# MEROVINGIAN GARNET JEWELLERY

By *Birgit Arrhenius*

KUNGL. VITTERHETS HISTORIE OCH ANTIKVITETS AKADEMIEN

Merovingian
Garnet Jewellery

Golden sword-pommels with garnet cloisonné manufactured in Frankish workshops in the sixth century and found in Sweden. Evidences are given in this work that these finds are indications of diplomatic relations between the Merovingians and Swedish chieftains.
From left to right Sturkö, Blekinge (Swed 16), Väsby, Uppland (Swed 13) and Hög Edsten, Bohuslän (Swed 21). Slightly larger than 1:1.

# MEROVINGIAN GARNET JEWELLERY

## emergence and social implications

By *Birgit Arrhenius*

with diffraction analysis by Diego Carlström

KUNGL. VITTERHETS HISTORIE OCH ANTIKVITETS AKADEMIEN

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*ABSTRACT*

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This book deals with different aspects of Merovingian garnet jewellery. The work is based on diffraction analyses of garnets and cements and on a study of technical elements in cloisonné settings. The origins of the garnets are discussed in chapter 1. Three sources for garnets with different physical qualities are recognized in the Merovingian material, two in Central Europe (in Bohemia and possibly in South-West Austria) and the third in the Black Sea area. Indian garnets, which were used mostly for intaglios in the Hellenistic period, are not found in this material. This may be explained by the necessity to use garnets which can be cleaved to produce thin, flat plates in cloisonné work. The different shapes into which garnets are cut are described in chapter 2. It is proposed that the cutting was carried out with a high-speed wheel. Chapter 3 lists the cements and sand putties used in cloisonné work. In chapter 4 the prerequisite conditions which indicate a cloisonné workshop are discussed and a hypothetical system comprising a central workshop with satellite workshops is presented. In the central workshop garnets are cut from templets and are often assembled into emblemata; objects of the highest quality, often with royal associations (such as the Childeric finds) are made in these workshops. Cut garnets and emblemata are imported to the satellite workshops where they are mounted in single, locally made objects. A central workshop situated in Constantinople is proposed as the source of cloisonné objects made in the cement technique with satellite workshops in Hungary and the Rheinland. Chapter 5 and 6 describe cloisonné jewellery made in the Merovingian Empire in the sixth century. The different types of sand putty used in these works allow several workshops to be recognized. It is proposed that a central workshop, characterized by garnets which were probably brought from Bohemia and were usually cut from f-St and g-St templets, was situated in Trier. Its satellite workshops were located in the Rheinland, the Upper Danube region, the North Sea area, Anglo-Saxon Kent as well as in Scandinavia. The organization of Merovingian workshops is discussed in chapter 7. The importance of cloisonné jewellery as gifts at a royal level or on the occasion of exogamy is analysed and the implications of this for the distribution of garnet cloisonné outside the Merovingian Empire is discussed.

*Assistant professor Birgit Arrhenius,* Arch. research laboratory, University of Stockholm, S-106 91 Stockholm, Sweden


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To the memory of
my parents

# Contents

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Fig. 10, British Museum; fig. 40, Musée de Cluny; fig. 41–42, Römisch-Germanisches Museum, Cologne; fig. 43, Victoria & Albert Museum; fig. 54, Römisch-Germanisches Zentralmuseum, Mainz; fig. 56, Liverpool City Museum; fig. 65–67, Bibliothèque Nationale; fig. 75, Liverpool City Museum; fig. 78, Institute of Archeology, Durham; fig. 103, Magyar Nemzeti Museum; fig. 131, Römisch-Germanisches Zentralmuseum;

Fig. 144–145, Historical Museum, Lund; fig. 195, Fries Museum, Leuwarden; fig. 205, The Cathedral in Trier; fig. 206, Basilique Notre-Dame, Tongeren.

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# Preface

This study started in 1958: on the excavations at Helgö directed by Professor Wilhelm Holmqvist, I had found a tiny piece of a garnet which caught my interest. My first study was concentrated to Nordic finds with garnet inlays and it was supervised by Professor Mårten Stenberger at Uppsala.

A few years later Professor Joachim Werner, Munich, who has always taken a kind interest in my work, offered me the opportunity to study in Germany. This enabled me to examine cloisonné jewellery from Germany and France using the techniques I had developed. I stayed for longer sessions in Römisch-Germanisches Zentralmuseum in Mainz, where Professor Kurt Böhner generously shared with me his extensive knowledge of Merovingian archaeology. When I subsequently obtained a post in Statens Historiska Museum, Stockholm, I had the chance in connection with exhibitions, to examine further finds from different museums around Europe. Scholarships enabled me to study for longer periods in Italy and Great Britain.

In 1971 I presented my doctoral dissertation "Granatschmuck und Gemmen in Nordischen Funden des frühen Mittelalters" under Professor Greta Arwidsson at the University of Stockholm. My intention was now to pursue my mineralogical studies of garnets, which I had started with Professor Otto Mellis and to publish the Merovingian cloisonné jewellery I had examined. Dr. Ilona Kovrig, however, invited me to examine the splendid finds from Szilágy Somlyó in Hungary and this inspired me to penetrate further into the garnet cloisonné jewellery from Eastern and South-Eastern Europe. These studies as well as the initiation of a research laboratory at the University of Stockholm delayed the final publication.

I have greatly benefitted, from the persons I have met during these studies in different museums and institutions. I want to mention especially the following: Director Dr. W. Angeli, *Austria;* Prof. Dr. H. Roosens, Prof. M.E. Mariën, *Belgium;* Dr. E. Muncksgaard, Dr. M. Ørsnes, *Denmark;* Director Dr. M. Fleury, Conservateur en chef Dr. R. Joffroy, Conservateur A. France-Lanord, *France;* Prof. Dr. H. Ament, the late Dr. P. La Baume, Prof. Dr.V. Bierbrauer, Dr. H.V. Böhme, Prof. Dr. K. Böhner, Landeskonservator Dr. H. Dannheimer, the late Prof. Dr. O. Doppelfeld, Prof. Dr. J. Driehaus, Dr. G. Fingerlin, Dr. S. Gollub, Prof. Dr. G. Haseloff, Dr. T. Haevernick, Prof. Dr. K. Hauck, Dr. U. Koch, Dr. H.E. Mandera, Prof. Dr. H. Petrikovits, Director Dr. R. Pirling, Prof. Dr. F. Stein, Dr. H. Vierck, Director Dr. K. Weidemann, Prof. Dr. J. Werner, Prof. Dr. W. Winkelmann, *Germany;* Prof. Dr. G. Behm-Blancke, Dr. B. Schmidt, *DDR;* Dr. R. Bruce-Mitford, Prof. Dr. S. Chadwick-Hawkes, Prof. Dr. R. Cramp, Prof. Dr. V. Evison, Mrs. A. Evans, Dr. D. Kidd, Mrs. L. Webster, Sir David Wilson, *Great Britain;* Prof. Dr. I. Bona, Dr. E. Garam, Dr. I. Kovrig, Dr. A. Kiss, Prof. Dr.G. László, *Hungary;* Prof. Dr. J. Raftery, *Ireland;* Prof. Dr. C. Carducci, Prof. Dr. B.M. Felletti Maj, Prof. Dr. O. Prinz von Hessen, *Italy;* Dr. H. Halbertsma, Dr. J. Ypey, *Netherlands;* Dr. E. Bakka, Prof. Dr.S.Marstrander, Prof. Dr. T. Sjøvold, Dr. W. Slomann, *Norway;* Prof. Dr. K. Godlowski, Dozent Dr. J.Z. Bukowski, *Poland:* Prof. Dr. G.E. Condurachi, Prof. Dr. K. Horedt, Director Dr. D. Popescu, Dr.M. Rusu, *Roumania;* Dozent Dr. A. Erä-Esko, *Suomi-Finland;* Prof. Dr. B. Almgren, Prof. Dr.G. Arwidsson, Prof. Dr. S. Gavelin, Dozent Dr. P. Hellström, Prof. Dr. W. Holmqvist, Dozent Dr. J.P. Lamm, Dr. I. Lindeberg, Prof. Dr. C.A. Moberg, the late Prof. O. Mellis, Dozent Dr. P. Olsén, Prof. Dr. B. Stjernquist, Prof. Dr. M. Strömberg, Prof. Dr. A. Westholm, *Sweden;* Dr. N. Firatli, *Turkey;* Dr. O. Davidan, Dr. G. C. Lebedenev, the late Dr. M. Tichanova, Dr. I.P. Zaseckaja, *USSR.*

Professor Greta Arwidsson has kindly read the manuscript in proof and thereby offered much useful advice. The heavy task of translating the manuscript into English has been skillfully and carefully carried out by Eva and Simon Wilson who have put great effort into seaking out suitable terminology. I have enjoyed their collaboration and I am also grateful to Sir David Wilson who has continuously encouraged me in this research. Professor Diego Carlström is not only an important contributor to this book, but the special interest he has taken in his analyses has provided much inspired information. The drawings have been made by Bengt Händel, Statens Historiska Museum and Fernando Alonso, the Archeological Research Laboratory, University of Stockholm and Rune Johansson typed most of the text.

Sara and Thordis Arrhenius have given me valuable help in editing and Thordis also composed the cover. Gustaf Arrhenius has written the computer programme used to sort the data and my husband, Professor Erik Arrhenius, directed with his usual readiness the descendants.

I am honoured that this book has been accepted by the Royal Academy of Letters, History and Antiquities for publication in one of their series and I also want to acknowledge generous grants from "Konung Gustaf VI Adolfs Fond för svensk kultur" and "the Swedish Council for Research in the Humanities and Social Sciences" to cover the costs for translation and printing.

I dedicate this book to my parents who have always encouraged my studies. My mother during her final illness closely watched over my work on this book and I keep in tender remembrance her happy smile when I presented her with the finished manuscript.

Stockholm in May, 1984

*Birgit Arrhenius*

# Reader's manual

This study deals with garnet jewellery: garnets have therefore been given precedence over other features in all illustrations. In the line-drawings great pains have been taken to reproduce accurately the actual shape of the individual garnets, whereas other elements (such as filigree) have either been omitted or drawn schematically. All garnets are drawn in black while the colours of other inlays are indicated by symbols set out below (cf. fig. 2b).

Each object is identified by an abbreviated reference to its present location, its general archaeological type and provenance, e.g. BM 1/Bu, Reastan refers to a buckle from Reastan in the British Museum. A number of features of these objects have been recorded (indeed it was originally intended to print such data in the catalogue), but the material proved too voluminous to fulfil this intention so that the catalogue now only supplies the additional information of a reference to a previous publication where the object is described. I have chosen to keep the name of the provenance used in the referred publication thus the Szilágy Somlyó treasure is still called so although in recent publications it is often called Simleul Silvanieu. In the name-list there is a cross-reference to the new names. The remaining details are contained in diagrams illustrating the principal technical features of the cloisonné, arranged in groups of objects from the same workshop or of objects with cloisonné mounted in the same technique.

Features recorded in the diagrams are the thickness of the garnets (G), the thickness of the cell walls (Wa), the height of the work, i. e. the total height of the object including the bottom plate (Wo) and the size of the garnets, expressed in terms of the area of a square box into which they can be fitted (G area) (fig. 2a and Introduction p. 16). The bars in the diagrams representing thickness, height and area show the range of the recorded measurements; the most frequently occurring measurement is also indicated by a horizontal marker (not the mean measurement). Where there is no such indication, the measurements are spread over the whole range. The remaining bars express as a percentage of the number of objects in the group certain features; garnets keeled (Ke), cut (Cu) or shaped by grooving and breaking (Gro); foil patterns (labelled foil): fine waffle patterns (close dots), grid patterns (cross-hatching), ring patterns (small circles), line patterns (broken lines). Where the bar has no pattern the foil has no pattern or there are two different patterns on the foils of the same object (the latter is indicated by a figure at the top of the bar) and a black bar indicates that foils are missing totally. The shape of the garnets (G shapes) are illustrated in the plates. Each shape is identified by a system of figures and letters. The letters refer to the name of the shape, e.g. T stands for a triangle, or to the actual shape, e.g. R stands for the shape of half a mushroom (see list of abbreviations p. 12). The drawings of the garnet shapes are in 5:1 thus providing a tool for classification of other garnets using a magnifier 5:1.

The shapes are usually indicated by capital letters, additional details are indicated by lower-case letters: 2Rv therefore describes the shape of a whole mushroom with a v-shaped notch. An exception to this rule is D which, when alone, indicates a concave shape while $D^3$ describes a triangular shape with three concave sides. TD, however, describes a triangular shape with one concave side only. Garnets of the same shape may not be of the same size, and it is only with stepped garnets (St shapes) that size can be inferred from the height and number of the steps.

Circular plates and stepped rhomboids are rarely complete: C therefore describes a circle segment, 2C a semicircle and 4C a complete circle. The same rules apply to stepped rhomboids. It will perhaps be sufficient to remember that C shapes are associated with circles, T shapes with triangles, P shapes with polygons and St shapes with steps.

It should be emphasized that the diagrams are based on varying numbers of objects. They should, therefore, be used as summaries of features which are typical of workshops or assemblages where percentage figures do not always allow of statistical treatment.

In general the tables are to be found in the running text, the large tables (Table I, X, XI) as well as the list of examined finds and the Bibliography are all collected at the end.

