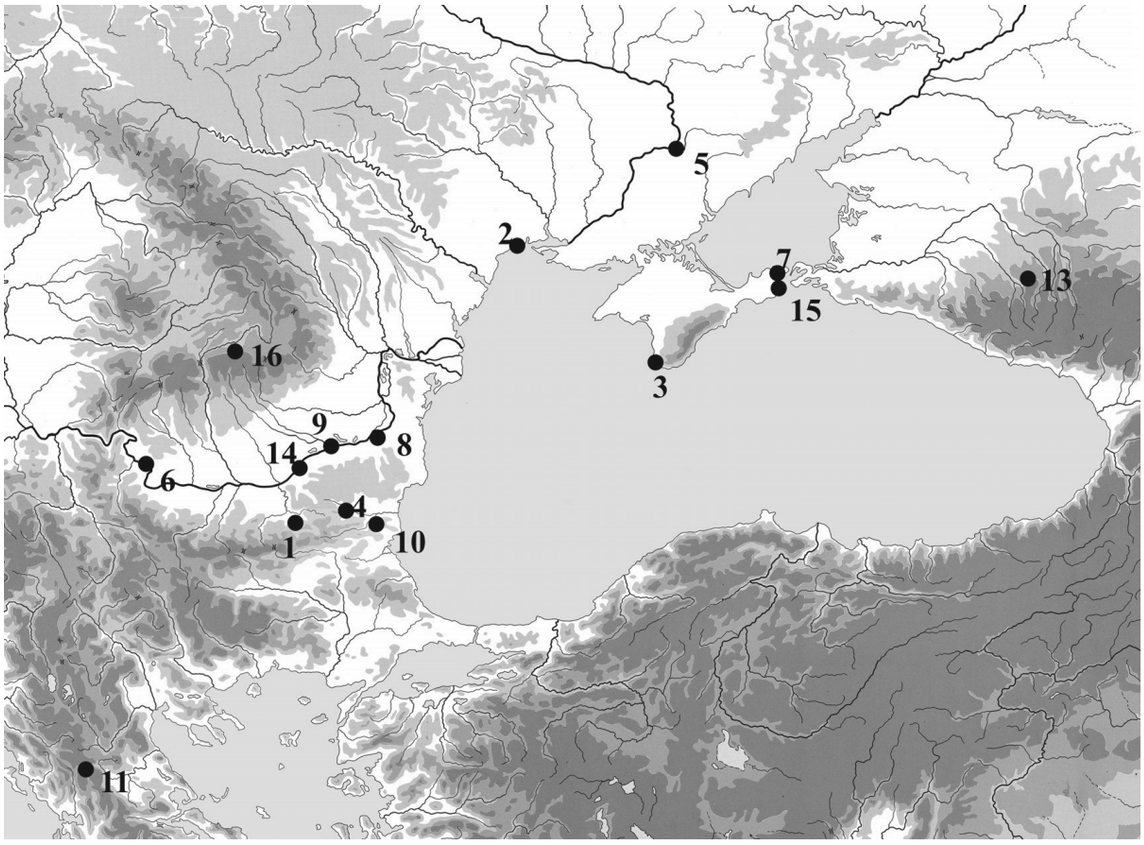


Fig 2.6.12 Distribution map of Matrixes and Punches

1 Arbanasi, 2 Berezan, 3 Chersonesus, 4 Dragoevo, 5 Kamenskoye, 6 Oprişor, 7 Panticapaeum, 8 Pîoaia, 9 Radovanu, 10 Ruen, 11 Thessaly, 12 Tyritake, 13 Ul'skiy Aul, 14 Garcsinovoi, 15 Nymphaeum, 16 Surcea.

the punch, the form and physical size. The majority of the punches are not long enough to be held comfortably in the hand whilst hitting them with a large hammer, which would be required to produce high pressure on the silver or gold that is being decorated in this manner. A number of authors believe that multiple striking could have been used to produce the desired effect;[29] however, this is not evident from the artefacts themselves, for in high magnification the edges are too crisp and sharp with no traces of over-striking, indicating that the mark was produced in one continuous applied pressure. It is also very difficult to produce a uniform copy using this technique because the strike angle would never be the same and the pressure would also vary resulting in variations between the different artefacts.

In the construction of ancient beads, large seed-like pendants were constructed from 10 separate components which were soldered together (Fig. 2.5.17). The body had been pressed or forced using a stamp where a constant force had been applied. This produced a uniform finished product which could be joined to its other half with a minimum of cold working.

Chasing and Repoussé

Chasing and repoussé are very important techniques. Although they are separate crafts, they are intertwined in such a way that it is impossible to treat them separately, and therefore they will be dealt as one subject. Technically, repoussé is the art of creating a relief by working on the reverse side, whilst chasing is the further decoration of the front. One of the most important requisites for the successful use of these techniques is to firmly secure the piece whilst working it; pitch should allow the metal to deform slowly under successive hammer blows. There are many recipes for the production of the pitch, which is essentially composed of a sticky elastic substance (resin or pine pitch), a filler to control the stiffness of the pitch (powdered clay) and oil or tallow to soften it. By varying the amount of clay or oil it is possible to change the characteristics of the resultant pitch.

Formula for a semi hard pitch:

1 kg resin + 2 kg red clay + 100 cc olive oil.

Or

[29] Özgen & Öztürk 1996, 230.

2 kg pine pitch + 2 kg red clay + 100 g tallow + 50 g of Venice turpentine.

The resin/pine pitch is broken into small pieces and heated until it is molten and then the clay is slowly added, stirring the mixture all the time to avoid lumping. The oil/tallow is then added and the mixture stirred until it is smooth. It is then poured into an iron pot or a wooden form and allowed to cool. The climate and temperature of the region changes the properties of the pitch, and therefore the formula has to be changed by the amount of clay and oil to achieve the desired properties. For repoussé a softer pitch is used compared with the pitch that is used for modelling and chasing.[30] All of the materials for the production of pitch would have been available to the ancient craftspersons.

Production of a bead or pendant using repoussé and chasing

The outline of the bead is traced with small dots made by a pointed chasing tool on one of two sheets of metal which have been fixed to the pitch with the corners turned over to stabilise them into position. The exact obverse of the bead is reproduced on the second sheet, so that the two pieces will have a perfect match when they are soldered together.

The sheet is then pressed into the pitch using an embossing punch with multiple hammer blows until the desired volume is reached. It is then removed from the pitch and the pieces are annealed. The hollow is then filled with a harder pitch to allow the front to be smoothed using a modelling punch and it is then decorated with chasing tools. The separate halves of the bead are cut from the sheet and soldered together.

This appears to be one of the standard techniques used for the production of beads for a limited production run in antiquity.

Casting

The basic technique of casting is where the liquid metal is poured into a mould and allowed to cool to produce the required form or object. This technique was used to produce complex forms which could not be produced in any other way without a high percentage of wasted material. As an example can mentioned the Ganymede and eagle earrings:[31] the casting of Ganymede appears to have been done by the lost wax moulding technique with minimal cold working. It has been mechanically attached to the casting of the eagle (Zeus) which has been extensively cold worked.

Lost wax moulds

An ancient technique used by the Ashanti culture from Ghana (and which is still being used) may have been the method that was used by the ancient cultures being discussed in this thesis.[32] However the existence of this technique for the production of metallic artefacts is very difficult to prove from direct evidence because the mould is broken and usually not found. Therefore there is only indirect evidence from complex forms which have been cast throughout prehistory to suggest that this technique was used. It is possible that this technique was used but there is a number of different techniques, a wax model of the required form is produced, which is covered by a thin layer of a liquid, homogeneous mixture of equal amounts of pulverized charcoal and potter's clay. Once this has been air-dried a second, thicker layer of 40% charcoal dust, 25% horse manure, 25% potters clay and 10% refractory clay is placed around it. When this layer is thoroughly dry, the last thick coat is applied which is made from a mixture of 45% potters clay, 45% horse manure and 10% refractory clay, which is once again allowed to dry to a biscuit-hard state before it is heated to allow the molten wax to flow out of the finished mould. The crucible is probably produced at the same time as the final layer is added to the mould because it is of the same mixture.[33]

The correct amount of metal is added to the crucible, which was calculated before the production of the mould from the wax figure. This can be done either by the multiplication of the mass of the mould by the specific gravity of the metal, which relies on the availability of accurate scales, or, more probably, the ancient goldsmiths could have submerged first the wax model in water and then the metal which was going to be used for the production of the finished piece, so that the same amount of displacement of the water occurred.[34] The mould is then joined to the crucible using a paste produced from the same mixture of clay and allowed to dry, so that there is no moisture present before it is heated to an orange-red colour with the crucible being closest to the heat source. A major advantage of this technique is that the crucible and mould form a single unit, so that they reach the same temperature simultaneously, which is advantageous when casting. The mould is then removed from the heat and rotated so that the molten metal flows into the cavity and it is allowed to cool before the mould is broken away from the finished casting.[35]

Sand casting

Another casting technique that is impossible to prove by direct archaeological means is sand casting, although this is a known ancient technique,[36] Modern sand casting is primarily used for the production of large parts, typically from iron, bronze, brass and aluminium.[37] It is only through indirect evidence that its usage can be proven, since sand castings generally have a rough surface sometimes with surface impurities and surface variations, although this can

[30] Codina 2000, 88.
[31] Williams & Ogden 1994, 76.
[32] Codina 2002, 50.
[33] Codina 2002, 50-51.
[34] McCreight 1998, 110.
[35] Codina 2001, 51.
[36] Goldmann 1981, 113-115; McCreight 1998, 136.
[37] www.efunda.com/processes/metal_processing/sand_casting_intro.cfm

be removed by the finishing processes that the piece has undergone, such as polishing, thus making it impossible to prove that sand casting has been used and there are no sharp edges in the casting but rather smooth transitions.