## List of abbreviations

### *1. General*

B – bow brooch
Bd – bossed disc brooch (Goldscheibenfibel in German).
Bo – bowl
Br – bronze
Bt – button
B–bt – button-on-bow brooch
Bu – buckle
Cu – cut garnets
D – disc brooch
Do – domed garnets
E – empty cells, e.g. no cement below the inlays
Ea – ear-ring
Eb – eagle brooch
Ed – enamelled disc brooch
G – garnet
Go – gold
Gr – grave
Gro – garnets shaped by grooving and breaking
H – height (height of the work, i.e. total height including the bottom plate)
I – other inlays than garnets
Ib – insect brooch
Ke – keeled garnets
L – necklace, armlet
M – mount
Mb – bridle-mount
Md – mount for a diadem
NP – no provenance
P – pendant
Pm – purse-mount
R – rosette brooch
Ri – finger-ring
Sb – S-shaped brooch
Sa – seax
Se – strap-end
SEM – scanning electron microscope
Si – silver
Sw – sword
Th – thickness
Wa – cell wall
Wo – piece of work

### *2. Garnet-shapes*

A – acanthus shape, (cf. fig. 3)
C – circle segment, (cf. fig. 4 for all shapes based on a circular plate)
4C – complete circular plate
2C – semi-circular plate
Ca – cabochon, (cf. fig. 3 for all shapes of cabochons)
Cao – oval cabochon
Cap – cabochon of pinhead size
Cc – long narrow curve
Cp – circular garnet plate with pierced centre
Cr – circle segment with a rectangular notch
Cs – circle sector often with a concave indentation at the top
Cu – horn-shape
D – concave shape, (cf. fig. 5 for concave shapes)
$D^2$, $D^3$, $D^4$, – the figures indicate the number of concave notches.
F – foil shape, (cf. fig. 4 for foil shapes)
Fx – irregular foil shape
$F^4$ – quatrefoil
$F^3$ – trefoil
$F^2$ – half-quatrefoil
Gt – boars tusk
H – heart shape
Ind – individually shaped garnets
K – cross shape
Ki – kidney shape, e.g. bean shape, (cf. fig. 3)
L – chevron shape, (cf. fig. 203)
Le – lentoid shape, (cf. fig. 3)
Lo – lotus shape, (cf. fig. 3)
M – multi-stepped narrow shape, (cf. fig. 203)
N – almond shape, (cf. fig. 3)
O – oval shape, (cf. fig. 3)
Ox – drop shape, (cf. fig. 3)
P – regular polygon, (cf. fig. 5 for all polygons)
Px – irregular polygon
$P^4$, $P^5$, $P^5$x, $P^6$ – different polygons where the number denote the number of sides
$P^4$r – rectangle
Pr – rectangle with one side distorted
Pa – palmette shape, (cf. fig. 3)
Ph – distorted hexagonal honey-combed shape, (cf. fig. 5)
$P^4$o – rhomboid (a stepped rhomboid is however called 4 St, cf. fig. 71)
$P^4$ox – irregular rhomboid
Pt – parallel trapeze, (cf. fig. 5)
Ptx – irregular parallel trapeze, (cf. fig. 5)
Q – omega shape, negative or positive
R – half mushroom shape, (cf. fig. 4)
2R – mushroom shape, (cf. fig. 4)
S – S-shape
St – stepped
$St^2$, $St^3$, $St^4$, etc. – the figures indicate the number of steps
1 St, 2 St, 3 St, etc. – the figures indicate the number of stepped sides
a. St – steps with a height of 1.8 mm, (cf. fig. 71)
b. St – steps with a height of 1.2 mm, (cf. fig. 72)
e. St – steps with a height of around 1.2 mm (only two steps), (cf. fig. 226)
f. St – steps with a height of 0.8 – 0.9 mm, (cf. fig. 73)
g. St – steps with a height of 0.5 – 0.6 mm, (cf. fig. 203)
T – triangle
Tr, Trx, $T^3$, $T^2$, Tx – different triangular shapes, (cf. fig. 5)
Tt – T-shape
Tf – an almost t-shaped garnet being part of an en face motif
v – v-shaped notch
W – wing-shape, (cf. fig. 71)
Y – arrowhead shape, (cf. fig. 203)
Z – zig-zag shape

### 3. *Provenance*

The finds are listed according to their residence.

| | |
|---|---|
| Ba | = Bagdad, Iraq Museum |
| BM | = British Museum, London |
| Bonn | = Bonn, Landesmuseum |
| Brno | = Brno, Archeologicky ustav CSAV, pop Brno |
| Br | = Brüssel, Musèes Royaux d'Art et de Histoire |
| Bud | = Budapest, Magyar Nemzeti Museum |
| Buka | = Bukarest, Muzeul National de Antichitati |
| Civi | = Cividale, Museo Archeologico Nazionale |
| Cluj | = Cluj, Muzeul Istoric al Transilvaniej, Cluj |
| Cop | = Copenhagen, Nationalmuseum |
| Dill | = Dillingen, Museum Dillingen |
| Eri | = Hermitage, Leningrad |
| Fe | = Szekesfehervar, Museum |
| Karl | = Karlsruhe, Badisches Landesmuseum |
| Kre | = Krefeld, Landschaftsmuseum der Niederrheins, Burg Linn |
| Köln | = Römisch-Germanisches Museum, Cologne |
| Liver | = Liverpool City Museum |
| Leu | = Leuwarden, Fries Museum |
| Maid | = Maidstone Museum |
| Mainz | = Mainz Römisch-Germanisches Zentralmuseum (R.G.M.) or Niederrheinischen Landesmuseum (L.M.) |
| Monza | = Monza, The Cathedral in Monza |
| Münch | = Munich, Præhistorisches Staatssammlung |
| Münster | = Münster, Landesmuseum Westphalen |
| Nürn | = Germanisches Nationalmuseum, Nürnberg |
| O | = Oslo, Universitetets Oldsakssamling |
| Paris | = Paris, Bibliothèque Nationale (B.N.) or Musée de Cluny (Cl), Musée Saint Germain-en-Laye (M.G.), Musée de l'homme (M.H.) |
| Parma | = Museo Nationale di Antiqità, Parma |
| Rom | = Rom, Museo dell' Alto Medioevo (M.A.), Musei Capitolini (M.C.) |
| Stutt | = Stuttgart Landesmuseum |
| Swed | = Sweden, Statens Historiska Museum, (S.H.M.) Stockholm; Gustavianum, Uppsala, Lunds Universitets historiska museum (L.U.H.M.) |
| Szeg | = Szeged, Mora Ferenc Museum |
| Szek | = Szekszard, Balogh Adam Museum |
| Tur | = Museo di Antichità, Torino |
| Tong | = Basilique Notre-Dame, Tongeren |
| Trier | = Rheinisches Landesmuseum, Trier and the Cathedral in Trier |
| Trond | = Trondheim Museum |
| Wash | = Dumbarton Oaks Collection, Washington |
| Westp | = Museum Westprüm |
| Wien | = Kunsthistorisches Museum, (K.H.), Naturhistorisches Museum, (N.H.) Vienna |
| Wiesb | = Städtisches Museum, Wiesbaden |
| Worms | = Städtisches Museum, Worms |

# Introduction

The garnet jewellery of the Merovingian period constitutes a unique and exceptional element in the art of the Germanic goldsmiths, whose most common type of ornamental decoration usually took the form of more or less disjointed animal figures or ribbon designs.

Garnet inlay seems mainly to have been used as decoration for weapons, horse-trappings and brooches. Contemporary sources also describe vessels decorated with precious stones, and some ecclesiastical vessels of this type have been preserved. It appears that objects decorated with garnets were often given as gifts, with some heraldic significance.

The discussion of the origins of garnet cloisonné has been in progress since Linas first scientifically examined garnet cloisonné jewellery in the three lavishly illustrated volumes of his *Les origines de l'orfèvrerie cloisonnée* (1877–1887). Linas focussed his attention on the oriental origins of the art and suggested that the *Petroassa* treasure was Sassanian. Shortly after this Odobesco, who finally published the *Petroassa* find (1889–1900), contradicted this suggestion: "Le sept pièces du trésor de *Petroassa* qui étaient ornées de pierres et de cristaux nous ont servi pour faire suffisamment apprécier, pensons nous, les divers procédés d'orfèvrerie et de joaillerie *que les Goths avaient empruntés*, tant à leur voisins de l'Occident qù'a á ceux de l'Orient aux temps où ils occupaient en vainqueurs toute la région du *Pont-Euxin de l'Ilster* et des *Carpathes* (1896, 111)."

New material was added to this discussion when Babelon (1919) published the finds from Childeric's grave in *Tournai* originally described by Chiflet (1655). He emphasized the importance of *Tournai* in Roman times, and suggested that the Childeric jewellery was a Frankish production influenced by Roman forms.

This view was later upheld by Arbman (1948) who also pointed out that the gold sword-pommels found in Sweden (1950) could have been Frankish imports. Kendrick (1933) also mentioned the connection with Roman art in his article on Kentish polychrome jewellery, but he also laid emphasis on the individual way in which this art had been developed by the Anglo-Saxons. In his book *Anglo-Saxon art* (1938), he expressed this in the following way; "No continental piece can be produced that makes any pretentations to being a model for the Kentish jewellers, who made the first of our cloisonné brooches, and if the Kentish craftsmen responded to the "Dannubian Gothic" style in the late fifth century, they did so in a way that was peculiarly their own" (1938, 69). Bruce-Mitford has developed Kendrick's view in several publications in which he has brought to light not only the rich jewellery of Sutton Hoo but also many other hitherto unknown items of cloisonné jewellery (Bruce-Mitford 1949, 1954, 1968, 1974, 1975, 1978).

German scholars have taken a somewhat different line. Riegl (1927) early pointed out the similarities between certain late antique openwork bronzes and the cloisonné settings. Böhner (1948) continued this argument, postulating that the Childeric jewellery was executed by goldsmiths from the Black Sea area who had taken refuge in the Frankish army, and preserved late antique traditions.

In her investigations of the Rhenish disc brooches H. Rupp (1937) first seriously discussed the question of the origins of the raw materials for garnet jewellery, and proposed that the garnets originally had come from India. She did in fact establish through analysis that most of the red material in the Rhenish disc brooches was indeed garnet, and suggested that the manufacture of these brooches ended when the Arabs invaded the Black Sea area in the seventh century, thus breaking the trade links between this area and the Germanic peoples of Western Europe. The analysis of the garnet material itself was continued by Arwidsson (1942), who demonstrated that the red material in Swedish button-on-bow brooches was also garnets.

Garnet jewellery has also been used as a key artefact in chronological studies. The presence of a particular cloisonné technique, known as *enge Zellenwerk* (cf. Werner 1935), has been associated with the distribution of the Germanic animal ornament of Salins Style II, and given a certain chronological significance.

The complicated techniques involved in the manufacture of garnet jewellery make these objects particularly suited to a technical examination which would make it possible to follow where and how these jewels were distributed among the Germanic peoples. The present study will demonstrate that, while pieces were finally assembled by local goldsmiths, these latter depended on

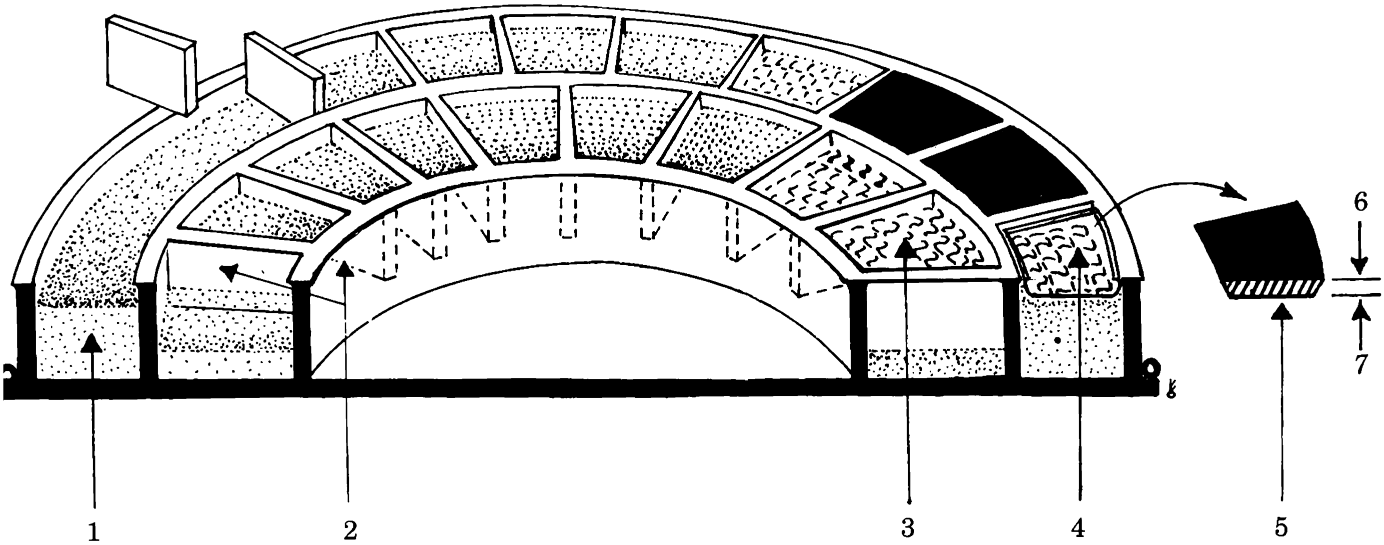



Fig. 1 The principal technical features of garnet cloisonné jewellery investigated in this study, exemplified by a disc brooch of Rhenish type.
1) Filling (cement or putty). 2) Thickness of cell walls. 3) Height of work.
4) Foil pattern. 5) Thickness of garnet. 6) Garnet shapes. 7) Other inlays.

the delivery of cut garnets from what was probably a small number of larger central workshops. The material used for the inlays can therefore throw light upon the longdistance trade of the Merovingians, while the mounting techniques reflect the distribution patterns from local workshops. A study of garnet jewellery thus provides an opportunity to examine communications between different areas of Europe in the Merovingian period.

However, when considering jewellery of such value as gold objects with garnet cloisonné it is necessary to exercise some caution before using them as chronological indicators. Such jewellery would have been passed on from generation to generation, particularly given its heraldic significance. Nevertheless, the detailed study of individual pieces of garnet jewellery may produce valid chronological evidence. Unlike most gold jewellery, garnet cloisonné is fragile and delicate, and often in need of repair: the inlays have a tendency to fall out or crack. Repairs in which stones are replaced are usually easy to detect, as it is difficult to insert a new stone without displacing the cell walls to some extent: the new stone will not usually fit the cloisonné cells as perfectly as the original. Its colour will often be slightly different, and the underlying gold foil may have a different pattern. Finally, the paste holding the inlay in the repaired portion may be of a different type to that originally used. As such repairs may already have been carried out during the first generation's period of use, while the jewellery was still fairly new, few chronological conclusions may be drawn from this evidence. The two disc brooches from *St. Denis* (Paris 14) demonstrate how, probably within the same generation, one brooch was replaced by another, of which certain features were of less high quality than the original. France-Lanord (1962, 350) emphasizes that the lustre and fitting of the stones on the replacement were particularly inferior.

It is quite common to find part of a cloisonné object preserved and later fitted into a new piece of jewellery. The mount from Tongeren (Tong 1) is thus probably made up from the reassembled parts of a larger cloisonné piece, being an example of secondary use. Single garnets from an older piece can likewise be mounted on one of later manufacture. This can often be detected, as the re-used garnet or garnets may have no matching opposite in the design, and the puzzle will not quite fit together. Attempts were sometimes made to make up the missing pieces, but the lack of the correct templet would result in the copied pieces fitting badly. A bad fit could also be the result of blemished pieces being re-cut to remove a damaged edge, for instance, before they were re-used. Such partial re-cutting is very common, and demonstrates the high value placed on individual stones. This is also true of Classical gems and intaglio, which often had their edges trimmed for further use in the Medieval period, and would thus diminish in size as time went by.

The present study of Merovingian garnet jewellery will therefore concentrate on the technical details of manu-

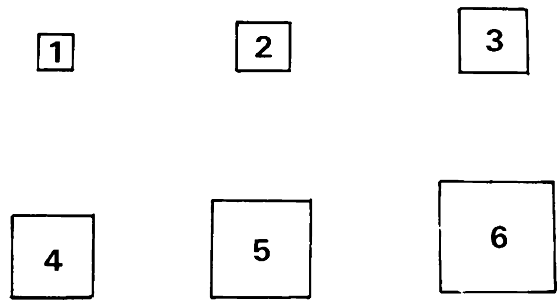



Fig. 2a. Square boxes into which garnets are fitted in order to describe their area, i.e. their size.
1 = 25 mm$^2$, 2 = 49 mm$^2$, 3 = 81 mm$^2$, 4 = 121 mm$^2$, 5 = 169 mm$^2$, 6 = 225 mm$^2$, > 6 > 225 mm$^2$.

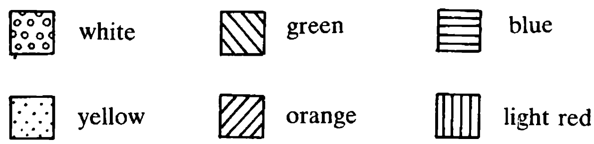



Fig. 2b. Symbols for colours used in the figures. Note that garnets always are black.

facture. I have deliberately refrained from any classification of the jewellery on stylistic grounds, basing my divisions on manufacturing techniques. The classification system arrived at by this means has subsequently been examined to ascertain whether the objects in these groups also display common stylistic features. However, it must be remembered that it is likely that even within the same workshop individual craftsmen would have developed their own particular methods and styles. Temporary technical changes—perhaps due to the lack of certain raw materials, such as pure calcite paste—could result in an object being assigned to a group with which it otherwise has few features in common. It seems important, therefore, to base the classification on a sizable number of common technical features, but also occasionally to assign to a group objects with certain individual deviations. This problem will frequently be discussed below.

In *Jungneolitische Studien* and *Metodproblem inom järnålderns konsthistoria,* M.P. Malmer (1962 and 1963) has emphasized the importance of recording independent typological elements as a basis for the classification of types. He distinguishes initially between technical and decorative elements, and further subdivides the former into four elements: the material used; proportions; form; and technique. I have here chosen to concentrate on only those technical elements which can be termed *manufacturing elements*. As explained above, I have avoided using decorative elements as a primary basis for classification, but equally a deliberate choice has been made from among the technical elements (cf. fig. 1). Only certain aspects related to proportions have been considered for the purposes of this classification; therefore overall measurements—sizes of individual objects—have not been included. It is important to note whether the cloisonné inlays cover larger panels or are limited to borders: when this difference is determined by the mounting technique I interpret it as a technical element, but where it is unrelated to the mounting technique it is interpreted as a stylistic feature, and is therefore not included as a classifying element. Moreover, overall measurements are usually given in the original publication of the objects. I have, however, considered the area of the garnets to be of particular importance, expressed as the size of the square in which they can be fitted (cf. fig. 2a).

The reason for recording the area of the garnets in terms of the circumscribing square is due first of all to their varying shapes, which make conventional calculations extremely complicated, and secondly to the fact that garnets would have been cut down to shape from larger pieces. The cleaved garnet plates are naturally more or less square in shape, and one can take for granted the craftsman's wish to reduce the amount of time-consuming cutting. In recording square measurements I have not produced exact figures, but have rather devised a division into classes (cf. fig. 2a). There are many reasons for the general avoidance of exact measurements in this study; exact measurements—that is, accurate to two decimal places—are not relevant when considering handmade craftsmanship of the kind described here. The goldsmiths of the day would hardly have been able to measure even a tenth of a millimetre. The thickness of a garnet is therefore usually recorded to an accuracy of only one decimal place, and as the variations in thickness of an individual garnet may amount to several tenths of a millimetre (as will be seen), only the largest measurement is recorded. Another essential measurement is the height of the cell work: this measurement gives some indication of whether there is a comparatively thick layer of paste behind the garnets, or whether they themselves fill the cell to its full depth. A measurement of more doubtful value, which must nonetheless be recorded, is the thickness of the cell wall. When taken on the surface of the cloisonné inlay it represents the thickness of the cell wall when flattened at the top, rather than the thickness of the actual wall. As it is generally impossible to measure the thickness of the cell wall itself except in broken objects, I have been content with this less accurate measurement.

When considering the material from which the jewellery was made, I have recorded the metal in general terms only—gold, silver, bronze, etc.—without stating the precise composition of the alloy. For the purposes of this study, this is judged to be largely irrelevant, although the gold content may provide some chronological pointers.

A great deal of work has gone into identifying different types of garnet, and where possible other inlaid material has also been identified. Garnets are often backed by patterned gold or silver foil. The designs may vary from waffle to grid patterns. The fineness of the patterns in each group may vary, but I have not subdivided groups of similar patterns according to this criterion (as recently in the publication of R. Avent and D. Leigh, 1977). In my view, it is not worth making such fine distinctions in a study covering so large an area, and including a considerable number of goldsmith's workshops, each using local designs. Such fine distinctions demand very careful and time-consuming microscopy. Most of my measurements were carried out with the aid of a graduated magnifier and callipers. Only those objects which could be examined in my laboratory (where there is both a microscope and a scanning electron microscope) have been subjected to the exhaustive examination I might have wished to give to all. Thus it is important to bear in mind the different degrees of accuracy achieved in studying this material. In collecting material from a large area, as in the present study, the aim must be a degree of accuracy adequate to the project in hand, which at the same time makes it practically possible to complete the project. Travelling abroad with a microscope is difficult because of customs regulations; colleagues in various museums have given me the use of microscopes, which have enabled me to make many valuable discoveries, but these have not always produced comparable data as regards measurements. I have therefore chosen to make all measurements with the same instruments so that the available data should be directly comparable.

The same kind of argument applies to paste analysis. Paste samples were analysed microscopically and by x-ray diffraction. Even before the samples were collected, I made exhaustive checks on each individual object to ascertain whether the sampled paste was indeed intact. In this respect I have been misunderstood by previous readers, who have imagined that my analyses of quartz sand pastes could have been based on only a few quartz grains found at the bottom of a cell (cf. 3:3a). My samples always consist of a *small piece* taken from a larger mass of paste; and I have also made sure that *the same paste* was present in other cells of the same object. In considering whether material found in the cells was in fact paste, I attempted where possible to find impressions made on the paste by the overlying foil. I have also endeavoured to discover whether substances have been introduced by conservators and others. It is of course possible that I have included occasional paste samples which were not entirely uncontaminated, but as I made renewed tests on several doubtful samples, I do not consider this a serious risk.

I have placed considerable emphasis on a detailed analysis of the techniques involved in the production of individual objects. As stated above, not every typological element has been recorded; indeed, this would hardly be feasible. Thus the selection of significant elements is dependent on an understanding of the technical processes involved in making the objects. The method used here can best be characterized as *a manufacturing typology*.

When studying the technology of a group of objects, changes are often interpreted in terms of a technical evolution. However, my work with garnet jewellery has shown that it is quite rare for technical changes to be the direct result of an evolutionary process. My technical research has here led to conclusions similar to those expressed by scholars who have criticized the Montelian theory of typological development (cf. Almgren 1955 and Gräslund 1974).

Why, then, did the Migration period goldsmith's techniques not evolve in a fashion similar to modern industrial production? The answer probably lies in the absence of the competitive market forces which dominate production in Western Europe today. The goldsmith's work may not have been produced for sale *on the open market,* but was rather commissioned by individual customers. Late Roman sources reveal that a customer ordering a cage-cup, for instance, would himself obtain the material for its manufacture (cf. Doppelfeld 1960b). This was probably also the case for jewellery, at least as regards the precious metal. The inlays themselves may have been selected by the goldsmith, but the customer had to provide the money for their purchase. Because the goldsmith always worked to commission, there was no incentive to *increase* production through technical innovation. However, he may have developed unobtrusive techniques for using a little less gold than the customer paid for. This

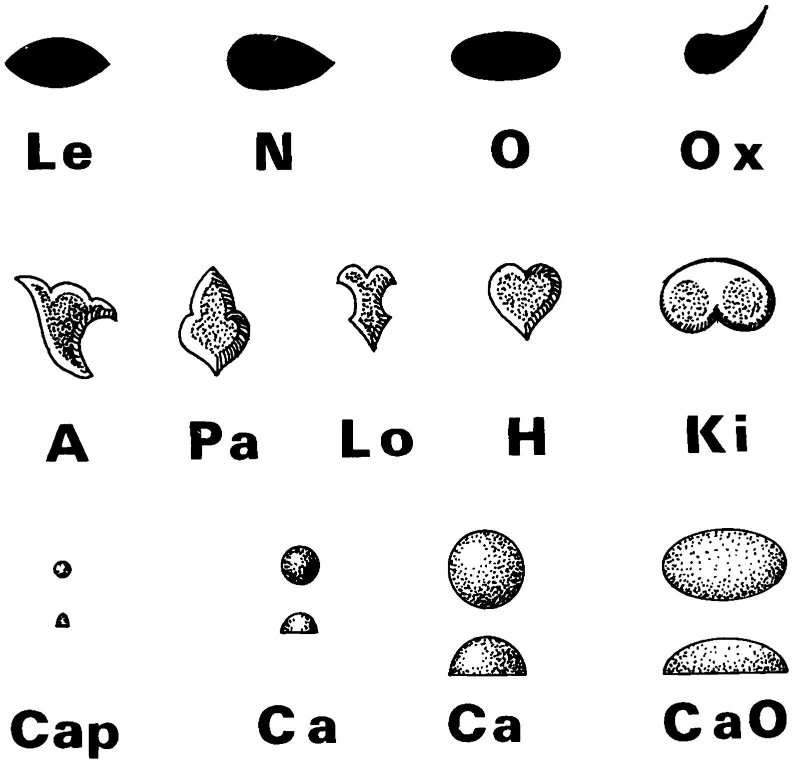



Fig. 3. Garnet shapes, mostly cut as domed garnets.

may be a plausible explanation for the fact that the examination of cloisonné work shows that with the passage of time the paste filled an ever greater proportion of the space. On the other hand, a paste-filled jewel demanded considerably more time and effort than a more solid cloisonné work, where the thick gold walls could by themselves secure the stones.

It is characteristic of the jewellery described here that the technologies used remain fairly uniform, the variations deriving from differencies in materials and stylistic features. When the technique of cleaving garnets into thin plates became firmly established in the *late Roman period*, the use of a wheel for cutting the stones also developed, along with the method of putting paste and gold foil in the cells. Cloisonné art was introduced into Western Europe with its technology fully developed, and such changes as then took place were concerned with new types of paste and the division of garnets into smaller pieces; the latter change being probably due to the increasing scarcity of the raw materials. In the late Merovingian period another technical change occurred, mainly in Scandinavia: the garnets were no longer cut with wheels, but retouched, producing new shapes in some cases. This is probably due to the phenomenon of 'lost knowledge': the gem-cutting techniques of the Classical world had apparently been lost.

These examples suggest some of the problems involved in the study of Germanic cloisonné art. An insignificant part of the art of the period, it nonetheless reflects how an advanced and specialized technology, originally developed in the Mediterranean and the Orient, was introduced into Western Europe to flourish for a short but intense period. Long after the techniques of producing such jewellery had been forgotten, it was simulated in illuminated manuscripts and metal-inlay on weapons, and was described in the Eddaic poems as mythical jewellery.

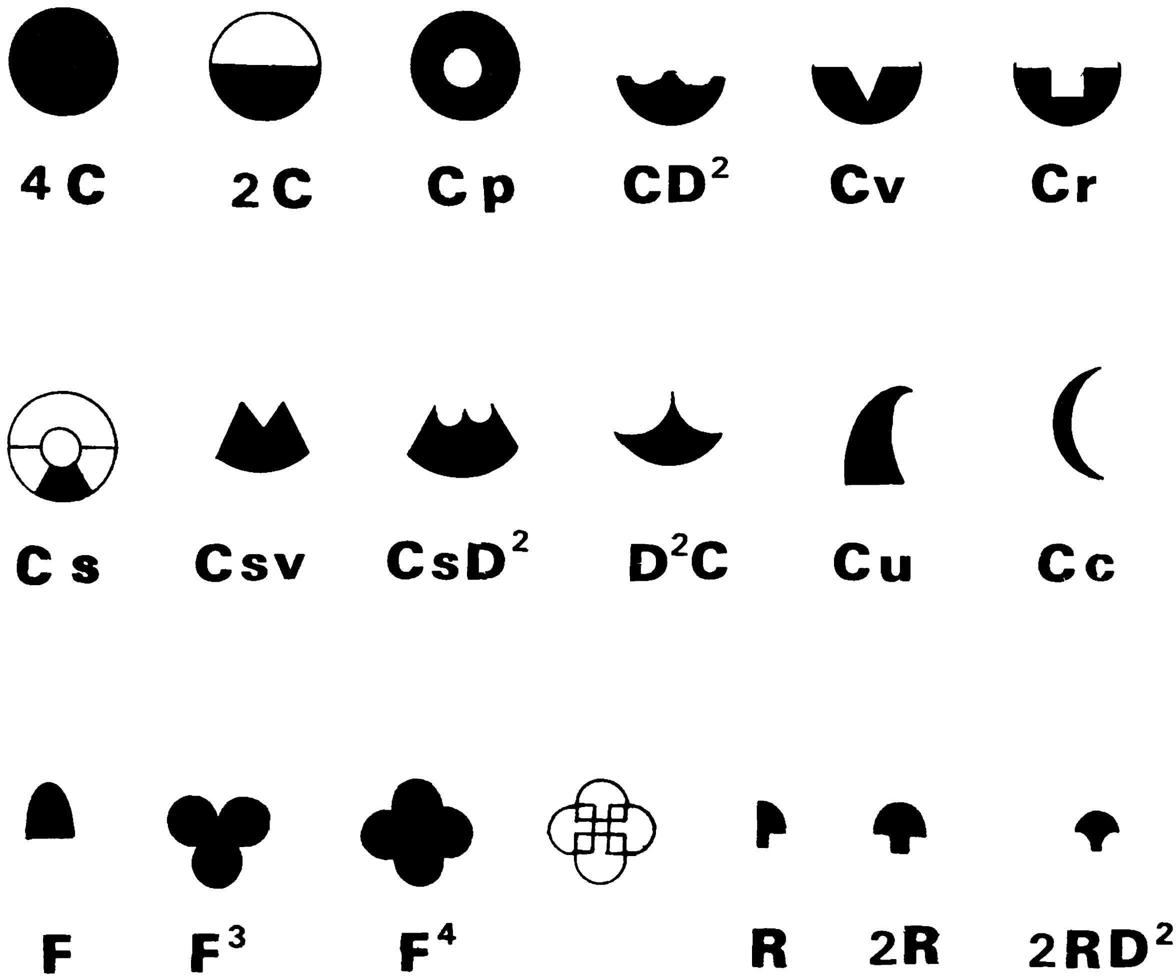



Fig. 4. Garnet shapes based on circles.

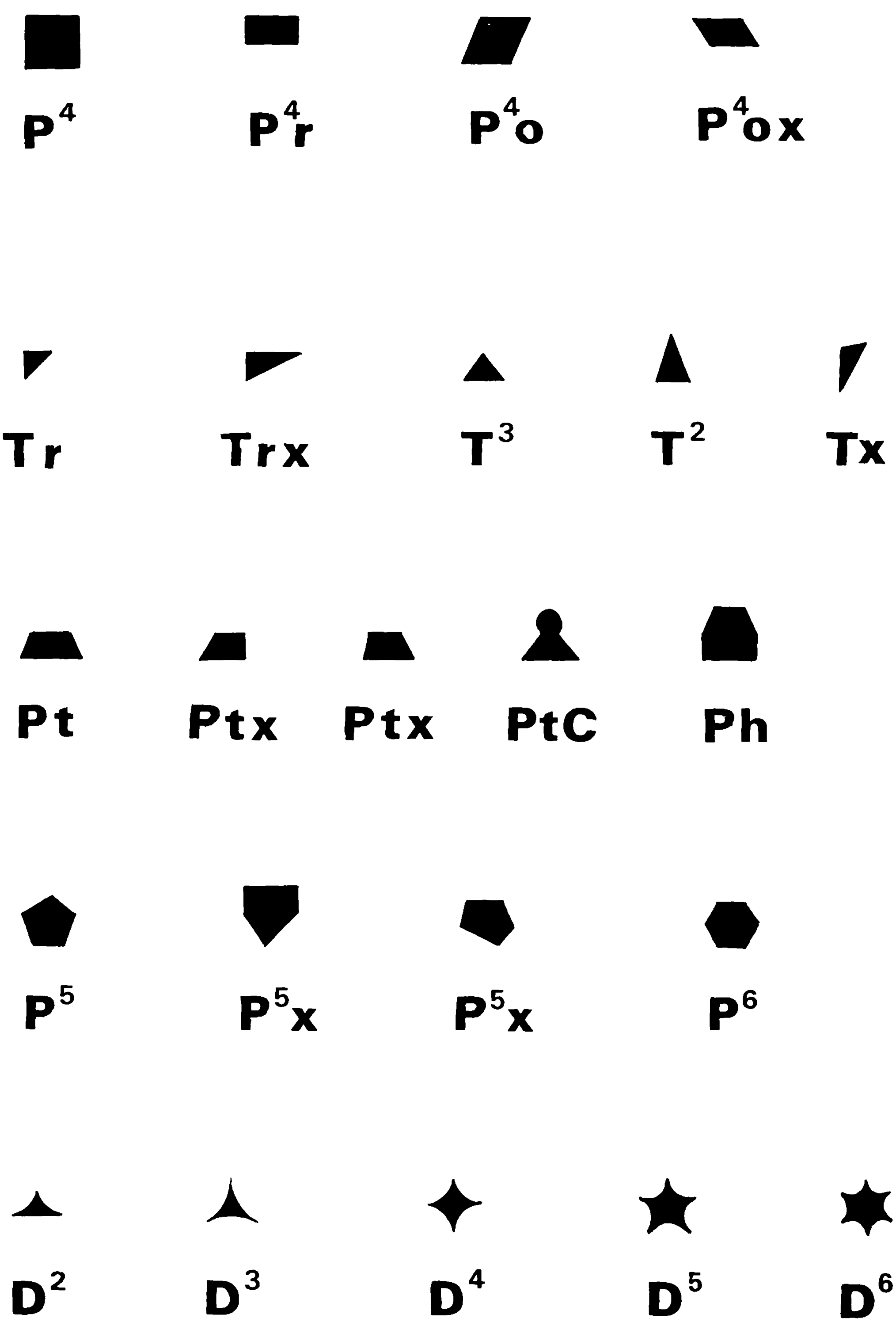



Fig. 5. Garnet shapes based on polygons.