The sand casting moulds are produced from a fine silicon based sand which has a round structure so that it can be closely packed together to form a smooth mould surface. Clay is used to bond the sand together cohesively and to give the mould strength. For the most basic and simple castings, ordinary beach sand may be used. It is possible for the sand to be bonded together by oils, such as olive oil.[38]

A form is then used to hold the sand around the object being cast. This form may be a simple box of wood. The forms are made in two sections, a top and a bottom half. Sand is poured into the bottom form to just cover the bottom and then the mould is placed into the lower form. A mould is made in the exact shape of the object you want to cast, perhaps by pressing in a model. The mould may be made out of wood or another casting. A release agent is placed on the mould to prevent it from sticking to the sand.

Sand is then poured around the mould and tamped down until it is nice and firm. Two or more channels are cut into the sand, going from the mould to the openings in the form. These are used to pour in the molten metal. The sand is levelled off to the top of the lower form and more release agent is poured over the mould and the top of the sand in the lower form. The upper form is then placed over the lower form and more sand is poured in and packed tight around the mould. The sand is again tapped down to make it firm around the mould. The upper half of the form may then be removed from the lower half. The sand will stay in the upper half of the form and will have the shape of the mould. The mould itself may now be removed. The upper form is then placed onto the lower form and the two halves are clamped together. The final step is the easiest; the molten metal is poured into the form through the casting, or sprue, holes. When the casting has cooled, the form is opened, and the new casting may be removed. The sprues are cut off the edge of the casting and the sand may be reused (Fig. 2.6.13).

Another technique that is used by modern goldsmiths which is not archaeologically provable due to the inability of this medium to survive in the archaeological record is that of cuttlefish (cuttlebone) casting. This is a simple and economical technique to produce a metal copy of a metal, wood or bone model that has been pressed into a prepared cuttlebone. Cuttlefish has a hard exterior but the interior has a texture which is similar to plastic.[39] With this technique it is only possible to produce a single precise copy per mould because successive castings lack the definition of the first copy.[40]

[38] Barlow 1998.
[39] Codina 2002, 52.
[40] Codina 2002, 52; McCreight 1998, 104; Rudolph 1995, 6.

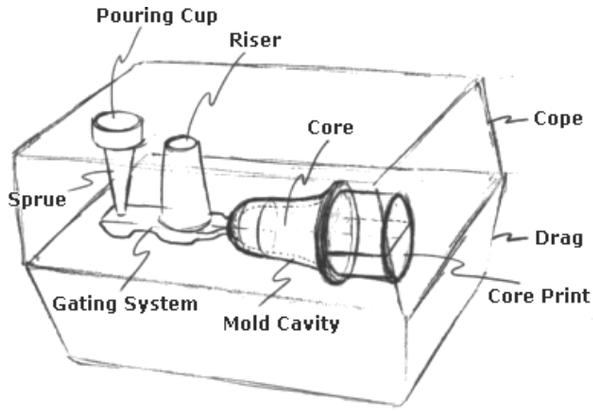


Fig. 2.6.13. Sand casting.

Casting in stone, clay and plaster

Precious metals can be cast in moulds that have a negative of the desired pattern which has been either cut or pressed into soft material. When the mould is a bivalve form then a riser and a caster also have to be formed to facilitate the pouring of the molten metal into the form. A number of moulds have been discovered in excavations at ancient settlement sites, which are often believed to indicate that there were workshops used for the production of jewellery.

There are a limited number of moulds discovered in the North Pontic region from this period at Olbia,[41] Panticapaeum,[42] and Chersoneses,[43] along with moulds that have been discovered at Corinth[44] and Miletos.[45] (Fig. 2.6.14). This is not due to the lack of excavation in this region but to the scale of excavation that has to be undertaken and the tendency to stop the excavations before the earlier levels are reached.

The conclusion that can be drawn from this chapter is that the craftsmen could have used a number of techniques to produce the same result and it appears that there were cultural differences. These resulted in the craftsmen using different methods to produce the artefact which in turn can be used to discern which culture the craftsmen belonged to.

[41] Denisova 1987, 327.
[42] Treister 1987, 45-48.
[43] Kadeev 1970, 49.
[44] Pemberton 1981, 105-108.
[45] Treister 1996, 162.

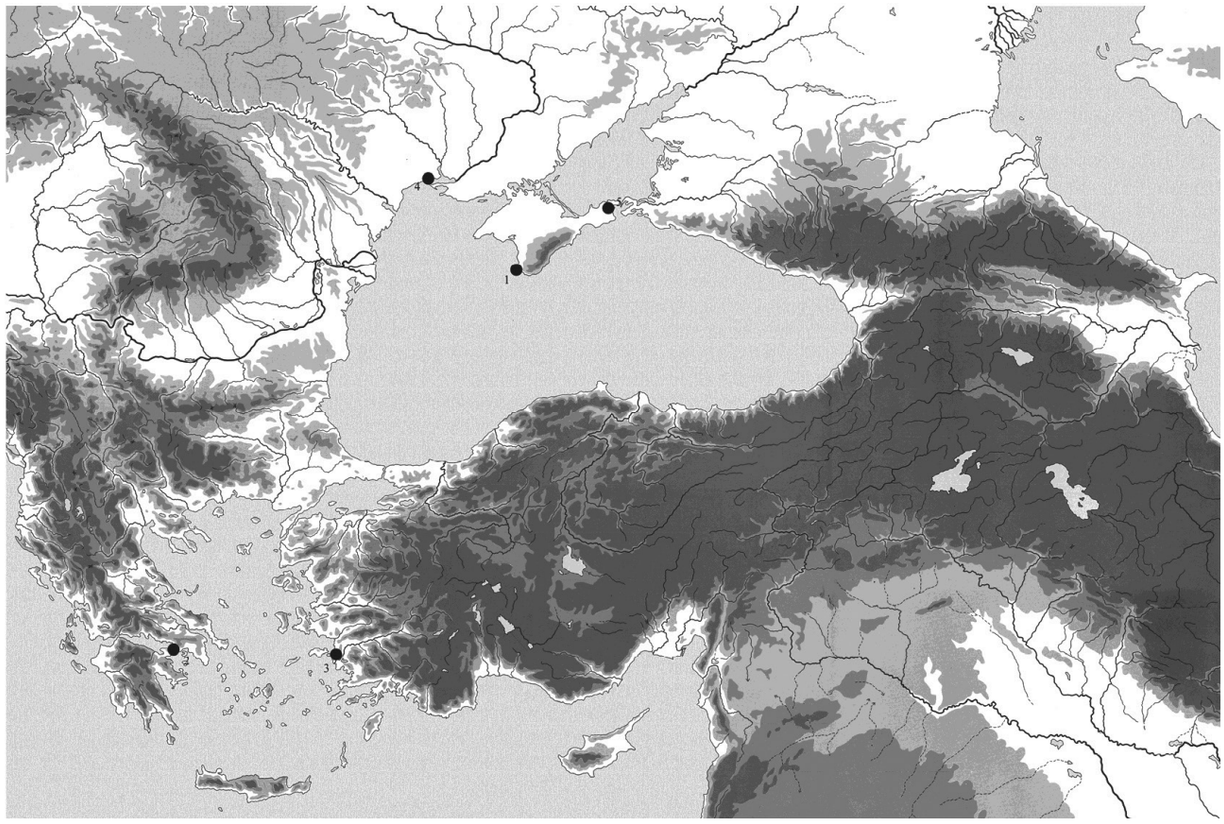


Fig. 2.6.14. Map of the distribution of moulds.