# Chapter 1. The raw material

## 1:1 Garnets

The most common materials used for inlays in the kind of jewellery considered in this study are translucent minerals belonging to the garnet group. The term *garnet* does not describe one specific mineral, but applies to a group of interrelated silicate minerals, usually red in colour, but sometimes also green, brown or yellow. The chemical structure consists of three silicate ions, $SiO_4$, combined with trivalent and divalent metal ions. In the gemstones considered here, the trivalent metal ions always consist of iron and aluminium. The divalent metal ions may be $Fe^{2+}$, $Mn^{2+}$, $Ca^{2+}$ or $Mg^{2+}$, or a combination of these elements. Trace elements such as chromium have also been encountered. A large number of variations in the composition of garnet minerals are therefore theoretically possible, but in practice the number of variations is limited. The red translucent garnets with which we are concerned in this study are known as almandine, pyrope, hessonite, spessartite and intermediate pyralspite garnets.

Garnets are the products of metamorphosis, being produced, for instance, in connection with rock-forming processes in conditions of great pressure and heat. It is even possible to make synthetic garnets in the laboratory (Matthes 1961).

An important characteristic is the fact that widely differing types may be produced in the same melt; this was also observed during laboratory experiments in connection with the production of synthetic garnets. This wide variability is due not only to variations in the raw material, but also to changes in heat and pressure during the crystallization process.

The variability of the composition of garnet minerals is also demonstrated in larger series of analyses such as those carried out on 192 garnets by Reid, Frazer and Fujita (1969). With the aid of an electron microprobe analyses were carried out on garnets from three areas where pyrope garnets are known to occur: Kimberley in South Africa, Trebnice in Czechoslovakia and north Arizona in the U.S.A., as well as on weathered-out and re-deposited garnets found in glacial strata in south Ontario, Canada. The purpose of these investigations was to attempt to assign the garnets to their areas of origin on the basis of an analysis of trace elements. The authors summarized the difficulties encountered thus:

> The data demonstrate the variability from a single occurrence and how misleading analyses of a few grains or a single bulk sample can be.

These results, based on the chemical composition of garnets, are important when discussing the provenance of garnets used in archaeological jewellery.

In my work on the archaeological garnet material I have found that archaeologists often believe that the provenance of garnets could be easily established on the basis of a simple chemical analysis. However, this is an extremely complex problem. In order to enable the reader to follow my conclusions in this respect, it is necessary to consider in more detail the characteristic properties of the garnets used in such jewellery.

### *1:1a Chemical composition*

The mineralogical divisions of the red garnet variants are based on the different divalent metal ions they contain. Almandine, $[(Al, Fe)\ Fe_3\ SiO_4]_n$, is the most iron-rich variant; spessartite, $[(Al, Fe)\ Mn_3SiO_4]_n$, contains manganese; pyrope, $[(Al, Fe)\ Mg_3\ SiO_4]_n$, contains magnesium; and hessonite, $[(Al, Fe)\ Ca_3\ SiO_4]_n$, contains calcium.

However, this is a theoretical division. Analysis shows that the composition is very rarely pure; the garnets contain compounds of almandine, pyrope, spessartite and hessonite in greater or smaller proportions. The formulae set out above may be regarded as the end results of a couple of mathematical series. Chemical analysis of the separate elements will thus provide only a rough division, which only very occasionally gives a clue to the provenance of the garnets. The complexity of the chemical structure has already been mentioned; in itself this creates analytical problems which have occupied scientific research for a long time. In order to calculate the proportions of the individual elements, the analyses have been calculated in relation to the theoretical garnet end member molecule (cf. Tröger 1959, Rickwood 1968, Knowles *et al.* 1969). An important treatment of chemical data is presented in Tröger, *Die Granatgruppe: Beziehungen zwischen Mineralchemismus und Gesteinart*

(1959). On the basis of calculations of data from 480 garnet analyses in relation to the theoretical garnet end member, he divides the garnets into twenty-eight different groups, in which the variations in chemical composition are related to the rock formations in which garnets occur. The divisions are based on calculations of the average values of the data from the chemical analyses, and the borderlines between the different types of garnet are therefore not exact. The practical application of Tröger's groups to gem garnets has therefore proved difficult; this is demonstrated, for instance, by Mellis's investigations using this method, which will be described below.

### *1:1b Density*

Similar problems occur when attempting to determine the density of the garnets. Almandine is heavier than the other garnet types because of its iron content: its density varies between 3.95 and 4.30, while that of pyrope varies between 3.65 and 3.95. Spessartite (4.12–4.20) and hessonite (3.63–3.65) lie within these extremes, together with a group of intermediate red garnets of transitional forms.

### *1:1c Colour*

Colour plays an important role in characterizing garnets. Sinkankas (1966) has demonstrated that the intensity of the red colouring depends on the iron content. The almandine garnets have the largest iron content, and are therefore deep red in colour, with a purple tinge. Garnets which contain less iron—hessonite and spessartite, for instance—are of a lighter red colour, and it is often difficult to differentiate between these two types on the basis of colour alone. Pyrope garnets are often as intensely red as the almandines, but there is a yellow tinge which some scholars have attributed to their chromium content (cf. Webster 1976, 148). However, the colour of the pyrope garnets varies greatly, and some even have a purplish shade.

### *1:1d Hardness*

The red garnets (hessonite, pyrope, almandine) have sometimes been described as the hardest of the garnets (cf. Bauer 1896, 395), with a hardness of 7.25–7.5 on the Moh scale, while the other garnet types have a hardness of around 7. However, the hardness of a particular piece of garnet may vary, as the edges of the crystal are always harder than the faces.

### *1:1e Refractive index*

The degree of light refraction is of considerable importance in estimating the value of a gemstone, particularly if it is to be given a facetted cut. The refractive indices of garnets vary considerably. Almandines generally have the highest refractive index, ranking from 1.75 to 1.83, but the highest values of the pyrope, 1.74–1.75, coincide with the lower values of the almandine. The index of spessartite is 1.75–1.81, and of hessonite 1.74, while the more intermediate pyralspite garnets range from 1.74 to values sometimes even higher than 1.81 (cf. Mellis 1963, 339).

### *1:1f X-ray diffraction analysis*

X-ray diffraction analysis measures the distances between the faces in the crystal lattice formed by the atoms in the molecule. Marie Králová-Jirovcová (1958, 70 ff.) has carried out a number of x-ray diffraction analyses on garnets from Bohemia: it was found that the diffraction analyses may be grouped together in correlation with the parageneses by which the garnets were formed. In this case, diffraction analysis proved a more sensitive indication than other types of analysis. With the aid of this technique, Králová-Jirovcová was able to determine different values for garnets found in primary rock and those from other parageneses.

### *1:1g Absorption maxima*

A study of light absorption maxima provides more detailed information about the colour of gemstones. Certain characteristic absorption maxima have been defined for red translucent garnets. However, the absorption maxima quoted in the literature as characteristic of pyrope and almandine do vary slightly (cf. Mellis 1963, 300 ff.). Characteristic maxima for almandine can be distinguished at about 462 $\mu$, 505 $\mu$, 527 $\mu$, 576 $\mu$ and 617 $\mu$, for pyrope between 561 and 575 $\mu$ and for spessartite at 432 $\mu$, 462 $\mu$ and 485 $\mu$. However, when garnets are made up of components of almandine, pyrope and spessartite, or of two of these components, a larger number of such maxima occur.

### *1:1h Inclusions*

Garnets usually contain a large number of inclusions of other minerals. It has been thought that some inclusions are characteristic of garnets from particular areas. Zircon inclusions, for instance, were considered typical of garnets from *Ceylon* (Gübelin 1960, 14–15). However, Mellis (1963, 359) points out that similar zircon inclusions have been recorded in Finnish garnets and in garnets found in the Riesengebirge and Bohemia. Mellis suggests, however, that a certain group of inclusions which typically occur in small zones, and which Gübelin described as typical of almandine and pyrope from Bohemia, seem to have a more limited distribution; similar inclusions have been recorded by Mellis in Scandinavian cut garnets which may possibly suggest that they originated in that area (see 1:3b). In a discussion of the provenance of garnets, large inclusions of apatite grains are of interest, as Mellis (1963, 361) suggests that this feature may indicate that the garnets originated in pegmatites.

The main significance of inclusions otherwise relates to the cleavage of gem garnets. This will be discussed further in the context of production techniques.

### *1:1i Investigative methods for garnet analysis: conclusions*

This description of the investigative methods used in the analysis of the provenance of garnets illustrates the complexity of the question. It would seem that no method will alone provide a definite answer; but by combining the results of different methods of analysis, it is possible to suggest some conclusions in respect of late antique and Germanic cut garnets. A compilation and study of the analyses carried out is given below (1:3).

## 1:2 Descriptions of garnets in Classical sources

The lapidaries of antiquity contain a considerable body of knowledge about precious stones, some of which is of relevance to the present study.

### *1:2a Anthrax*

In what is thought to be the earliest extant lapidary, Theophrastus records a stone called *anthrax,* which cannot be burnt, but which when held up to the sun has the colour of burning coal (*Theophrastus, On stones,* passage 18, Caley and Richards *ed.* 1956).

Another type of *anthrax,* from *Miletus,* is also incombustible, but has crystals of a hexagonal shape and many properties in common with *adamas* (Caley and Richards 1956, 89). According to Theophrastus, *anthrax* was used for engraved gems. Caley and Richards, like Furtwängler (1900), identify *anthrax* as garnet, which is the only red engraved gemstone known from this period, ruby and spinel being too hard to engrave with the available techniques. We may compare Theophrastus' statement with Aristotle's comment (Meteorologica IV, 9):

> Anthrax is the name of the intaglio which of all stones is least affected by fire (cf. Caley and Richards *ed.* 1956, 81).

Theophrastus' statement that *anthrax* from *Miletus* is crystallized in a hexagonal form and has much in common with *adamas* is particularly interesting in the present context. It should not, in fact, be possible to identify the *Miletus anthrax* as garnet, because garnet crystals are never hexagonal. But crystal agglomerates in garnet sometimes take on forms which may well be described as hexagonal, these forms consisting of several crystals combined. As there was no true definition of a mineral crystal at this time, it is quite possible that the hexagonal forms described may have been the result of crystal agglomerates.

If this explanation is not acceptable, the *anthrax* from Miletus must be identified as ruby, which belongs to the hexagonal system. It seems, however, that the only place where rubies were found in antiquity was India. The identification of *Miletus anthrax* as red spinel by Caley and Richards seems less likely, as spinel crystals are cubic, and unlike garnets rarely occur in closely-joined crystal compounds. When Theophrastus compares *Miletus anthrax* to *adamas* it is possible that he is referring to the use of crushed garnets as a polishing powder. According to Pliny's work on stones (Pliny, *Natural History, libri* XXXVI–XXXVII, *ed.* Eichholz 1962), which in many ways copies Theophrastus' text but contains more detailed descriptions, *adamas* was not used in our sense, simply to denote a diamond, but as a term to describe stones which are impervious (in that they are unaffected by fire, cold etc.) and of unequalled hardness. Pliny describes six types of *adamas,* of which one comes from *Cyprus* and is copper-coloured, and another has the colour of iron. Both these types of *adamas* can be used to cut and polish other stones, while they themselves may be worked by other kinds of *adamas* (Eichholz *ed.* 1962, 209 ff.). Garnet crystal agglomerates crushed in a garnet mortar produce an abrasive which has been much used in more recent times (cf. Bergström 1943). The hardness of this abrasive is due to the fact that the edges of crystals are harder than other parts of the mineral. The numerous crystal edges of the agglomerate produce a perfect abrasive, well suited, for instance, to polishing the chalcedony stones (i.e. onyx, agate and cornelian) which were much appreciated by the Romans.

For engraving, the hardness of the garnet polishing powder would not have been sufficient; it would have been necessary to use either true *adamas* (diamond) or the stone from *Naxos* described by Pliny, which is emery (Eichholz *ed.* 1962, 41).

Theophrastus and Aristotle both state that it is characteristic of *anthrax* that it is unaffected by fire. This statement is reiterated by Pliny, and is also recorded in medieval lapidaries. However, this assertion is not entirely true. It is possible to melt garnets if they are heated to a temperature in excess of 800–900 degrees. Almandine and hessonite are easiest to melt, while it is more difficult to melt pyrope with a blow-pipe flame. It would seem that the statement concerning the incombustibility of garnets is associated with the techniques of heating used to produce the flat garnet plates for cloisonné work, which will be discussed in more detail below.

At lower temperatures—400–500 degrees—garnets are completely unaffected by heat, although they quickly become incandescent. However, even when heated to lower temperatures, there is a certain difference between pyrope and the more iron-rich garnets, in that dark patches of discoloration appear easily in the iron-rich varieties owing to the susceptibility of iron to heat. The possibility cannot therefore be excluded that the appellation *anthrax* referred to pyrope garnets, or at least to garnets with a high pyrope content. In view of this hypothesis, it is of interest to examine more closely the frequency of different garnet minerals in the gemstones of Classical antiquity.

In the series *Antike Gemmen in Deutschen Sammlungen,* E. Brandt (1968, 1970 and 1972) has published information about the different kinds of garnet minerals present in gemstones in *Munich's* museums. The composition of the stones was not determined by chemical or spectrographic analysis, but using the methods of Bauer (1896), with colour as the most important distinguishing property. Thus the gems were distinguished using largely the same methods as the Classical authors. In the *Munich* collections, 42% of the garnet gems were of pyrope, while only 24% were almandine and the remaining 34% hessonite and spessartite. These collections from the Classical world therefore differ markedly from those found in a modern jeweller's shop or precious stone collection. Today almandine is most widely used, while pyrope is almost exclusively restricted to the pinhead-sized rose-cut stones used in 'Bohemian' jewellery, and even among these, almandines are frequently found: since the nineteenth century large almandines have been regularly imported from *Ceylon,* where these stones are easily available.

In the last century even the flourishing garnet industry in Bohemia was dependent on almandines imported from *Ceylon,* as pyrope occurs only in very small crystals (thus determining the typical form of 'Bohemian' jewellery). The *Munich* collection seems largely to consist of bought pieces; it cannot therefore be seen to represent only the local availability of stones, and it seems likely that the predominance of pyrope recorded in this collection is typical of Classical gems. This accords well with my observations from such collections elsewhere.

Thus it is of interest to establish the provenance of *anthrax* in antiquity. Today it is extremely rare to find pyrope of the size used in Classical gems.

Theophrastus writes (*Theophrastus, On stones,* passage 18, Caley and Richards ed. 1956, 48) that *anthrax* was brought from *Carthage* and *Marseille* (Marsilia). He writes of *anthrakion* (diminutive of *anthrax* Op. cit.. passage 34, *ed.* 1956, 52) that there are many varieties of this stone, but the most valuable come from *Carthage,* from the *Marseille* region, from Egypt at the First Cataract, from *Syene* near the city of *Elephantine,* and from the *Psepho* region.

Theophrastus' statement that valuable stones of this kind come from Egypt at the First Cataract agrees with the information provided by Lucas (1948, 452), who states that garnets of this quality were used as beads as early as the Pre-Dynastic period. Such garnets may be found at *Assuan* and in the *Sinai* desert.

Today sources of pyrope in Tanzania and South Africa are famous because the pyrope found there occurs in large crystals, unlike that found in Bohemia. It is not impossible that at an earlier period there were sources of pyrope further north in Africa, especially as garnets of this type are found in the *Nile delta* and at *Assuan*, having doubtless weathered out from an outcrop of rock. It is possible that the situation is here similar to that of the Egyptian emeralds, which Pliny records at carefully detailed areas, which were then forgotten for centuries and only recently rediscovered (cf. Webster 1976, 84).

It is obvious that the *anthrax* brought in trade from *Marseille* may have been of African origin. However, Theophrastus clearly states that *anthrakion* comes from the area around *Marseille.*

It is well known that as early as the Celtic period an important trade route existed between *Marseille* and central Bohemia, carrying such items as painted Greek pottery (cf. Bittel *et al.* 1981, fig. 147); it is therefore not impossible that the garnets from *Marseille* were quite simply Bohemian in origin. It is very likely that in the past garnets of considerably larger size than at present were found in Bohemia. Bauer (1896, 407) quotes earlier sources as stating that pieces of pyrope the size of a fist were found in Bohemia in the seventeenth and eighteenth centuries. Today these sources of larger garnets have presumably been exhausted.

Theophrastus does not mention exports of *anthrax* from India at all. His descriptions of *anthrax* and *anthrakion* also contain no mention of a purplish tinge to the red colour of the stone.

### *1:2b Carbuncle*

Most writers equate Theophrastus' *anthrax* with carbuncle, the precious stone described by Pliny (cf. Pliny, *Historia Naturalis,* Book XXXVII, Eichholz *ed.* 1962, 243). Whole sections of Pliny's descriptions were indeed taken word for word from Theophrastus (Book XXXVII, passage XXV Eichholz *ed.* 1962, 92ff.).

Pliny states that there are two types of carbuncle, the Indian and the Garamantic. In Greek the latter was known as the *Carchedonic* because it was associated with the great Carthaginian Empire. To these varieties are added the Ethiopian and the *Alabandan*; the latter, he states, is found at *Orthosia,* but cut and polished in *Alabanda.* In each variety there are so-called male and female stones, of which the former are the more brilliant, while the latter have a weaker lustre . . . The finest are the amethyst-coloured stones, especially those in which the fiery red shade passes at the edge into amethyst-violet, and the next best, known as *syrtatae,* have a bright feathery lustre. Satyrus asserts that Indian *carbunculi* lack brilliance and have a dark, dull lustre (*non esse claros ac plerumque sordidos ac semper fulgoris retoridi*) . . .

Pliny further states that Callistratus describes Carthaginian *carbunculi* as much smaller than those from India, and that the Indian stones can be hollowed into vessels (Book XXXVII, passage XXV Eichholz *ed.* 1962, 95). Archelaus states that carbuncles from *Carthage* have a dusky appearance, but light up more intensely than the rest when they are viewed by sunlight or firelight or through an edge (that is, with the light shining through the edge of the crystal). He mentions also that they appear purple indoors and flame-red in the open air, that they sparkle when they are held up to the sun, and that, when they are used as signets, they melt the wax even in the dark. Pliny quotes many writers as saying that the Indian carbuncles are lighter in colour than those from *Carthage,* but that, conversely, they become darker when viewed through an edge. Pliny also states that carbuncles from *Alabanda* are darker than the rest, but also rougher (*scrabrosque*).

The passages quoted above are those where Pliny deviates from Theophrastus' description of *anthrax.* In his chapter on carbuncles Pliny virtually quotes Theophrastus word for word on *anthrakion* and allows this stone to keep its Greek name.

It is particularly significant that Pliny mentions the importation of carbuncles from India. Indian carbuncles differ from others in that they are of a lighter colour and occur in such large pieces that they can be hollowed out and made into vessels. In my opinion this description is appropriate to hessonite garnets; hessonite occurs in large blocks in *Ceylon* and is characteristically light in colour. The study of the *Munich* collection demonstrates that hessonite (or spessartite, as these varieties are difficult to distinguish by colour) was the second most common type of garnet, comprising 34% of all garnet gemstones. I would also suppose that the garnets from India described by Kosmas Indikopleustes (6th century) and discussed by Roth as a possible source for Merovingian garnet jewellery (Roth 1980) are garnets of this type.

With a hardness of $7\frac{1}{4}$ hessonite is a little softer than almandine and pyrope, being in this respect more similar to chalcedony, a material used in antiquity to make the vessels known as cage-cups. Hessonite would therefore also have been very suitable for this purpose. It must be pointed out, however, that spessartite rarely occurs in sizes suitable for such use.

### *1:2c Anthrax and carbuncle in medieval lapidaries*

In medieval lapidaries we often find information which harks back to Pliny's work. However, in these lapidaries considerable attention is paid to the magical concepts associated with precious stones. Most of this material seems to have been taken from Hellenistic literature (cf. Evans 1922). Of particular interest in the present context are the details of the origins of the carbuncles. In Epiphanius' lapidary, which dates from the end of the fourth century, when garnet cloissonné began to develop, only one source of carbuncle is mentioned: 'they are formed at *Carthage* in Libya, known as Africa.' It is further stated that 'the carbuncle looks like bright red soil'. (I wish to thank Professor Dag Norberg, Stockholm for his translation of this passage from Latin into Swedish.)

This statement is repeated by Marbodius of *Rhennes* in the fourteenth century (Book CLXXI, Migne *ed.* 1854), but he also includes a section on *alabandina,* which are found in Asia but cut in *Alabanda.* According to this work, a stone comparable to *alabandina* is found on *Sardinia.* These lapidaries contain no information that carbuncles occurred in India.

In lapidaries from the fifteenth and sixteenth centuries Indian carbuncles are regularly recorded, the authors following Pliny. In view of the growing trade with India in the Middle Ages, India naturally became the most important source of precious stones. Marco Polo repeatedly tells of precious stones from India being sold in the markets of Asia Minor. It is interesting to note that Marco Polo was aware that red precious stones also occur in places other than India; he mentions 'Balas ruby', a stone which is often described in the medieval lapidaries in connection with carbuncle:

> In the province of Balashan (Afghanistan) the people are Mahometans...
>
> In this country are found the precious stones called Balas Rubies, of fine quality and great value, so called from the name of the province. They are embedded in the high mountains, but are searched for only in one, named Sikinan. In this the king causes mines to be worked, in the same manner as for gold or silver; and through this channel alone they are obtained... Occasionally the king gives them as presents to strangers who pass through his dominions, as they are not procurable by purchase from others, and cannot be exported without his permission. His object in these restrictions is, that the rubies of his country, with which he thinks his credit connected, should preserve their estimation and maintain their high price; for if they could be dug for indiscriminately, and every one could purchase and carry them out of the kingdom, so great is their abundance that they would soon be of little value (Komroff *ed.* 1928, 84–85).

It seems likely that 'Balas rubies' were garnets, as they occur in such large quantities. It is noteworthy that the Balas rubies are not particularly highly valued in the medieval lapidaries (cf. Evans 1922, 93).

### *1:2d Summary*

In Classical sources there are many examples of known sources of garnets, known as *anthrax, anthrakion* or, in Latin, *carbuncle.* In Epiphanius' lapidary, which is the earliest medieval source, India is not mentioned at all as a source of *anthrax.* Pliny specifically states that only *one kind of carbuncle* comes from India. It is only in the fifteenth century that the medieval lapidaries regularly contain information about Indian carbuncles, while the early medieval lapidaries are content to mention places associated with Carthage. Roth's (1980) suggestion that the almandines from Carthage can be identified as Indian garnets is unconvincing in view of Pliny's clear statements.

## 1:3 Mineralogical analysis of inlaid garnets

### *1:3a Chemical and physical analysis*

We have seen above (1:1) that garnets are characterized by a number of properties which can be examined and analysed and which, when properly used, may yield information about the quality of the garnets and sometimes about their provenance.

The earliest published study of analyses of red stones in inlaid work would seem to be the examination of the inlays in the brooches from *Nordendorf* and *Wittislingen* (Weerth 1882, 86). Weerth measured the density of one of the stones as approximately 4.45, which he interpreted as indicating that the inlaid stones were red zircon. Rupp (1937, 13) established that these stones are in fact garnets. It is probable that the density determination was incorrect and that it should have been about 4.3, the density of almandine. The garnets in these brooches have a characteristic reddish-brown colour suggesting a high iron content.

Tischler (1890, 23) examined red stones in connection with his study of finds from *Warnikam,* with a view to distinguishing between garnet, glass and carnelian. He measured the refractive index, which was found to be 1.77.

In the publication of the second treasure from *Szilágy Somlyó,* Fettich (1932, 71) records the densities of five garnets, with values of 3.66, 3.85, 3.86, 3.92 and 3.93. The garnets were taken from different pieces of jewellery. The first and lowest value is considered to indicate hessonite, while the higher values are said to conform to intermediate values of pyrope and almandine. Hertha Rupp (1937, 14), in connection with her work on Rhenish disc-brooches, records the density of stones in brooches from *Kalscheuren, Rill, Andernach* and *Heidenheim.* The tests were carried out with Clerici solution, giving values of 4.28, 4.28, 4.20 and 4.1.

In a study of Merovingian glass, Greta Arwidsson (1942, 92) had x-ray analyses made of a number of red inlaid stones in order to establish whether they were glass or garnet. The results showed that they were all garnets.

Plenderleith (1956) measured the refractive indices of all twenty-one garnets in St Cuthbert's cross. The values recorded were between 1.66 and 1.75. Absorption spectra were also examined: all the garnets produced spectra common to both almandine and pyrope, save one which produced spectra indicating almandine alone.

In connection with a publication of finds from *Paviken* on Gotland (Lundström 1973) which contained uncut rough garnets and one cut garnet, J. Löfgren (1973) carried out mineralogical tests on these stones. A microprobe analysis, from which the theoretical garnet end member was calculated, yielded the following results: almandine 56.34%, pyrope 27.07% spessartite 2.38% and grossular 14.25%. The densities of four rough garnets were between 3.996 and 4.018; the refractive indices of these garnets were between 1.770 and 1.780. Fifty-five rough garnets produced fifty-one diffraction values ranging from 11.540 to 11.560. Two of the garnets produced lower values of 11.535 and 11.538, while the remaining two produced higher values of 11.561 and 11.562 (cf. table VII). The diffraction value of the cut garnet from *Paviken* was 11.543. Löfgren maintains that the rough garnets were the raw material for garnets of the same type as the cut stone. He also believes it possible to establish that these garnets came from *Sjönevad* in Halland. This conclusion will be discussed below.

On my instruction Otto Mellis carried out tests on forty-one red translucent stone plates from inlaid work found in *Sweden, Germany* and the *Crimea.* He published the results in 1963. Forty-one stones were tested for density, refractive index and absorption maxima; finally the inclusions were studied microscopically. The garnets were divided into five groups on the basis of their densities and refractive indices (cf. Table I, chapter 8). Group 1 had the highest densities, with values of 4.16 or above and refractive indices of 1.810 or above. Nine garnets belonged to this group. Group 2 had density values between 4.16 and 4.121, and refractive indices of an average value of 1.800. Seven stones belonged to this group. Group 3 had density values of between 4.12 and 4.03, and the average value of the refractive indices was 1.791. This was the largest group, with a total of eighteen stones, some of which, however, came from the same piece of jewellery. Group 4 had density values between 4.03 and 3.84, while the refractive indices varied between 1.789 and 1.770. Three stones belonged to this group. Finally, group 5 had density values betwen 3.74 and 3.69 with a refractive index of 1.748. There were only two stones in this group.

Using Kennedy and Tröger's division of garnets into groups (cf. 1:1a) Mellis carried out calculations relating to the composition of the five theoretical end members of the garnets. Mellis points out that these calculations are rather uncertain, as it is possible to arrive at several different results from the same values. He maintains that the main component in groups 1, 2 and 3 is almandine, but that the proportion of pyrope rises: in group 1 it is no more than 17%, in group 2, 25% and in group 3 up to 35%. There are also minor variations regarding the content of spessartite, grossular and andradite. In group 4 the content of almandine and pyrope is so high that all other components taken together do not exceed 30%. The two garnets in group 5 contain 70% pyrope.

Mellis also studied the frequency of inclusions in the different groups of garnets. Group 1 is comparatively free of inclusions, with none of the long needle-like inclusions characteristic of groups 3 and 4. In group 2, three plates contain inclusions of this kind, while all the garnets in groups 3 and 4 have long needle-like inclusions. In group 5 this type of inclusion is absent, but inclusions of small round zircon crystals are found.

An archaeological evaluation of Mellis's groups made it difficult to accept these divisions without reservation. Stones from objects of identical type were represented in each of the first three groups, and garnets taken from *one* Rhenish disc brooch, Swed 2, produced values assigning them to groups 1 and 3.

As a complement to these tests Professor D. Carlström carried out x-ray diffraction analysis on a large number of the garnets examined by Mellis. We have seen (1:1f) that Králová's investigations (1970) demonstrate that diffraction analysis can distinguish garnets from different parageneses. X-ray diffraction analysis (see table II, III, IV) suggests that the garnets in Mellis's groups 1 and 2 belong to the same paragenesis, while in group 3 some garnets also belong to this paragenesis, while others seem to have

Table II showing the density values and diffraction values of class 1 garnets.

| Find no. | Provenance | Density (d) | Diffraction |
|---|---|---|---|
| Swed 16/Sw | Sturkö | >4.03 | 11.516 |
| Mainz 18/R | N.P. Germany | >4.03 | 11.517 |
| Swed 90/B-bt | Sanda | >4.03 | 11.518 |
| Mainz 18/D | N. P. Germany | >4.03 | 11.519 |
| Mainz 14/Sb | N. P. Germany | = 4.03 | 11.519 |
| Swed 95/B-bt | Allekvia | >4.03 | 11.519 |
| Mainz 16/R | Dalsheim | – | 11.520 |
| Mainz 13/D | Schwazrheindorf | 4.03>d>4.015 | 11.520 |
| Mainz 16/R | Dalsheim | – | 11.521 |
| Swed 2/D | N. P. Germany | >4.03 | 11.521 |
| Swed 50/M | Kylver | >4.03 (4.16 Mellis 1963) | 11.522 |
| Swed 14/Bu | Sjörup | >4.03 (4.12 Mellis 1963) | 11.522 |
| Bud 7/R | Tatabanya | – | 11.522 |
| Swed 2/D | N. P. Germany | >4.03 >4.16 Mellis 1963) | 11.522 |
| Swed 51/B-bt | Björkome | >4.03 (4.12 Mellis 1963) | 11.522 |
| Swed 2/D | N. P. Germany | – | 11.522 |
| Mainz 15/D | Abenheim | – | 11.523 |
| Swed 25/M | Varv | >4.03 (>4.16 Mellis 1963) | 11.524 |
| Nü 1/Eb | Domagnano | – | 11.524 |
| Mainz 11/D | N. P. Germany | – | 11.525 |
| Swed 105/B-bt | N. P. Gotland | = 4.03 | 11.525 |
| Swed 18/B–bt | Hällan | >4.03 (4.16>d>4.12 Mellis 1963) | 11.528 |
| Mainz 8/D | Abenheim | – | 11.529 |
| Swed 74/B-bt | Tofta | >4.03 (4.12 Mellis 1963) | 11.530 |
| Swed 17 a/G | Helgö | | 11.531 |
| Swed 99/B-bt | Anga | >4.03 | 11.531 |
| Total | N 26 | d>4.015 | av. 11.527 |
| | | Standard deviation S.D. =4.47 | |

a different paragenesis. In group 4 all the diffraction values were similar, and close to those in group 3 which could not be equated with groups 1 and 2. The same was true for the only garnet tested from group 5. It can be seen, therefore, that diffraction analysis to some extent modified the divisions produced by Mellis.