CHAPTER 3

Conclusions

In this comparative study of Scythian and Greek jewellery manufacturing technology a limited data-base of 146 artefacts has been studied. The results have shown that it is possible to give indications for the potential production area or culture of the jewellery on the basis of technical details. The study of art styles, which has been undertaken by numerous scholars to enlighten our understanding of this question, has suffered from the limitations that occur through the survival in the archaeological record, including even tectonic and climatic changes which has resulted in the sea level submerging many monuments in the Black Sea basin. The regional concentration of excavations, due to funding and international politics (especially after the collapse of the Soviet Union), has led to biased conclusions in the study of the Scythians and Greeks.

The origin of the Scythian culture is a complex problem not yet fully understood. This is because there is no single clear archaeological definition of the Scythian material culture and thus of the Scythian culture. As a consequence the sphere of influence of this culture can also not be defined; it is currently believed to range from China in the east to the Hungarian plain and possibly to modern Poland in the west, and to Siberia in the north with the southern borders on the Caucasus. This is a vast area and to expect that the cultural indicators would be the same throughout this region is unreasonable as there will be localised variations due to the climatic conditions and previous indigenous populations, along with the external cultural influences which would affect the Scythian culture. The majority of the information we have about the "nomadic" Scythians from the 8th to 4th centuries BC comes from the graves of the social elite and Greek written sources; only a very few settlements have yet been excavated and these do not usually belong to the nomadic half of this culture, who lived in wagons.

The chronologies proposed for Scythian culture are convoluted and based on circular arguments which can often lead to conflicting dates for the burials, depending upon which artefact is studied. The Scythian arrowhead chronologies developed from the work by Rau in the 1920's, and later by Meliukova and Petrenko,[1] have to be used cautiously because later forms co-exist with earlier types: it is possible to derive an incorrect date of a burial or of an attack on defensive structures by the Scythians based solely on the discovered arrowheads. The chronologies that have been developed for the dating of the akinakai, considered to be an important indicator of Scythian presence in a region, are based on the early work of Ginters from 1928.[2] This work was updated in the early 1960's by Meliukova who produced a new typology based on the akinakai with and without antenna.[3] This comprehensive study was used as the foundation for the chronology for the material from Romania by Vulpe.[4]

The study of the Scythian animal style is another complex problem because of the volume of material that is presently in museums throughout the world. The artefacts in Russia have not yet been fully catalogued. (This is currently being undertaken, but it is unclear when it may be finished.) Each year more excavations are being undertaken, increasing the amount of material that is available for study and it is virtually impossible to keep up to date with all the literature from these excavations. The Scythians are believed to have been an illiterate society whose principal form of communication was through the spoken word and by visual representations of symbols. The symbology has been studied in two ways by scholars, the first being a physical representation of the religious philosophy of the world tree. The other technique that has been used by scholars such as Rostovtzeff[5] has been to try and interpret the artistic meaning and the tradition(s) behind them. The latter research has shown that the Scythian animal style was influenced by external contacts with other cultures from the Near East resulting in the Scytho-Iranian style, exemplified by the artefacts discovered in the excavation of the Kelermes Kurgan.[6] The origin of the Middle Eastern influence is still being debated among scholars, with some believing it to be Assyrian or Urartian, whilst others think that it could have been Median. Research of this problem has been made more difficult since the 1980's due to the political and religious circumstances in Iran and Iraq.

It was thought that the Greeks were a major influence on the animal style because the earliest excavations of kurgans were in the vicinity of the Greek colonies on the Black Sea and the majority of the kurgans contained a combination of Greek imports and indigenous manufactured products. The theory that the Ionian Greeks stood at the origin of the animal style because of the incorporation of Middle Eastern elements into the art of the Classical Greeks was introduced by Farmakovskii in 1914.[7] This early work still influences modern scholars' interpretation when considering the origins of the influences on jewellery from the North Pontic region. This biasing to the Greek civilisation is a product of the Ancient Greek ethnocentrism

[1] Rau 1929; Meliukova 1964; Petrenko 1967. See also Hančar 1972 and Boroffka 2002.

[2] Ginters 1928.
[3] Meliukova 1964.
[4] Vulpe 1990.
[5] E.g. Rostovtzeff 1973 (1929).
[6] See, for examples, Galanina 1997.
[7] Farmakovskii 1914.

and the resulting Eurocentrism which began with the discovery of the Scythian civilisation in the 18th century and still influences our philosophical understanding of the development of civilisations. An illiterate culture appears inferior to a literate culture in every way, because we assume that writing is the superior method of communication within a society and do not consider any other technique as being equal with this.

The idea that any other culture might have developed its own gold working tradition superior to Greek gold working techniques, has largely been ignored, e.g. the objects and quality of the North Pontic gold jewellery have always been assumed to be produced by Greek master craftsmen for the Scythian market. It is only recently that this idea has been questioned, e.g. in the case of the Tolstaya Mogila pectoral, which has always been assumed to have been produced by a Greek master working for a Scythian patron. "If it is correct that the best of Scythian gold work represents Greek craftsmanship but the visions and directions of Scythian patrons, we would have a mutual moment in art history; when art represents a truly collaborative effort between artist and patron, across boundaries of ethnicity, language, and self identity".[8] This ignores the fact that both these cultures had contact with the highly developed cultures of the Middle East. It is not a valid hypothesis that the Greeks were the only group influenced by this contact. The material culture of the Scythians was obviously influenced by these cultures, perhaps just as much or even more, before the initial contact with the Greeks is apparent in the archaeological record.

The Greeks considered jewellery as a mobile form of bullion which could be exploited, not for its artistic value but for the weight of the metal, in times of national crisis for the minting of new coins. In the crisis that affected Athens during the wars with Persia the temple inventories were stripped of most of the gold and silver artefacts for the production of new warships. Quite differently, in the Scythian world jewellery may have been considered to be a cultural marker, of the tribe to which the individual belonged (the symbols of the panthers, deer and fish etc. may denote membership of individual clans) and/or the social elite within this society (gold could possibly only be worn by individuals who belonged to the clan referred to as the "royal Scythians" regardless of the standing of the individual within the social hierarchy of his clan).

These tendencies may have been followed in the colonies on the North Pontic shore, where individuals would have objects produced in a Greek artistic style to show that they had influence in the city and possibly Greek blood. This can explain why so many of the so-called masterpieces of the Greek world are found in this region.

The aforementioned social consideration of the value of jewellery may be the reason for the differences in the production techniques, as evidenced in this study, of Scythian and Greek jewellery. The goldsmith in the Greek world was probably not considered to have the same value to society as in the Scythian sphere of influence. The Greek craftsmen are thought to have been itinerant, moving from one patron to another or moving to a different market. The Greek craftsmen would not have the same social influence to construct pieces which were time-consuming, because they were paid a percentage of the gold used to produce the artefact. In largely slave-based economies it is important that these individuals are fully employed to achieve social stability. This factor would not have been an incentive to increasing development of technology or to improve the quality and productivity.

The acceptance that these pieces were produced by Greek craftsmen has long been held because it was previously thought that gold-working had been introduced to the Scythian culture through their contact with the Greek colonies. However, there was indigenous development of this craft, which has been discovered in the Andronovo and Arzhan cultures that are now thought to be cultures the Scythians developed from. Scholars have neglected the influence of the ancient civilised cultures of the Near East with whom the Scythians had had direct contact in the period of the Scythian dominance of that region, and possibly afterwards as well. The collapse of the Urartian Empire, in which the Scythians were a major influence, probably introduced an advanced technology through the taking of slaves from this culture; this hypothesis cannot be proven at this time because there has never been a technological study of the artefacts from Urartu.

The use of tool marks can also produce a relative chronology in the production of artefacts and link various pieces, introducing the possibility of recognising the products of workshops not only through the artistic style which has been traditionally used. The variation in the technological level has also introduced a method for differentiating the products of a culture and discerning them from others, which was not previously possible through the simple analysis of the artistic styles.

The artefacts that were studied from Nymphaeum, a Greek colony, show that here two different technological levels were used for production. The minority were produced using pressing tools along with shearing tools, as is readily apparent in the production of the hare plaques and the necklace (1885.482). This reduces the production time and increases the quality of the produced artefacts. In the necklace it is also apparent that a jig was used to produce a standardization of the cloisonné panels. This was also the case with the Vettersfelde/Witaszkowo pendants. The standard size, which is also apparent in the gold wire used to produce the cloisonné, could have been produced by the use of a drawing plate, similar to those which have been discovered further west in Dacia. The type of rivet which was found to have fixed the petals has only been discovered on artefacts from the North Pontic region, indicating that this technique was applied only here with the use of a pressing tool. These artefacts can be attributed

[8] Jacobson 1995, 9.

to a Scytho-Greek metic who knew the techniques of production for Scythian jewellery, but applied them to artefacts produced in a Greek style for this necklace. The rest of the artefacts were produced in a labour-intensive method which resulted in variations within the desired form possibly indicating that they are products of a Greek craftsman.

Although the amount of material from controlled excavations studied at present is limited to Vettersfelde/ Witaszkowo and Nymphaeum, there are indications that the conventional belief that the "Barbarians" were technologically inferior to the Classical Greeks is a fallacy. The idea that the art style was influenced by the Greeks is undoubtedly true. The "masterpieces of Greek art" found in this region, however, probably owe more to the indigenous population than has previously been thought, through the technological innovations which have their origin in the Scythian culture.

The seven artefacts that were studied from Vettersfelde/ Witaszkowo proved that it is possible to construct a relative chronology through the wear that could be discerned in the tools with which the artefacts were decorated by the craftsmen. The redating of this hoard through the decorative motif of the Assyrian Ištar on the sword sheath and the Akinakes handle to the 7th century BC, not relying on the historical dating of this hoard which has been used ever since Furtwängler published his conclusions in 1883, is important. Through the tool marks the conclusion was drawn that the hoard came from a single individual and is not a collection that was buried together.

The results of the study of the Maikop hoard indicate that the majority of this material is likely to be modern forgeries. The technological techniques that were used to manufacture the majority of the artefacts studied do not conform to known ancient techniques. There are very limited numbers of matching tool marks and no evidence of reworking with engravers. The tool marks that could be linked have contradictions because the artefacts which were found to have links come from various stylistic regions, e.g. the sea-eagle-hunting-fish plaques and the opposed-lotus-blossom plaques. The former have been stylistically compared to the Seven Brothers kurgan and used to provenance the complete hoard to the Maikop region. The latter have been stylistically compared to Ionian Greek artefacts and are thought to have been manufactured in this region. The study of these artefacts, however, has shown that it is possible to discern modern reproductions from the tools that were used to manufacture them along with the techniques that were used by the craftsmen. The limited number of genuine artefacts that were identified by this study indicates a technological advance which has not been previously been considered for the north Pontic region. The use of a matrix and patrix to produce the small plaques resulted in the high quality reproduction with only a small variation due to the wear in the tools.

In the material studied from Nymphaeum it was apparent that two types of manufacturing were used to produce the artefacts. The Scytho-Greek technique used on necklace 1885. 482 may have used the pressing tool to produce the acorn beads and the rivets on account of their uniformity. The chain for this necklace was not produced in the standard method of a loop in loop – each individual link would have had to have been soldered in place and the risk of damage would have increased.

The rest of the artefacts studied from Nymphaeum were constructed with standard techniques used by Greek craftsmen. These techniques are labour-intensive and do not rely on technical innovation to ease the production of the artefacts. The hare and lion plaques were produced using a pressing tool which could have been constructed from bone or a hard wood.

The beaded wire used to decorate the flower petals on necklace 1885.502 was produced as a spiral beaded wire, while the wire itself was probably produced by twisting a square-sectioned wire to form a barley sugar form which was then rolled to produce a uniform round wire. The cloisonné used by the Greek craftsmen would have been produced either by hand or through the use of pliers for the free form cloisonné panels.

The gold strap necklace with seed-like pendants which was originally bought as a modern reproduction in the Greek style was found, upon examination, to be originally manufactured in the 4th century BC. Although this necklace has been damaged and repaired in recent times and the early history before it came into the hands of the present owners of this piece can not be reconstructed there are indications that it may have been produced by the craftsman who made the Great Blizniza finds [?] or even come from the same grave.

The necklace from Nikolaev has all the indications that it was produced by Scytho-Greek craftsmen because, although it is manufactured in a Greek style, the technical innovations are Scytho-Greek. The use of burnished drawn gold wire to produce the strap and the loop in loop chains along with the use of the pressing tool to form the uniform beads, shield and flower motifs are not typical of a purely Greek craftsman. It could have been manufactured by the "Great Blizniza Master" who was identified by Dyfri Williams because there are similarities which suggest that this necklace was constructed in a similar way as the pieces from the Blizniza Kurgan.

The results of the study of the material from the North Pontic Region shows that it is possible to sub-divide the manufacturing technology into four groups: Scythian, Scytho-Greek, Greek and modern forgeries. Each group has specific indicators in the manufacturing techniques listed below. The interpretation that the masterpieces of the classical world which have been discovered in Eastern Europe were all produced by Greek craftsmen is no longer valid.

Indicators of the culture that produced the artefact:

Scythian: indigenous art style with the introduction of external influences, casting, pressing, sheering, use of jigs, opposed swages.

Scytho-Greek: combining indigenous and Greek art style and production in pure Greek style, casting, pressing, sheering, use of jigs, opposed swages, rolling swages and lathe produced spiral beaded wire, possible use of drawn and burnished wire.

Greek: Labour-intensive, rolled wire, driving, rolling swages and free hand spiral beaded wire.

These variations in technology are due to the variation in the culture and the market which the artefact is being produced for. The Greek colonies were cultural mixtures, not independent from the indigenous cultures that surrounded them. The foundation of the Bosphoran Kingdom consolidated this, including the production of a society for which jewellery gave the elite prestige through technology. This technological level did not reach Western Europe until it was brought here by the migrating tribes after the collapse of the Roman Empire.

Bibliography

Akishev, K. A. 1978: (Акишев, К. А.) *Курган Иссык. Искусство саков Казахстана*. Москва.

Alekseev. V. A. & Kuznetsova E. F.1983: (Алексеев, В. А. & Кузнетсова, Е. Ф.) Кенказган, Древнии медны рудник в Централном Казахстане. *Советская археология*, № 2, pp. 203-212.

Amandry, P. 1954: *Stathatos collection. La Collection Hélène Stathatos. I. Les Bijoux Antiques. II. Les Objets Byzantins et Post-Byzantins. III. Objets Antiques et Byzantins*. Strasbourg.

Amyx**,** D. A. 1988: *Corinthian vase painting of the Archaic Period. 3 vols*. Berkeley.

Aristotle, *Politics*, translated by H. Rackham, 1932. Harvard.

Armbruster, B. 2006: Steingeräte des bronzezeitlichen Metallhandwerks. *Ethnographisch-Archäologische Zeitschrift*, 47.2, pp. 163-191.

Artamonow, M. 1970: *Goldschatz der Skythen in der Eremitage*. Prague, Leningrad.

Artamonov, M. I. 1974: *Cimmerians and the Scythians*. Leningrad.

Auberson, P. 1974: La reconstitution du Daphnéphoreion d´Erétrie. *Antike Kunst*, 17, pp 60-68.

Balaša, G. 1960: *Praveké osídlenie stredného Slovenska*. Bratislava.

Barlow, K. 1998: Sand casting. www.pride-net.com/1998/april/sculpture/casting.htm 22/07/2004

Beazley J.D. 1951: *The development of Attic Black figure*. Berkeley, Los Angeles.

Beazley J.D. 1956: *Attic Black-figure vase painters*. Oxford.

Beazley J.D. 1963: *Attic Red-Figure vase painters*. Oxford.

Biers, W. R. 1992: *Art, Artefacts and Chronology in Classical Archaeology.* New York.

Bintliff, J. & Snodgrass A. M. 1985: The Cambridge / Bradford Boeotia expedition: the first four years. *Journal of Field Archaeology* 12 pp 123-161.

Blochmann, H. 1873: *The Ā-īn-i-Akbarī, Abū L-Fazl*, Vol **1**. New Delhi.

Boardman, J. 1957: Early Euboean pottery and history. *Annual of the British School at Athens*, 52, pp 1-29.

Boardman, J. 1974: *Athenian Black Figure Vases*. London.

Boardman, J. 1980: *The Greeks Overseas: Their Early Colonies and Trade*. London.

Boardman, J. 1994: *The Diffusion of Classical Art in Antiquity*. Princeton.

Born, H. 1992: Zu den Herstellungstechniken der Armringe aus dem Bronzefund von Lengyeltóti/Ungarn. *Acta Prehistorica et Archaologica*, 24, pp. 289-294.

Boroffka, G. 1927: Der Skythische Tierstil. *Archäologischer Anzeiger* 1926 (1927), pp. 369-385.

Boroffka, G. 1928: Kunstgewerbe der Skythen. In: Bossert, H. Th. (Ed.), *Geschichte des Kunstgewerbes aller Zeiten und Völker*, 1. Berlin, pp. 101-157, pl. 8-11.

Boroffka, G. 1930: Wanderungen eines archaisch-griechischen Motives über Skythien und Baktrien nach Alt-China. In: *Fünfundzwanzig Jahre Römisch-Germanische Kommission. Zur Erinnerung an die Feier des 9.-11. Dezember 1927*. Berlin, Leipzig, pp. 52-81, pl. 6-17.

Boroffka, N. 1995: Descoperiri hallstattiene târzii la sud de Carpaţi. *Apulum*, 32, pp. 101-112.