In order to examine whether the divisions based on diffraction analysis agreed with known archaeological data, tests were carried out on garnets from brooches where an analysis of the paste had shown that they had not been subjected to secondary repairs. Three garnets were taken from each of brooches Swed 2/D and Swed 39/B-bt and two garnets from Swed 55/B-bt. These analyses produced a maximum difference of 0.01Å for garnets from the same brooch, and thus did not affect the groupings suggested by the previous analyses. Supplementary diffraction analyses were then carried out, making a total of fifty-two. The results were divided into classes, each containing values of a range of 0.020Å. The applicability of the class divisions was tested statistically (cf. tables II–IV). The diffraction values of classes 1, 2 and 3 showed a normal distribution, with a frequency well separated from each other.

Class 1 includes garnets with diffraction values between 11.511 and 11.531.
Class 2 includes garnets with diffraction values between 11.532 and 11.552.
Class 3 includes garnets with diffraction values between 11.553 and 11.573.

Class 1 contained all the garnets included in Mellis's groups 1 and 2, as well as three garnets from group 3. Apart from the twelve garnets examined by Mellis, a further fourteen garnets of this class were subjected to diffraction analyses. Where possible, these latter were supplemented by density measurements. The results of the measurements conformed to the density values given for Mellis's groups 1 and 2, e.g. values >4.015. Nine of

Table III showing the density values and diffraction values of class 2 garnets.

| Find no. | Provenance | Density (d) | Diffraction |
|---|---|---|---|
| Bud 17/B | Szilágy Somlyó | 3.96>d>3.82 | 11.534 |
| Swed 10/Bt | Ekeby | 4.015>d>3.96 | 11.534 |
| Swed 55/B-bt | Allekvia | – | 11.534 |
| Swed 17/G* | Helgö | =4.01 | 11.536 |
| Swed 26/G | Skrävsta | 3.96>d>3.82 | 11.538 |
| Swed 55/B-bt | Allekvia | 3.74>d>3.69 (Mellis 1963) | 11.538 |
| Bud 17/B | Szilágy Somlyó | 3.96>d>3.82 | 11.538 |
| Bud 20/B | Szilágy Somlyó | 3.96>d>3.82 | 11.540 |
| Bud 30/Bu | Hungary | 3.96>d>3.82 | 11.541 |
| Szeg 2/G | Szeged-Nagy. | 3.96>d>3.82 | 11.542 |
| Swed 61/G | Paviken | – | 11.543 |
| Swed 113/B-bt | Othem | 4.015>d>3.96 | 11.545 |
| Swed 41/B-bt | Köping | 4.015>d>3.96 | 11.547 |
| Bud 23/B | Szilágy Somlyó | 3.96>d>3.82 | 11.548 |
| Bud 25/B | Szilágy Somlyó | 3.96>d>3.82 | 11.548 |
| Bud 1/Bu | Hungary | – | 11.549 |
| Total | N 16 | 4.015>d>3.69 | av. 11.541 |
| | | Standard deviation S.D. = 5.28 | |

* Mellis 1963 gives the density 4.03 but this measurement cannot be repeated and may be due to the garnet not being quite clean.

Comparison between the averages with standard deviation of classes 1 and 2.

*Hypothesis.* Both classes have normal distribution with separated frequencies. The difference in frequency is calculated according to the following formula, (cf. Arkin and Colton 1955, 120–122).

$$\sqrt{\frac{(S.D._1)^2}{N_1}+\frac{(S.D._2)^2}{N_2}} \times 3 < av._1 - av._2$$

i.e.

$$\sqrt{\frac{(4.47)^2}{26}+\frac{(5.28)^2}{16}} = \sqrt{0.77 + 1.73} = \sqrt{2.50} = 1.58$$

The difference between the averages is 14. As 3 × 1.58 is considerably less than the difference between the averages, the distribution of the classes are significantly separated to 99%.

Table IV showing the density values and diffraction values of class 3 garnets.

| Find no. | Provenance | Density (d) | Diffraction |
|---|---|---|---|
| Swed 45/B-bt | Rullerum | = 4.03 | 11.553 |
| Swed 39/B-bt | Tuna | 4.03>d>4.015 | 11.554 |
| Swed 54/B-bt | Björkome | = 4.03* | 11.555 |
| Swed 39/B-bt | Tuna | 4.03>d | 11.555 |
| Bud 19/B | Szilágy Somlyó | 4.015>d>3.96 | 11.556 |
| Swed 1/M | Krim | 4.01>d>3.84 (Mellis 1963) | 11.557 |
| Swed 40/B-bt | Ruda | = 4.03 | 11.558 |
| Swed 52/B-bt | När | 4.01>d>3.96 | 11.559 |
| Swed 31/Sw | Vendel 1 | = 4.03 | 11.559 |
| Swed 39/B-bt | Tuna | 4.03>d>4.01 | 11.564 |
| Total | N 10 | d 4.03–3.84 | av. 11.557 |
| | | Standard deviation S.D. = 3.036 | |

* Mellis 1963 gives the density >4.03 but this value could not be repeated and may be due to the garnet being not quite clean.

The separation of the distribution between classes 2 and 3 was examined as for 1 and 2, considering however the small number ($N < 30$) using N–1 as multiple (cf. Arkin and Colton 1955, 127.

i.e. $\sqrt{1.86 + 1.024} = \sqrt{2.88} = 1.70$. The difference between the averages is 16 and 3 × 1.70 is considerably less than this value. This proves that the distributions are significantly separated to 99%.

the twenty-six garnet samples analysed by diffraction analyses were too small to be tested for density. However, of these, six samples were from garnets from Rhenish disc brooches; seven other garnets from this type of brooches had produced both density and diffraction values. The refraction values measured on eight garnets were from >1.810 to 1.790.

Two garnets from Mellis's group 3 and one from group 5 could be assigned to class 2. A further twelve were included in this class and their densities were measured. The densities were all below 4.015, varying between 3.70 and 3.96. The refractive indices of two garnets gave values from 1.775 – 1.785. Class 3 included six garnets from Mellis's group 3 and both garnets from his group 4. One garnet from one of the disc brooches from *Szilágy Somlyó* was also assigned to this class. The values for the densities of the garnets in this class had a wider range than in class 1 and 2. The density values varied from 4.03 down to 3.84. The refractive indices were also about the same as in class 2 but with a wide range from 1.798 to 1.77.

It appears that while Mellis's group 1 and 2 largely agree with class 1, based on diffraction values, Mellis's group 3 was completely divided by the diffraction classes. Mellis himself however indicated (Mellis 1963, 346) that group 3 was a heterogeneous group. One of the reasons for this was the comparatively coarse gradation Mellis used to establish densities below 4.03. With modern pipetting techniques it is possible to achieve considerably smaller intervals between the density values given by the Clerici solution for values below 4.035. Above this value the Clerici solution becomes so concentrated that it begins to crystallize, forming a bottom layer which continues to grow until equilibrium is reached at about 4.03–4.04, depending to an extent on temperature and atmospheric pressure. Accurate density values over 4.03 are therefore not as easily determined with a Clerici solution. Thus in my density determinations I chose to record values above 4.03 only as >4.03. As a control, every measurement was repeated twice with a day's interval.

While thus classes 1 and 2 are easily differentiated on the basis of density and refractive index, it is not possible by these means so easily to distinguish class 3 from class 1 and 2. There are certainly no examples in class 3 of the high density or refractive index values of most of the class 1 garnets, e. g. densities, higher than 4.03 and refractive indices >1.800 but in the case of garnets with densities between 4.01 and 4.035 and refractive indices between 1.790 and 1.799, *only the diffraction values can determine the class*. This is also the case for garnets with low densities, that is, less than 3.74, and refraction indices below 1.780. In these cases it is not possible to use these values to determine whether the garnets belong to classes 2 or 3.

Calculations were finally carried out in order to establish whether there was a direct or inverse correlation between individual diffraction values, densities and refractive indices. As predicted, these calculations gave a negative answer.

By this means it was established that in a division into classes based on diffraction values, a correlation with density values and refractive indices could be established, within certain intervals, in the case of the first two classes, while in the third class the extreme values were similar to those found in the other two.

This suggests very clearly that this method of division is only relevant when considering a limited body of material of a comparatively uniform origin. It has been suggested above that the classes can be associated with certain archaeologically homogeneous groups of objects. Thus all the Rhenish disc brooches belong to class 1. Ojects of Hungarian-Gothic type, including the brooches from *Szilágy Somlyó*, a mount from *Szeged-Nagyszéksós* and two circular gold buckles from Hungary all belong to class 2. Late Scandinavian button-on-bow brooches and cloisonné work belong to class 3, as do a number of objects from the Black Sea.

Chapter 1:3d contains a discussion of the significance of these classes for an understanding of the geographical origins of cut garnets. In conclusion I wish to emphasize that the classes established here, if based only on diffraction values, are only relevant to an archaeologically limited body of material, a fact which also emerged from the above examination. The tests on a single piece of Parthian jewellery from *Hatra* in Persia produced values which completely contradicted the classes set out above. While the diffraction value of this garnet was 11.529—within the limits of class 1—its density was between 3.80 and 3.87. The refractive index was 1.740. Class 1 contains garnets with low diffraction values and high refraction values and densities, but this garnet produced low values both in diffraction, refraction and density. It was also remarkable for its lack of inclusions. The garnet from *Hatra* suggests the existence of another class, class 4. The garnets included in this study have not provided any opportunity to determine the characteristics of this class.

### *1:3b Comparison between the classified cut garnets and rough garnets from Ceylon and Bohemia*

The classification of garnets according to their diffraction values would appear to be reliable both from an archaeological and a statistical point of view. It therefore remains to establish how these divisions may illuminate the question of their geographical origin. Can the classes be equated with particular areas, and if this is the case, can these be identified?

The close correlation between the classification based on diffraction values and other chemical properties of the garnets suggests that the garnets within one class are a mineralogically homogeneous group. We have already seen that garnets from the same area may differ as to both chemical composition and crystal structure. This would explain the variations in diffraction values. However, I have been unable to find examples in the literature of variations in excess of 0.020 Å in garnets with the same paragenesis and geographical origin. Garnets with different parageneses, but from the same area, may of course demonstrate wider variations. Thus the Bohemian pyrope garnets described by Králová (see above 1:1f) produced diffraction values which apparently distinguished between garnets from the primary rock and from serpentine deposits.

As India with *Ceylon* are relevant as sources of almandine garnets, I had tests made on six randomly-collected garnets from this area. The diffraction values lay between 11.527 and 11.539 with an average of 11.53216. Frequency calculations for the diffraction values of these garnets (cf. table V) demonstrated that their distribution was clearly distinct from both classes 1 and 2, although the diffraction values, taken on their own, belong to these classes. One of the tested garnets (2) had a colour and a refractive index very similar to the garnet from *Hatra* described above, and appeared to have a lower density (3.87–3.82) than the others.

An examination of the diffraction values conclusively proves that garnets like those collected in *Ceylon* today cannot have been the raw material of the garnets classified here. The Bohemian pyropes displayed a slight degree of correlation (5%), but this is too small to be considered. Before examining further the question of geographical origin, we must consider a further property of garnets, which was first noticed by Mellis (1963).

In his study of cut garnets, Mellis points out that the inclusions show a peculiarly distinctive and regular orientation. It has long been known that inclusions in garnets lie parallel to the crystal faces. Mellis's measurements showed that all the inclusions were at the same angle relative to the cut surfaces, and that the cut surfaces must therefore coincide with the crystal faces. Mellis interprets this as an indication that the raw material must have had well-developed rhombododecahedron crystals, the garnets being ground down parallel to the crystal faces (Mellis 1963, 358). If the material used had been weathered-out and rounded garnets such as those found in *Bohemia* and *Ceylon*, extreme skill would have been required to grind the garnets along the crystal faces. Garnets are not considered cleavable, that is, they do not split along the crystal faces: Mellis therefore maintained that garnets of this type could not have been used.

Table V showing density and diffraction values of almandine garnets from Ceylon (purchased on Ceylon).

| No. | Provenance | Density (d) | Diffraction |
|---|---|---|---|
| 1 | Ceylon | 4.035>d>4.015 | 11.527 |
| 2 | Ceylon | 3.89>d>3.82 | 11.528 |
| 3 | Ratnapura, Ceylon | 4.015>d>3.96 | 11.529 |
| 4 | Ceylon | 4.035>d>4.015 | 11.534 |
| 5 | Ceylon | 4.035>d>4.015 | 11.536 |
| 6 | Ceylon | 4.035>d>4.015 | 11.539 |
| Total | N 6 | 4.035>d>3.82 | av. 11.532 |
| | | Standard deviation S.D. = 4.89 | |

The difference in distribution between *Ceylon* garnets and class 1 garnets was established by the method already described.

$$\sqrt{\frac{(4.47)^2}{25} + \frac{(4.89)^2}{5}} = \sqrt{0.799 + 4.782} =$$

$$\sqrt{5.581} = 2.36$$

As the difference between the averages is 10, 2.36 × 3 leaves a margin to show that the frequency is significantly separated to 99%. The same calculation was made between class 2 garnets and *Ceylon* garnets. This produced the value 2.58 to be compared with the difference betwen the averages, which in this instance was 9. Thus the frequency in this case was also significantly separated to 99%.

However, the parallel grinding suggested by Mellis as the technique for producing garnet plates was technically impossible until recently, as it requires a cutting tool powered by advanced technology, ensuring a closely-regulated pressure on the piece being worked. The manually-powered cutting tools in use until the present day could never afford such possibilities. Even presupposing modern technology, the smoothness of the garnets is remarkable. Mellis's observation that the surfaces coincide with the crystal faces *must indicate that the garnets were cleaved.*

Methods of cleaving garnets will be described more closely in the next chapter; it will suffice here to point out that cleaving necessitated the selection of garnets of a particular quality. Mellis stated that the garnets under consideration must have had a well-developed rhombododecahedron crystal structure, but it should be noted that they must also have undergone metamorphosis after crystallization, causing the crystals to be compressed, and resulting in a schistose structure. Only in such circumstances may garnets be split along the crystal faces, although in general they are not cleavable, as is stated in all handbooks on mineralogy. *Therefore the raw material for cut garnets in antiquity must have been crystalline garnets which had undergone a certain metamorphic change.* Thus the sources of garnets in more recent times, when the stones were either cut in facets or cabochon, were not relevant to collectors of stones in antiquity, and it is understandable that no correlation has been found between the ancient and modern garnets.