Boroffka, N. 1998: Ein neues hallstattzeitliches Grab aus Siebenbürgen. *Arheološki Vestnik*, 49, pp. 93-100.

Boroffka, N. 2002: Mormântul hallstattian de la Batoş, jud. Mureş. *Angustia*, 7, pp. 233-240.

Boroffka, N. & Heck, G. 2006: Resursele minerale din România şi stadiul actual al cercetărilor privind mineritul preistoric. *Apulum*, 43.1, pp. 71-94.

Borovka, G. 1928: *Scythian Art*. New York

Bottema, S. 1974: *Late Quaternary vegetation history of north-western Greece*. Groningen.

Bottema, S. 1979: Pollen analytical investigations in Thessaly Greece. *Palaeohistoria*, 21, pp.19-40.

Bottema, S., Woldring, H., & Aytuğ, B. 1993: Late Quaternary vegetation history and climate in northern Turkey. *Palaeohistoria*, 35/36*,* pp.13-72.

Bradley, R. 1990: *The Passage of Arms. An archaeological analysis of prehistoric hoards and votive deposits*. Cambridge, New York, Port Chester, Melbourne, Sydney.

Brepohl, E. 1994: *Theorie und Praxis des Goldschmieds*. Leipzig, Köln.

Buchner, G. & Ridgeway, D. 1993: *Pithekoussai I: La Necropoli: Tombe 1-723 Scavate dal 1952 al 1961*. Rome.

Bukowski, Z. 1969: *Studia nad południowym i południowo-wschodnim pograniczem kultury łużyckiej*. Wrocław, Warszawa, Kraków.

Bukowski, Z. 1977: *The Scythian influence in the area of Lusatian culture*. Wrocław, Warszawa, Kraków, Gdańsk.

Buschor, E. 1930: Heraiion von Samos: Frühe Bauten. *Mitteilungen des Deutschen Archäologischen Instituts, Athenische Abteilung*, 55,.pp 1-99.

Buschor, E & Schleif, H. 1933: Heraion von Samos: Der Altarplatz der Frühzeit *Mitteilungen des Deutschen Archäologischen Instituts, Athenische Abteilung*, 58, pp 146-173.

Catling, R. 1984: New Archaeology. *Classical review*, 34, pp. 98-103.

Chernenko, E. V. 1980: (Черненко, Е. В.) *Древнейщие будет скифский церемониальными срагами (Мелыунов и Келермес)*. *Скифы и Кавказ*. Киев.

Chernenko, E.V. 1981: (Черненко, Е. В.) *Скифские лучники*. Киев.

Chernikov, S. S. 1949: (Черников, С. С.) *Древныаыа металлургиыа и горное дело Западного Алтаыа*. Алма-Ата.

Chernikov, S. S. 1960: (Черников, С. С.) Восточнои Казахстан в епоху бронзы. *Материая и иссиедования по археологя СССР*, **88**. Москва.

Chernykh, E. N. 1992: *Ancient Metallurgy in the USSR*. Cambridge.

Cherry, J. F. 1982: Appendix A. register of archaeological sites on Melos. In: Renfrew A. C. & Wagstaff, M. (Eds.), *An island polity*. Cambridge, pp. 291-309.

Childe, V. G. 1958: *The Prehistory of European Society*. Harmondsworth.

Codina, C. 2000: *Handbook of Jewellery Techniques*. London.

Codina, C. 2002: *Jewellery & Silversmithing Techniques*. London.

Cook, J. & Dupont J. P. 1998: *East Greek Pottery*. London.

Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property,www.un-documents.net/cppiiecp.htm 28/08/2010

Craddock, P. Meeks, N. Cowell, M. Middleton, A. Hook, D. Ramage, A.& Geçkinli, E. 1998: The refining of gold in the Classical world. In: Williams, D. (Ed.), *The art of the Greek Goldsmith*. Cambridge, pp. 111-122.

Denisova V.I 1987: (Денисова, В. И.) Раскопки в Ольвии. *Археологические открытия*, 1985, pp 327-328.

Diodoros, *Library of History, V books 12.41-13*. Translated by C. H. Oldfather. Harvard.

Domanskii, Yu. V., Vinogradov, Y. G, & Solovyov, S. L. 1989: (Доманскии, Ю. В. Виноградов, Ю. Г. & Соловьов, С. Л.) Главныйа итог Березан експедизиа. Smirnova, G. I. [Смимоыа, Г. Л.] (Ed.), (*Главныйа итог археологических экспедиций положения Ермитаж.* Ленинград, pp. 33-60.

Dugas, C. 1952: *Exploration archéologique de Delos XXI: les vase attiques à figures rouges*. Paris.

Dušek, M. 1956: *Der Eingriff der Skythen in der hallstattzeitliche Entwicklung in der Slovakei*. Prague.

Dušek, M. 1964: Einfluss der Thraker auf die Entwicklung im Karpatenbecken in der jüngeren Hallstattzeit *Bratislova Archeologicznego Istitute*, 27, pp.55-76.

Eckhardt, H. 1996: *Pfeil und Bogen. Eine archäologisch-technologische Untersuchung zu urnenfelder- und hallstattzeitlichen Befunden*. Internationale Archäologie, 21. Espelkamp.

Eusebius Armeniun. Chronicle

Farmakovskiy B. Y.. 1914: (Фармаковкий, Б. В) Археологическая карта Причерноморья Украинской ССР. *Материалы по археологии России*, 34. Москва.

Feininger, A. 1979: *Feiningers grosse Fotolehre*. Ulm.

Fettich, N. 1934: *Der Skythische Fund von Gartschinow*. Budapest.

Forbes, H. 1996: The uses of uncultivated landscapes in modern Greece: a pointer to the value of the wilderness in Antiquity. In: Shipley, G. & Salmon,, J. B. (Eds.), *Human Landscapes in Classical Antiquity*. London, New York, pp. 68-97.

Fossey, J. M. 1986: The ancient topography of Eastern Phokis. Amsterdam.

Francis, E. D. & Vickers, M. 1983: Signa priscae artis: Eretria and Siphnos. *Journal of Hellenstic* studies, 103, pp. 49-67.

Francis, E. D. & Vickers, M. 1985: Greek Geometric Pottery at Hama and its Implications for Near Eastern Chronology. *Levant*, 17, pp. 131-138.

Francis, E. D. &. Vickers, M. 1988: The Agora revisited: Athenian chronology c. 500-450 BC. *Annual of the British School at Athens*, 83, pp 143-167.

Freir, F. 1985: *Fotografieren lernen, Sehen lernen*. Köln.

Furtwängler, A. 1883: *Der Goldfund von Vettersfelde*. Berliner Winckelmannsprogramm, 43. Berlin.

Galanina, L.K. 1997: *Die Kurgane von Kelermes. „Königsgräber" der frühskythischen Zeit*. SteppenVölker Eurasiens, 1. Moskau. / Л. К. Галанина, Келермесские курганы. «Царские» погребения раннескифской эпохи. *Степные народы Евразии*, 1. Москва.

Gardner E. A. 1884: Ornaments and armour from Kerch in the new Museum. *Journal of Hellenic Studies*, 5, 1884, pp.62-73, Pls. 46-7.

Gautier, Yu. V. 1925: (Гаутиер, Ю. В.) Описания *на истории материалной культуры восточного Европе*. Ленинград.

Ginters, W. 1928: *Das Schwert der Skythen und Saramaten in Südrussland*. Vorgeschichtliche Forschungen, 2. Berlin.

Glodariu, I. & Iaroslavschi, E. 1979: *Civilizaţia fierului la Daci (sec. II î.e.n. - I e.n.)*. Cluj-Napoca.

Goldmann, K. 1981: Guß in verlorener Sandform – das Hauptverfahren alteuropäischer Bronzegießer? *Archäologisches Korrespondenzblatt*, 11, pp. 109-116.

Graef, B. & Langlotz, E. 1925: *Die antiken Vasen von der Akropolis zu Athen*, 1. Berlin.

Graham A. J. 1964: *Colony and Mother City in Ancient Greece*. Chicago.

Graham A. J. 1982(a): The colonial expansion of Greece. In: Boardman, J. & Hammond N. G. L. (Eds.), *Cambridge Ancient History*, 3. Cambridge, pp. 162-195.

Graham A.J. 1982(b): The Western Greeks. In: Boardman, J. & Hammond N. G. L. (Eds.), *Cambridge Ancient History*, 3. Cambridge, pp. 83-162.

Greaves, A.M. 2002: *Miletos, a history*. London, New York.

Greifenhagen, A. 1970: *Schmuckarbeiten in Edelmetall 1. Fundgruppen*. Berlin.

Greifenhagen, A. 1982: Centenarium eines Goldfisches. *Antike Welt* 13. pp 3-9

Hančar, A. 1972: Die Bogenwaffe der Skythen (Aus dem Nachlaß F. Hančars, Universität Wien 1938-1968).

Mitteilungen der Anthropologischen Gesellschaft in Wien, 102, pp. 3-25, pl. 1-5, Table 1.

Hanfmann, G. M. A. 1963: The Iron Age Pottery of Tarsus. In: Goldman, H., *Excvations at Gözlu Kule, Tarsus* III. *The Iron Age*. Princeton, pp. 18-332

Hartmann. A. 1970: *Prähistorische Goldfunde aus Europa **3***. Berlin.

Hartmann, A. 1982: *Prähistorische Goldfunde aus Europa **II,5***.Berlin.

Hecht, E. & Zajac, A. 1974: *Optics*. Reading, Mass.

Helm, R. *Die Chronick des Hieronymus. Eusebius werk,* Berlin 1956

Hensel, W. 1969: *Polish lands in prehistory*. Warsaw.

Herodotus IV, V, IX: translated by A. D. Godley, 1921. Cambridge, Mass., London.

Higgins, R. A. 1961: *Greek and Roman Jewellery*. London.

Hoffman, H. 1969: Greek Gold reconsidered. *American Journal of Archaeology*, 73, pp. 447-451.

Illins´ka, V. A. 1973: (Іллінська, В. А.) Бронзові наконечники стріл так званого жаботинського і новочеркаського типів. *Археологія (Київ)*, 12, pp. 13-26.

Isager, S. & Skydsgaard, J.1992: *Ancient Greek Agriculture*. London.

Jacobi, G. 1979: Drahtzieheisen der Latènezeit. *Germania*, 57, pp. 111-115.

Jacobson, E. 1995: *The art of the Scythians. "The interpenetration of cultures at the edge of the Hellenic World"*. Leiden, New York, Köln.

Jahn, M. 1928: Die Skythen in Schlesien. *Schlesiens Vorzeit in Bild und Schrift*, 9, pp.11-25.

Jantzen, U.1972: *Ägyptische und orientalische Bronzen aus dem Heraion von Samos*. Mainz.

Jentsch, H. 1883: Prähistorisches aus den Kreisen Guben, Sorau, Crossen und den Namen Heinchen. *Zeitschrift für Ethnologie (Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte)* 15. pp.286-289.

Jentsch, H. 1884: Gubener Altertümer. *Zeitschrift für Ethnologie (Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte)*, 16, pp. 13-16.

Jentsch, H. 1915: Zum Goldfund von Vettersfelde, Kr Gruben. *Zeitschrift für Ethnologie (Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte)*, 47, pp 306-312.

Jessen, A.A. 1947: *Greek colonization of the North Black Sea Area*. Leningrad.

Johansen, K. 1957: Exochi: Ein frühRhodisches Gräberfeld. *Acta Archaeologica,* 28, Copenhague. pp. 1-192.

Jones R & Wykes C, *Holographic and Speckle Interferometry*, 1989, Cambridge.

Jüngst, H. 1981: *Wesen und Wandlungen des "Chrysocolla" Begriffs*. Frankfurt am Main.

Kadeev, Y. I. 1970: (Кадеев, Ю. И.) *Очеркц цсторцц экономцкцz Херсонеса в 1-4 веках*. Харков.

Kossack, G. 1987: Von den anfängen des Skytho-iranischen Tierstils. In Franke, H. (Ed) *Skythika.* München. Pp. 24-86.

Krause, E. 1883: Fundstelle der Vettersfelde Goldsachen. *Zeitschrift für Ethnologie (Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte)*, 1883, pp. 488-490.

Krÿzhitkii, S.D. 1982: (Крыиткий, С.Д.) *Житые дома античных городов северного причерноморья*. Киев.

Kul´kova, T. 1963: (Кулкова, Т.) *Микро- химический анализ предметов золота: новый метод археологического исследования*. Москва, Ленинград

Kull, B. 1997(a): Die Sieldlung Opişor bei Turnu Severin (Rumänien) und ihre Bedeutung für die thrakische Toreutik. Mit einem Fundbericht von I. Stîngă. *Germania*, 75.2, pp. 551-584.

Kull, B. 1997(b): Tod und Apotheose. Zur Ikonographie in Grab und Kunst der jüngeren Eisenzeit an der unteren Donau und ihrer Bedeutung für die Interpretation von „Prunkgräbern". *Bericht der Römisch–Germanischen Kommission*, 78, pp. 197-466.

Lang, A. 1976: Zur Chronologie frühskythischer Funde im Karpatenbecken und an der unteren Donau. In: *Actes du II^e Congrès International de Thracologie (Bucarest, 4-10 septembre 1976) Vol. I. Histoire et archéologie*. Bucureşti, pp. 229-233.

La Niece, S. 1993: Silvering. In: La Niece, S. & Craddock, P. (Eds.), *Metal plating and patination: Cultural, technical and historical developments*. Oxford, pp. 201-210.

Lappo-Danilevskiĭ, A. & Mal´mberg, V. 1894: (Лаппо-Данилевский А. & Мальмберг В), Курган Карагодеуашх.. *Материалы по археологии Россиu*, 13. Санкт-Петербург, pp. 1-118.

Larson, E. B. 1987: The Gundestrup Cauldron, Identification of Tool Traces. In: Black, J. (Ed.), *Jubilee Conservation Conference papers. Recent Adventures in the Conservation and Analysis of Artefacts*. London, pp 398-408.

LeConte, J. 1862: *Instructions for the manufacture of Saltpetre*. Columbia, S.C.

Leigh, D 1990:Aspects of early brooch design and production. In: Southworth, E. (Ed.) *Anglo-Saxon Cemeteries*. Oxford, pp.109-115.

Leskov, A. 1990: *Grabschätze der Adygeen : neue Entdeckung im Nordkaukasus 1981-1983*. München.

Leskov, A. & Lapushnian V. L. 1985: (Лесков, А. & Лапушниан, В. Л.) *Шедевры древнего искусства Кубани: каталог выставки*. Москва.

Lindner, G. 1958: *Wir Fotografieren*. Gütersloh.

Littledale, A. 1934: A new process of hard-soldering and its possible connection with the methods used by the Ancient Greeks and Etruscans. In: *The scientific and technical factors of production of gold and silver work*. London, pp. 44-63.

Litvinsky, B.A: 1950: (Литвинский, Б. А.) К истории добычи олова в Узбекистане. *Труды Среднеазаитского Государственного Университета (Ташкент), Новая серия XI, Гуманитарные науки*, 3, pp. 51-67.

Levina, E. A., Ostroverkhoye, A. S. & Gedina, Ye. F. 1993: (Левина, З. А., Островерхов, А. С. & Редина,

Е. Ф.) О Производстве изделий в зверином стиле на территории Ольвийского Полиса. In: *Древности Причерноморских Степей.* Киев, pp. 86-90.

Lukonin, V. G. 1977: (Луконин, В. Г.), *Искусство древнего мцра*. Ленцнград.

Lyutsenko, A. 1870: (Лютсенко, А.) Древности. *Труди Московского Археологческии Обшества*, II, pp. 54-55.

McKechnie, T.S. 1976. Image-plane speckle in partially coherent illumination. *Optical and Quantum Electronics* 8:61-67

McCreight, T. 1998: *Jewellery fundamentals of metalsmithing*. London.

Malinowski, T. 1964: Możliwości interpretacyjne znaleziska złotych przedmiotów scytyjskich w Witaszkowie. *Wiadomości Archeologiczne*, 30, pp 215-230.

Marchetti, C. 2005: *Human Population Dynamics Revisited with the Logistic Model: How much can be modeled and predicted*. New York

Marinescu, G. 1984: Die jüngere Hallstattzeit in Nordostsiebenbürgen. *Dacia N.S.*, 28, pp. 47-83.

Marton, L. V. 1907: A Féregyházi Öskori Aranylelet. *Archaeeologiai Értesitö***, 27**, pp 57-68.

Mattingly, D. 1996: First fruit? The olive in the Roman world. In: Shipley, G. & Salmon, J. (Eds.) *Human Landscapes in Classical Antiquity*. London, New York, pp. 213-253.

Mazarakis-Ainian, A.1997: *From Ruler´s dwellings to Temples: Architecture, Religion and Society in Early Iron Age Greece*. Jonsered.

Meeks, N. 1998: A Greek Gold Necklace: A case of Dual identity. In: Williams, D. (Ed.), *The art of the Greek Goldsmith*. London, pp. 7-138

Meeks, N. 2000: Scanning Electron Microscopy of the Refractory Remains and the Gold. In: Ramage, A. & Craddock, P. (Eds.) *King Croesus' Gold: Excavations at Sardis and the History of Gold Refining*. Archaeological Exploration at Sardis, Monographs, 11. London, pp. 99-151.