Our search for sources of garnets of the quality required in antiquity must therefore concentrate on areas where the rocks have undergone metamorphic changes which may have produced garnets of this kind. It is not very unusual for garnets to have been metamorphosed in some way, but the particular properties which are relevant here, with the crystalline structure partially preserved in one direction and the crystals forming relatively large surface planes, are less common. In searching for records of such deposits in a very large number of publications on mineralogy, I became convinced that sources of such garnets of a quality suitable for jewellery—sufficiently transparent and bright in colour, for instance—are rare, although I am unable to support this statement with precise statistics. Metamorphic changes commonly also cause discoloration in garnets.

In a study of precious stones, Brückmann (1773 and 1778) provides interesting information concerning Bohemian garnets: he describes a method of splitting the stones by heating and rapid cooling. This technique would also have necessitated the use of garnets of the type described above. There was, interestingly enough, a source of such garnets in Bohemia: they occur in the form of schistose porphyroblasts and may be found in fist-size pieces at a site by *Zbyslav,* not far from *Càslav* in south Bohemia, now in Czechoslovakia. These garnets are of a good and even colour and also easily cleavable and have a density of 4.03. Diffraction analysis produced the value 11.525, well within the standard deviation range for garnets of class 1 type. It is quite possible, therefore, that class 1 garnets originate in this area.

The Zbyslav rocks belong to a crystalline complex associated with the Kutna hora-complex, and consist of a band of strongly metamorphosed orthogneisses, migmatites and amphibolites. The garnets are embedded in an amphibolite. It is characteristic of the rocks in this complex that they have a pronounced schistose structure, which suggests that the area has been severely metamorphosed.

Within this same crystalline complex, Bohemian garnets of a more common kind also occur, without the schistose structure. Králová-Jirovcová (Králová-Jirovcová 1958, table 2) gives the values of crystalline Bohemian almandine garnets. They have refractive indices from 1.816 to 1.880; densities from 4.019 to 4.0735 and diffraction values 11.530±0.010. The values correspond well with the values in our class 1 although the diffraction values are at the outer limits of the class.

Diffraction values of garnets from severely metamorphosed rocks are however lower than those from less metamorphosed rocks, as the heat and pressure accompanying metamorphosis cause the compression of the garnet crystal. It must be pointed out, however, that this does not mean that garnets with higher diffraction values are generally less metamorphosed, the chemical composition is the most important feature in the formation of the crystal lattice. But where it is possible directly to compare garnets from the primary rock with those from rocks metamorphosed from it, as in the example quoted above, a reduction of diffraction values does seem typical.

It is therefore possible to state with a certain degree of probability that garnets from class 1 could have originated in these areas of Bohemia, or at least in sites similar to these.

Table VI showing refraction, density and diffraction values of Bohemian pyropes (analysed by Králová 1958).

| No. | Provenance | Refraction | Density (d) | Diffraction |
|---|---|---|---|---|
| 1 | Měrunice | 1.700 | 3.701 | 11.540 |
| 8 | Linhorka | 1.740 | 3.705 | 11.540 |
| 6 | Podsedice | 1.770 | 3.709 | 11.542 |
| 3 | Dlažkovice | 1.710 | 3.702 | 11.550 |
| 4 | Chodovlice | 1.750 | 3.707 | 11.550 |
| 5 | Černívo | 1.750 | 3.707 | 11.550 |
| 7 | Třtěno | 1.715 | 3.702 | 11.550 |
| 9 | Již. od Chrášť | 1.730 | 3.702 | 11.550 |
| 2 | Semč | 1.760 | 3.707 | 11.560 |
| Total | N 9 | 1.700–760 | 3.701-709 | av. 11.5478 |
| | | | | Standard deviation S.D. = 6.4 |

The difference in distribution between the Bohemian pyropes and *Ceylon* almandine garnets was established using the method described above.

$$\sqrt{\frac{(4.89)^2}{5} + \frac{(6.4)^2}{8}} = \sqrt{4.78 + 5.12} = \sqrt{9.90} = 3.14$$

As the difference between the averages is 15.62, the frequencies of both groups are significantly separated to 99%.

The difference in distribution between Bohemian pyropes and class 2 garnets was also analysed.

$\sqrt{1.86 + 5.12} = \sqrt{6.98} = 2.64$. As the difference between the averages in this case is only 6.8 the distributions are not quite separated, e.g. the distributions are only separated to 95%.

*1:3c The origins of class 2 and 3 garnets*

The find from *Paviken* mentioned above is of special interest when discussing the provenance of class 2 and 3 garnets, and will therefore be examined in greater detail.

During the archaeological excavations at *Paviken*, a trading-post from the late Iron Age at *Västergarn* on Gotland, a total of 278 rough garnets was found: of these, 258 came from a limited area about twenty square metres in size. A cut garnet was also found in this area, presumably intended for a cloisonné setting. Another garnet was found attached to a piece of rock. Lundström (1973, 67 ff.) points out that tesserae, glass rods and glass beads were also found in this area.

We have already mentioned Löfgren's examination of the garnets using microprobe analysis (of one sample), refractive indices (four samples), density (four samples) and finally an x-ray diffraction analysis of fifty-five garnets. The garnets were selected at random, irrespective of whether they came from the limited area or from the excavation in general. With the results of these analyses Löfgren described the parageneses in which the garnets were formed: he particularly underlines the fact that the garnets must have been considerably metamorphosed, as they had nearly lost their crystalline form and had an almost layered structure. An analysis of the inclusions revealed that among them were apatite, ilmenite and hornblende. Together with the microprobe analysis, which showed that these garnets contained almandine as well as 27% pyrope, these results indicate that the garnets were formed through metamorphosis of a basic rock, that is, a garnet amphibolite.

Löfgren's conclusion that these garnets had been subjected to very strong metamorphosis accords well with Liu's (1977) observations concerning the formation of ilmenite, a common mineral component of these garnets. Liu has shown that ilmenite is formed from pyrope garnets in conditions of high pressure (300 kilobars) and temperature (between 1 000 and 1 400°C). Löfgren's description of the paragenesis of the *Paviken* garnets could with advantage be extended to include the majority of the gem garnets considered in this study, as severe metamorphosis is such a common characteristic (see above).

However, in one respect the *Paviken* garnets differ from cut garnets: their x-ray diffraction values vary to a much greater extent, ranging from 11.535 to 11.562, and thus extending over both classes 2 and 3.

Neither Löfgren nor Lundström discusses the possibility that the garnets at *Paviken* could have different geographic origins. Löfgren maintains that they originated in a garnet amphibolite in *Sjönevad* in Halland. A mineral sample from this site produced diffraction values of 11.537 and 11.549, which according to Löfgren fall within the broad limits of the diffraction values of the *Paviken* garnets.

The large spread of diffraction values produced by the *Paviken* garnets results in an anlysis series which differs completely from those we have found in relation to the cut garnets and in the analysis of garnets from Bohemia and India. The standard deviation of the *Paviken* garnets, 7.4 (cf. table VII), is greater than in any of the other categories. It would therefore be of interest to find out whether the *Paviken* garnets' analysis series could represent two different sequences, Tables VII, VIII and IX show that a division of the *Paviken* garnets into two classes corresponding to the classes previously identified produces normal distribution curves clearly separated from each other. The garnets from *Paviken* in class 3 produced the same frequencies as the cut garnets, while those in class 2 had a slightly higher average value.

Is there any archaeological evidence to suggest that garnets from two different sources could have been found at the trading-post at *Paviken*? In order to answer this question we must first examine other finds of class 2 and 3 garnets in Sweden.

In the material from Gotland, class 2 garnets have been found on one button-on-bow brooch from Nerman's second Vendel period, and on another from the late

Table VII showing diffraction values of 55 rough garnets from *Paviken*, Gotland.

| Number | Diffraction |
|---|---|
| 1 | 11.535 |
| 1 | 11.538 |
| 3 | 11.541 |
| 3 | 11.543 |
| 4 | 11.544 |
| 1 | 11.545 |
| 6 | 11.546 |
| 4 | 11.547 |
| 5 | 11.548 |
| 4 | 11.549 |
| 7 | 11.550 |
| 2 | 11.551 |
| 2 | 11.552 |
| 1 | 11.554 |
| 2 | 11.555 |
| 3 | 11.556 |
| 1 | 11.557 |
| 2 | 11.558 |
| 1 | 11.559 |
| 1 | 11.561 |
| 1 | 11.562 |
| Total N 55 | av. 11.558 |
| | Standard deviation S.D. = 7.43 |

Vendel period, Nerman's fifth period. The garnets from the former brooch (Swed 55) consist of round plates, 0.7 mm thick, cut by a rotating wheel (cf. chapter 2). The garnets from the latter brooch (Swed 113) are remarkably large, size 2–3: these garnets are not cut, but reshaped by retouching. The thickness—0.7 mm—is the same.

Outside Gotland, another fragment of a late Vendel period button-on-bow brooch with retouched class 2 garnets was found in a grave from *Klinta* on Öland. It is probable that the retouched garnets on the pendant from *Edsberg*, Närke (Swed 42), which Mellis assigned to his group 5, can also be assigned to class 2 (see above).

Finds from a cremation grave in *Skrävsta*, Södermanland (Swed 26a–b) included a sword pommel of gold with garnet cloisonné in fused paste technique (cf fig. 213) and one garnet belonging to another object, probably a buckle, (fig. 50 compare fig. 148 from a Hungarian buckle). A garnet from the sword pommel, highly burnt and therefore opaque, fig. 51, had a density which refers it to class 1, whereas the loose garnet had a density and diffraction value belonging to class 2. The shape of the latter garnet, which is closely similar to the shape of garnets of class 2 found on Hungarian buckles of fig. 148–149, makes these analyses conclusive. A clasp button from *Ekeby*, (Swed 10), belonging to a type clearly produced in Uppland but with connection to Hungary (cf. Arrhenius 1975), also had a garnet of class 2.

Table VIII showing diffraction values of 43 rough garnets from *Paviken*, Gotland, belonging to class 2.

| Number | Diffraction |
|---|---|
| 1 | 11.535 |
| 1 | 11.538 |
| 3 | 11.541 |
| 3 | 11.543 |
| 4 | 11.544 |
| 1 | 11.545 |
| 6 | 11.546 |
| 4 | 11.547 |
| 5 | 11.548 |
| 4 | 11.549 |
| 7 | 11.550 |
| 2 | 11.551 |
| 2 | 11.552 |
| Total N 43 | av. 11.547 |
| | Standard deviation S.D. = 3.69 |

It is noteworthy that the rough class 2 garnets from *Paviken* have a frequency which is in part different from the cut garnets, whose average value of 11.541 and standard deviation of 5.12 are rather less than those of the *Paviken* garnets. The only cut garnet at *Paviken* has a value of 11.543, which is well within the top values for class 2, suggesting that pieces were deliberately selected for cutting. This problem will be discussed in more detail in chapter 2.

Table IX showing diffraction values of 12 rough garnets from *Paviken*, Gotland, belonging to class 3.

| Number | Diffraction |
|---|---|
| 1 | 11.554 |
| 2 | 11.555 |
| 3 | 11.556 |
| 1 | 11.557 |
| 2 | 11.558 |
| 1 | 11.559 |
| 1 | 11.561 |
| 1 | 11.562 |
| Total N 12 | av. 11.557 |
| | Standard deviation S.D. = 2.45 |

Comparison between the frequencies of *Paviken* garnets and cut garnets of class 3 according to the formula set out above:

$$\sqrt{\frac{5.98}{12} + \frac{9.22}{10}} = \sqrt{0.50+0.92} = \sqrt{1.42} = 1.19$$

As the difference between the averages is 0, the frequencies are seen to belong to the same normal distribution curve.

In the settlement deposits from *Helgö* a class 2 garnet (Swed 17a), with the remains of a (concave) cut edge was found. It came from the settlement area (building group 3), within which was situated a workshop of Migration period date and where, among other objects, clasp buttons related to the example *Ekeby* were produced (cf. Arrhenius 1975).

Class 2 garnets therefore occur in several finds in Sweden other than *Paviken*: some from the Migration period and early Vendel period, the majority of stones having cut edges; and others from the late Vendel period and early Viking Age, where the stones are either rough or have retouched edges.

Of the non-Scandinavian material, Hungarian finds account for a majority in class 2. All the garnets were cut with a wheel. It is likely that the Swedish examples with cut edges were manufactured in the same place as the Hungarian (cf. chapter 2).

Retouched garnets are characteristic of Scandinavian finds from the late Vendel period and the early Viking Age (cf. chapter 2). These were manufactured from garnets in classes 2 and 3. It is therefore quite reasonable that garnets of both these types were found at *Paviken*. However, their use on this site was probably secondary, perhaps as a polishing agent in glass bead manufacture.

Is it then likely that these garnets, and by extension class 2 garnets in general, came from *Sjönevad*? For several reasons I consider this to be very doubtful. In the first place it seems most unlikely that these garnets were exported to Hungary as early as the Migration period, given that the majority of garnets in the Scandinavian finds of this period and the subsequent Vendel period are of class 1 type. If sufficient class 2 garnets were produced in Scandinavia to allow them to be exported, one would expect them to be most common in the Scandinavian material: this is not the case; indeed, they are less numerous than the class 1 or 3 garnets. Furthermore, the *Sjönevad* garnets were not very suitable for use as gemstones, as they do not have the attractive bright colour and, in the author's experience, are difficult to cleave into larger plates, as the crystals are so metamorphosed that the garnets easily disintegrate into powder. It is this characteristic which allowed the *Sjönevad* garnets to be used as abrasives (cf. Bergström 1943).

Amphibolite garnets are not in fact particularly rare, occurring in Scandinavia both at Kragerö in Norway and *Åbo* in Finland. I have been able to carry out x-ray diffraction analysis on material from the latter area. The resulting value of 11.539 lies within the limits of class 2. The garnets from *Åbo* are more cleavable than those from *Sjönevad,* but their colour is not very even. I doubt that these garnets were used as gemstones.

Tröger records a number of sources of garnet amphibolite in Eastern Europe, in particular in Lower Austria. *Kotes* and *Rosenburg,* along with *Kor-Alpen* in Steiermark, are of particular interest, as the composition of the garnets from these sites agrees fairly well with Löfgren's analysis of the *Paviken* garnets (the grossular content is higher in the Austrian samples, but this difference would seem to fall within the tolerance of the analytical methods). Brückmann's record of garnet sources describes garnets from Steiermark which he maintains could reach the size of a fist (Brückmann 1778, 84).

These sources of garnet amphibolite are of special interest, as they were situated in an area where natural stone was used in the construction of mosaics since Roman times. This will be considered in more detail in chapter 2.

In classes 1 and 2 it is probable that we are dealing with comparatively homogeneous European sources of garnets. In considering class 3 this is much less likely. Although the analysis series is dominated by Scandinavian finds, there are important examples from outside Scandinavia: from a Gothic mount from the *Crimea;* and from one of the circular brooches in the second treasure at *Szilágy Somlyó,* fig. 6. The isolated position of this brooch in the *Szilágy Somlyó* treasure was already noted by Riegl (1927, 388). The probable oriental origin of this brooch will be discussed in more detail in the context of cutting techniques in chapter 4:3. The garnets from the two non-Scandinavian brooches show a marked similarity as regards density and refractive index. The body of material is too small to attempt an identification of the geographical origin of these garnets, but I consider an oriental origin to be most likely.