Meliukova A. I. 1958: (Мелюкова, А. И.) Памятники скифского времени лесостепного средного Поднестровья. In: *Памятники Скифо-Сарматского времени в Севенном Причерноморье.* Материалы и Исследования по Археологии СССР, 64. Москва, pp. 5-102.

Meliukova, A. I. 1964: (Мелюкова, А. И.) *Вооружение скифов*. Археология СССР. Свод Археологических Источников, Д 1-4. Москва.

Meliukova A. I. 1972: (Мелюкова, А. И.) О датировке и соотношении памятников начала железного века в лесостепной Молдавии. *Советская археология* , № 1, pp. 57-72.

Melles Griot 1995/1996: *The practical application of light*. New York.

Mihăilescu-Bîrliba, V. 1976: The akinakai of Moldavia. A new discovery. In: Recueil d´études à l´occasion du II^{e} Congrès International de Thracologie (Bucarest, 4-10 septembre 1976. *Thraco-Dacica*, 1. Bucureşti, pp. 109-116.

Mikov, V. 1958: *Le trésor d'or de Valcitran*. Sofia.

Milojčič, V. 1953: Ein Goldfund der Kupferzeit aus Ungarn. *Germania*, 31, pp 7-11.

Minns, E. H. 1913: *Scythians and Greeks*. Cambridge.

Minns, E. H. 1942: *The art of the Northen Nomads*. Leningrad.

Morintz, S. & Şerbănescu, D. 1985: Rezultatele cerctărilor de la Radovannu, punctual "Gorgana a doua" (jud Călăraşi) 1. Aşezarea din epoca bronzului 2. Aşezarea geto-dacică. *Thraco-Dacia,* ***6***, pp. 5-30.

Nagler, A. 1996: *Kurgane der Mozdok-Steppe in Nordkaukasien*. Archäologie in Eurasien, 3. Espelkamp.

Nebelsick, L. D. 2002: *The geography of treasure: Finding a context for the Witaszkovo/Vettersfelde Hoard. a progress report*. Dresden

Oddy, A. 1997: The Production of Gold Wire in Antiquity. *Gold Bulletin*, **10(3)**, pp. 79-87.

Ogden, J. 1982: *Jewellery of the Ancient World*. London.

Ol'khovskiy, V. S. & Yevdokimov, G. L. 1994: (Олвховский, В. С. & Евдокимов, Г. Л.) *Скифские изваяния*. Москва.

Ostroverkhov, A. S. 1989: (Островерхов, А. С.) *Стекло архаического Беразан*. Odessa.

Ottaway, B.S. 2002: Towards interpretative archaeometallurgy. In: Bartelheim, M., Pernicka, E. & Krause, R. (Eds.), *Die Anfänge der Metallurgie in der Alten Welt / The beginnings of metallurgy in the Old World*. Forschungen zur Archäometrie und Altertumswissenschaft, 1. Rahden/Westf., pp.7-13.

Özgen, I. & Öztürk, J. 1996: *Heritage Recovered. The Lydian Treasure*. Istanbul.

Parke, H. W. 1985: *The oracles of Apollo in Asia Minor*. London.

Parzinger, H. 1997: Sejma-Turbino und die Anfänge des sibirischen Tierstils. *Eurasia Antiqua*, 3, pp. 223-247.

Parzinger, H. 1993: Vetterfelde - Mundolsheim - Apres-lés-Corps, Gedanken zu einem skythischen Fund im Lichte vergleichender Archäologie. In: Lang, A., Parzinger, H. & Küster, H. (Eds.), *Kulturen zwischen Ost und West. Das Ost-West-Verhältnis in vor- und frühgeschichtlicher Zeit und sein Einfluß auf Werden und Wandel des Kulturraums Mitteleuropa. Georg Kossack zum 70. Geburtstag am 25. Juni 1993*. Berlin, pp. 203-237.

Parzinger, H. & Boroffka, N. 2003: *Das Zinn der Bronzezeit in Mittelasien I. Die siedlungsarchäologischen Forschungen im Umfeld der Zinnlagerstätten*. Archäologie in Iran und Turan, **5**. Mainz am Rhein.

Payne, H. G. G. 1931: *Necrocorinthia: A study of Corinthian art in the Archaic period*. Oxford.

Pemberton, E. 1981: The Attribution of Corinthian Bronzes. *Hesperia*, 50, pp.101-111.

Perea, A. 2004: The first Millenium B.C. technological domain systems in the Iberian Peninsula: Gold workshops and Production. In: Lehoërff, A. (Ed.), *L´artisanat métallurgique dans les sociétés anciennes en Méditerrannée occidentale. Techniques, lieux et*

formes de production. Collection de l´École Française de Rome, 332. Rome, pp. 33-43

Perevodchikova, E. V. 1994: (Переводчикова Е. В.) *Очерки искусства евразийских степей скифской злохи*. Москва.

Piotrovskiy B. B. 1959: (Пиотровскиы, Б. Б.) Ванскоые тсарстыо. Москва.

Pliny the Elder, *Natural history 5*. Translated by J. Bostock, 1855. London.

Plutarch, *Moralia*, Volume IV. Translated by C. Frank. 1936. Harvard.

Polacký, F. 1867: *Dějiný národu českého v Čechách a na Moravě, Vol 1*. Praque.

Popescu, D. 1958: Problema sciţilor din Transilvania in opera lui Vasile Pârvan. *Studii şi Cercetări de Istorie Veche*, 9, pp. 9-38

Popescu, D. 1962: Autour de la question des Scythes en Transylvanie. *Dacia N.S.*, 6, pp. 443-455.

Potter, T. W. 1979: *The changing landscape of South Etruria*. London.

Potts, P. J. A. 1987: *Handbook of silicate rock analysis*. New York

Pridik, E. 1911: (Придик, Е.), Мельгуновский клад 1763 г. *Материалы по археологии России*, 31. Москва.

Rau, P. 1929: *Die Gräber der frühen Eisenzeit im unteren Wolgagebiet. Studien zur Chronologie der skythischen Pfeilspitze*. Mitteilungen des Zentralmuseums der Aut. Soz. Räte-Republik der Wolgadeutschen / Известия Центрального Музея Авт. Советск. Республики Немцев Поволжья, 4.1. Pokrowsk.

Redfern, D. 1993: *a comparative study of tool marks from two Anglo-Saxon grave yards in Northern Britain*, unpublished BA dissertation Durham University

Reeves, A. A. 1990: *Optimized Fast transform of the MC68000 with applications in image Processing*. Honover, New Hampshire.

Reinecke, P. 1896 Die skythischen Alterthümer im mittleren Europa. *Zeitschrift für Ethnologie*, 28, pp. 1-43, Pl. 1.

Roeder, M. 1997: Zur Bedeutung der im Basarabi-Stil verzierten Keramik. Heiligtümer in der Hallstattzeit? In: Becker, C., Dunkelmann, M.-L., Metzner-Nebelsick, C., Peter-Röcher, H., Roeder, M. & Teržan, B. (Eds.), *Χρόνος. Beiträge zur prähistorischen Archäologie zwischen Nord- und Südosteuropa. Festschrift für Bernhard Hänsel*. Internationale Archäologie. Studia honoraria, 1. Espelkamp, pp. 601-618.

Rolle, R., Müller-Wille, M. & Schietzel, K. 1991: *Gold der Steppe. Archäologie der Ukraine*. Neumünster.

Rolle, R., Murzin, V. Ju. & Alekseev, A. Ju. 1997: *Königskurgan Čertomlyk. Ein skythischer Grabhügel des 4. vorchristlichen Jahrhunderts*. Hamburger Forschungen zur Archäologie, 1 (1997). Mainz.

Rostovtzeff, M. 1973 reprint (1929): *The animal style in South Russia and China*. Princeton, London.

Rostovtzeff, M. 1922: *Iranians and Greeks in South Russia*. Oxford.

Rostovtzeff, M. 1925: *Skythien und der Bosporus*. Berlin.

Rostovtzeff, M. 1932: *Caravan Cities*. Oxford.

Rostovtzeff, M. 1931: *Skythen und der Bosporus I*. Berlin.

Rudolph, W. 1995: *A Golden Legacy: Ancient Jewellery from the Burton Y. Berry Collection at Indiana University*. Bloomington.

Rustoiu, A. 1996: Metalurgia bronzului la Daci (sec. II î. Chr. - sec. I d. Chr.). Tehnici, ateliere şi produse de bronz. *Bibliotheca Thracologica*, 15. Bucureşti.

Rybakova V. D. 1961: (Рыбакова В. Д.), *О связях правобережной лесостепной Украины с централной Европой в эпоху бронзы и раннего железа*. Ленинград.

Šafařik, P. J 1837: *Slovanské starožitnosti, Vol. 2*. Praha.

Savage, R. D. A. Lowery, P.R. & Wilkins, R. L. 1976: The Technique of the decoration on a belt plate from Vognserup, Kundby sogn, Tuse herred, Zealand. In *Archaeologia*, 13, pp. 459-469.

Saverkina, I. I. 2001: (Саверкина, И. И.) Греческие ожерелья на рубеже классики и эллинизма. In: Захарова, Н. (Ed.), *Ювелирное искусство и материальная культура. Сборник статей*. Санкт-Петербург, pp. 95-103.

Seger, H. 1926: Völker und Völkerwanderung im vorgeschichtlichen Ostdeutschland. *Der ostdeutsche Volksboden*, 2, pp. 78-84.

Scheider, P.1996: Zum alten Sekos von Didyma. *Istanbuler Mitteilungen*, 46, pp. 147-152.

Shaley, S. 1993: The earliest gold artefacts in the southern Levant: reconstruction of the manufacturing process. In: *Outils et ateliers d´orfèvres des temps anciens*. Paris, pp.9-12.

Simion, G. 2003: Gètes et Scythes aux Bouches du Danube. In: Simion, G., *Culturi antice în zona Gurilor Dunării. Volumul I Preistorie şi protoistorie*. Biblioteca Istro-Pontică, 5. Tulcea, pp. 247-258.

Smirnov, J. I. 1934: Сокровище изАхалгори. Tiflis.

Stark, J. & Smith, J. 2000: *Classical loop in loop chains and their derivatives*. London.

Stoddert, K. 1975: "From the lands of the Scythians". *The Metropolitan Museum of Art Bulletin*, 32.5. New York.

Stos-Gale, Z. A. 1998: The role of Kythnos and other Cycladic islands in the origins of Early Minoan metallurgy. In: Mendoni, L. G. & Mazarakis-Ainian, A. (Eds.), *Proceedings of the 1994 International Symposium "Kea-Kythnos:Historical and Archaeological Research"*. Meletemata, **27**. London, pp 72-92.

Sulimirski, T. 1936: *Scytowe na zachodniem Podolu*. Prace Lwowskiego Towarzystwa Prehistorycznego, 2. Lwów.

Székely, Z. 1954: *Ádátok á Dákok késő vaskori máveltségéhez*. Csikszereda.

Telge, P. 1885: *Prähistorische Funde in gesetzlich geschützten Nachbildungen*. Berlin.

Temizsoy, I. 1988: *The Anatolian Civilisations Museum*. Ankara.

Themelis, P. G. 1979: Anaskaphi Eretrais. *Praktika*, 135, pp. 40-55.

Thucydides, *History of the Peleponnesian War, III, Books 5-6***.** Translated by C. F. Smith. 1921 Harvard

Trantalidou, C. 1990: Animals and human diet in the prehistoric Aegean. In: Hardy, D. A. (Ed.), *Thera and the Aegean World*, 3, pp. 392-405.

Treister, M. Y. 1996: *The Role of Metals in Ancient Greek History*. Leiden, New York, Köln.

Treister, M. & Vickers, M. 1996: Stone matrices with griffins from Nymphaeum and Euesperides. *Colloquia Pontica*, 1, pp. 135-141.

Tuchelt, K. 1973: Vorarbeiten zu einer Topographie von Didyma. *Instabuler Mitteilung*, *Beiheft*, 9. Tübingen.

Turaev, B. A. 1911: (Тураевъ, Б. А.), Скарабеи съ о. Берзани. Известия Императорской Археологической КомиссIи, 40. pp 118-120.

Untracht, O. 1985: *Jewelry concepts and technology*. London

Untracht, O. 2008: *Metal Techniqueas for Craftsmen; A basic manual on the methods of forming and decorating metals*. London.

Vallet, G. & Villard, F. 1952: Les dates de fondatation de Megara Hyblaea et de Syracuse. *Bulletin de Correspondance Hellénique*, 76, pp. 289-346.

van Zeist, W. & Bottema, S. 1982: "Vegetational history of the Eastern Mediterranean and Near East during the last 20000 years". In: Bintliff J. L. & Van Zeist, W.(Eds.), *Palaeoclimates, palaeoenviroments and human communities in the Eastern Mediterranean Regions in later prehistory*. British Archaeological Reports, 133, pp 277-321.

Vasiliev, V. 1980: *Sciţii agatîrşi pe teritoriul României*. Cluj-Napoca.

Vasiliev, V. 1989: Problèmes de la chronologie du Hallstatt sur le territoire de la Roumanie. *Apulum*, 25, pp. 83-102.

Vasiliev, V. 1994: Despre câteva opinii referitoare la cronologia primei epoci a fierului în Transilvania / À propos de quelques opinions concernant la chronologie du premier Âge de Fer en Transylvanie. *Acta Musei Napocensis*, 31.1, pp. 37-47.

Vasiliev, V. 1999: Betrachtungen zur Chronologie der älteren Eisenzeit in Siebenbürgen In: Boroffka, N. & Soroceanu, T. (Eds.), *Transsilvanica. Archäologische Untersuchungen zur älteren Geschichte des südöstlichen Mitteleuropa. Gedenkschrift für Kurt Horedt*. Internationale Archäologie, Studia honoraria, 7. Rahden/Westf., pp. 173-179.

Vickers, M. 1979: *Scythian treasures in Oxford*. Oxford.

Vickers, M. 1985: Artful crafts: the influence of metalwork on Athenian painted pottery. *Journal of Hellenic Studies*, 105, pp. 108-128.

Vickers, M. 2004: Was ist Material wert; Eine kleine Geschichte über den Stellenwert griechischer Keramik. *Antike Welt* **35 (2)**, pp. 63-69.

Vickers, M. & Gill, D. 1996: Bocchoris the Wise and absolute chronology. *Römische Mitteilunggen* **103**, pp. 1-9.

Vinogradov, V. B 1963: (Виноградов, В. Б.) *Сарматы Северо-Восточного Кавказа*. Грозный.

Vinogradov, V. B. 1972: (Виноградов, В. Б.) Поздненеолитическая стоянка Орловка. *Советская археология*, № 4, pp. 254-258.

Vinogradov, Yu. G. 1989: ((Виноградов, Ю. Г.) *Политическая история ольвийского полиса VII-I вв. до н.э*. Москва.

Vulpe, A.1967: *Necropola hallstattiană de la Ferigile. Monografie arheologică*. Biblioteca de Arheologie, 11. Bucureşti.

Vulpe, A. 1970: Archäologische Forschungen und historische Betrachtungen über das 7. bis 5. Jh. im Donau-Karpatenraum / Cercetări arheologice şi interpretări istorice privind sec. VII-V î.e.n. în spaţiul carpato-dunărean. *Memoria Antiquitatis*, 2, pp. 115-213 and fig. 1-12.

Vulpe, A. 1972: Observaţii privitor la analiza antropologică a osemintelor incinerate din mormintele hallstattiene de la Ferigile. *Buridava*, 1, pp. 269-272.

Vulpe, A.1979: Review: B. Hänsel, Beiträge zur regionalen und chronologischen Gliederung der älteren Hallstattzeit an der unteren Donau. Beiträge zur Ur- und Frühgeschichtlichen Archäologie des Mittelmeer-Kulturraumes 16-17 (Bonn 1976). *Germania*, 57, pp. 207-215.

Vulpe, A. 1990: *Die Kurzschwerter, Dolche und Streitmesser der Hallstattzeit in Rumänien*. Prähistorische Bronzefunde, VI.9. München.

Whitfield, N. 1985: Recent research in Jewellery Studies. In: *Society of Jewellery Historians Third international Symposium on the history of jewellery materials and techniques*. pp. 13-28 London.

Wille, M. 1995: Pollenanalyses aus dem Löwenhafen von Milet. *Archäologischer Anzieger*, 1995, pp. 330-333.

Williams, D. 1998: *The art of the Greek Goldsmith*. Cambridge.

Williams, D. & Ogden, J. 1994: *Greek Gold: Jewellery of the Classical world*. New York.

Whitley, J. 2005: *The Archaeology of Ancient Greece*. Cambridge.

Wollmann, V. 1996: Mineritul metalifer, extragerea sării şi carierele de piatră în Dacia Romană / Der Erzbergbau, die Salzgewinnung und die Steinbrüche im römischen Dakien. *Bibliotheca Musei Napocensis*, 13. *Veröffentlichungen aus dem Deutschen Bergbau-Museum Bochum*, 63. Cluj-Napoca / Klausenburg.

Zurowski, K. 1973: Methoden zum Weichmachen von Geweih und Knochen in frühslawischen Werkstätten. In: Herrmann, J. & Otto, K.-H. (Eds) *Berichte über den II. Internationalen Kongreß für Slawische Archäologie Berlin August 1970 III*. Berlin, pp.483-490.