The Scandinavian finds in class 3 are from the late Vendel period, where the garnets are cut in coarse step-patterns, and from the transitional period of the Viking Age, where they were retouched. The coarse step-patterns have some parallels in the material from the Black Sea area (cf. chapter 4). To my knowledge, no Scandinavian garnet amphibolite has registered a diffraction value as high as those recorded for class 3 garnets. If the two garnets discussed above are believed to originate in the Black Sea area, it is not impossible that this is also the case for all the remaining garnets in class 3. Differences in density and refractive index within a certain limit may be due to different parts of a garnet amphibolite being exploited in different periods. Variations in density and refractive index can apparently be considerably larger within the same site than the diffraction values (cf. 1:1b and 1:1c).

We have seen above that the material examined contained only one example suggesting the existence of another class of gem garnets, class 4. This garnet was characterized by a low density and diffraction values of about 11.530. It is tempting to hypothecate that this represents a type similar to the garnets recorded from *Ceylon.* The garnet from *Hatra* (fig. 8) could in that case prove the existence of Indian garnets of the kind described by Pliny. This would also be in agreement with the evidences of Roman trade with India (cf. Warmington 1974).

### *1:3d The provenance of cut garnets: conclusions*

In order to establish the provenance of cut garnets, sixty-five garnets from archaeological artefacts and a number of rough garnets from different sites were mineralogically examined. The cut garnets could be divided into four classes on the basis of their diffraction values, densities and refractive indices. Three of the four classes were represented by statistically valid samples, while class 4 contained only one cut garnet.

An analysis of the archaeological objects showed that class 1 apparently comprised garnets from West European (Frankish) almandine jewellery, while class 2 gar-

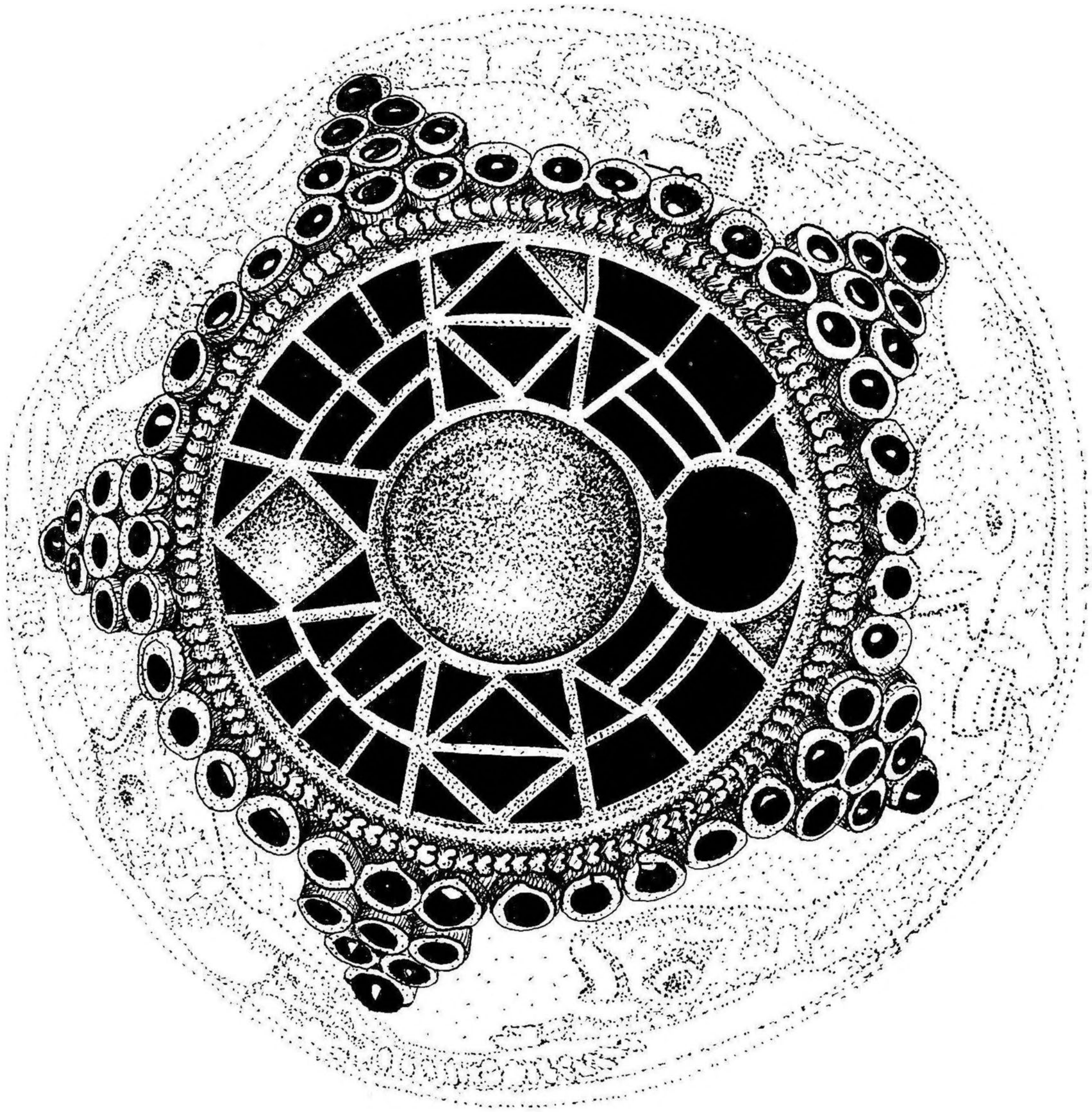


Fig. 6–7. Domed disc brooch from Szilágy Somlyó. 6. Appr. 1:1. 7. 2:1.

nets were mainly found in Hungarian jewellery and class 3 garnets occurred on objects from the Orient and Scandinavia. The suggested provenance of class 1 garnets was south-west Bohemia, of class 2 south-west Austria, while the provenance of class 3 garnets, with some reservations, is suggested as Asia Minor.

The garnets in classes 1–3 would seem to have somewhat different chronological frequencies. Class 3 seems to be the earliest (this point will be discussed further in chapter 4:3). However, class 3 garnets continue to be used on archaeological objects dating from the late Roman period up to the Viking Age. Class 1 garnets have the shortest chronological span, being known only from the later fifth century until the middle of the Merovingian period, about 600. Class 2 garnets are known from the latest part of the fourth century up to and including the Viking Age.

It may be questioned whether the analysis material recorded here can ~~be seen as representative~~ of garnet jewellery from the whole Germanic area. This problem will be pursued further in the next chapters. It appears that all the garnets have fairly similar shapes, which suggests that there were not many centres of manufacture. By this token it can be argued that the garnets described in this study may be fairly representative. It may be pointed out, however, that this is only true for the Germanic area. There is a large body of Hellenistic garnet jewellery, which probably consists of mineralogical groups from different sources. The only garnet in class 4, from *Hatra,* may serve as an example. The number of sources of carbuncle quoted by Pliny demonstrates that this was the case.

## 1:4 Other inlay materials

As it developed, garnet work tended gradually to become increasingly monochromatic. This tendency was probably due to garnet art becoming more provincial as it spread outwards from the late antique central workshops. The polychromatic inlays were intended to heighten the red colour of the garnets: hence the predominance of contrasting colours like blue and green stones as well as white inlays. In the late Roman and early Migration periods, however, the opposite effect is sometimes achieved where the sparing use of garnets served to set off the lustre of, for instance, a larger inset stone. This effect can be observed on the carnelian brooch from *Årslev* where small keeled garnets were inlaid on the foot and head-plate of the brooch (fig. 24), and on the large sardonyx brooch from *Szilágy Somlyó* (Bud 26), where small garnets in rectangular cells surround the large sardonyx. Inlays with large precious stones later become rare, one of the few exceptions being the chape from Childeric's seax which has a large sardonyx surrounded by a border of garnet cloisonné, fig. 11. A considerably smaller onyx is set together with stepped garnets from the b-templet on a small, possibly Vandal, bow brooch from *Algeria* (fig. 12). Other stones, which were probably originally cut in late antique workshops, and which later occur on garnet jewellery, include rock crystal, turquoise and, mainly on Christian objects, emerald and amethyst. Malachite and lapis lazuli also occur, but imitations of these precious stones are more common; thus opaque blue glass imitates lapis lazuli and opaque green glass malachite. It is likely that the glass imitations were cut in the same workshop as the garnets. These imitations must not be confused with the enamelling which also occurs, although only rarely with garnet cloisonné. Enamelling is found on Hellenistic goldsmith's work which sometimes also has inlaid garnets, while at a much later date a yellowy-orange, porous enamel is found primarily on cloisonné in the fused paste technique (cf. chapter 6). On some fused paste work there are inlays in transparent glass of different colours (green, yellow, pale blue and pale red), a feature which probably resulted from the scarcity of garnets in the seventh century (cf. 5:4). Among opaque glass inlays, the mosaic-like stones used at *Sutton Hoo* (cf. Bruce-Mitford 1978), for instance, are particularly remarkable, as they provide a direct link with mosaic art; it is likely that these green and blue inlays were originally cut from glass tesserae.

This suggestion is supported by analyses (cf. Bimson in Bruce-Milford 1978) which show that the opaque coloured glass has the same chemical composition as late antique glass. The polychromatic inlays described here are mainly found on cloisonné objects using the cement technique (cf. chapter 4) and sand putty technique (cf. chapter 5). Most polychromatic inlays described in the literature are from Anglo-Saxon work, but it must be emphasised that the same type of opaque coloured glass is found on the cloisonné work both of the Franks and the East Goths. As the material is probably glass tesserae, it was probably brought from the Byzantine area. Particularly noteworthy is the polychromatic element in the cloisonné work from *Domagnano* (cf. 152). The Franks used another type of polychromatic inlay, of coloured bone (ivory). I was able to ascertain that this substance was in fact bone, as the hardness of the material could be determined by scraping and this identification was confirmed by analyses of similar material from Swedish button-on-bow brooches (cf. Arrhenius 1971, 223 no. 126–129).

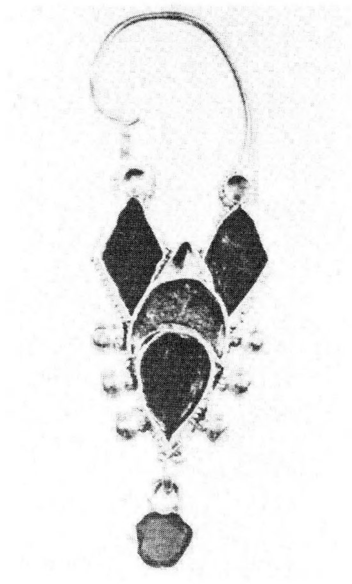


Fig. 8. Ear-ring with garnet cloisonné from Hatra Irak (Bagdad 1). 1:1.

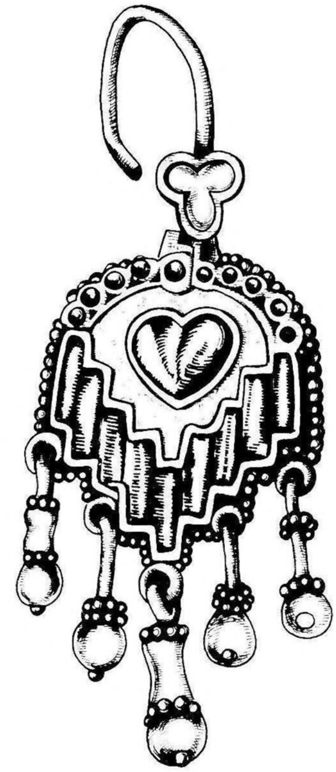


Fig. 9. Ear-ring from Armazis Khevi, Georgia with relief-cut garnets in the shape of a heart and a corrugated chevron. 1:1.

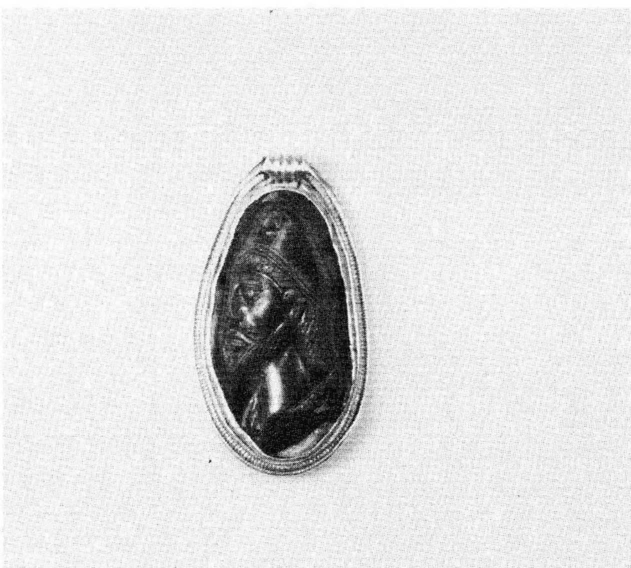


Fig. 10. Garnet cameo, probably Sassanian, mounted in an Anglo-Saxon pendant found at Epsom, Surrey. 1:1.

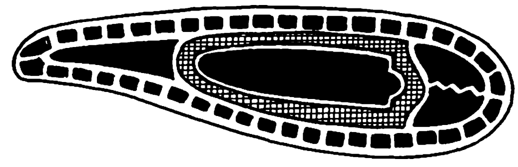


Fig. 11. Chape from Childeric's seax with garnets (black) and a large grey-white onyx (cross-hatched); in the centre a red garnet. 1:1.

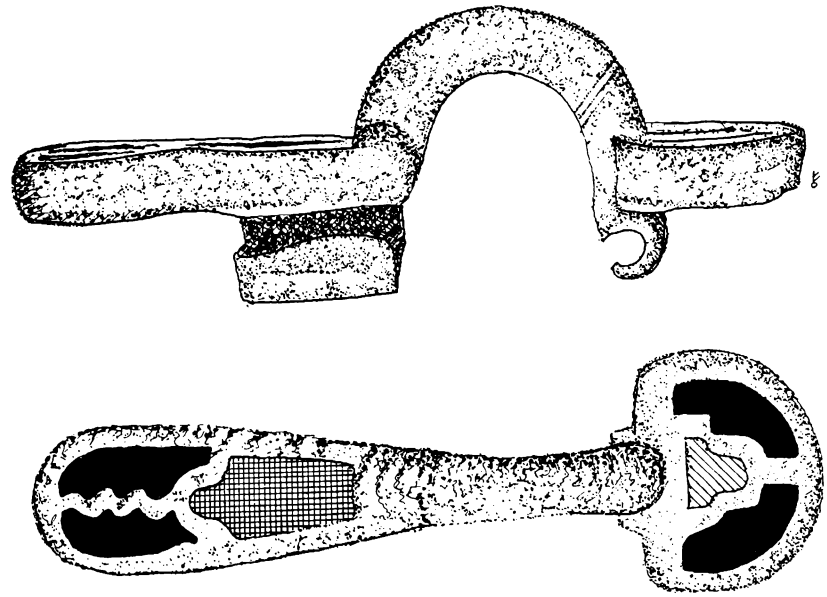


Fig. 12. Brooch from Algeria (Paris 9) with garnets (black), a black onyx (cross-hatched) and green glass (diagonal hatching). 2:1.

While coloured inlays are usually of glass, it appears that the white material which was often used to mark the centre was usually of some other material. There are exceptions, such as the creamy-white opaque glass used, for instance, on the cross in the centre of a disc brooch from *Schwenningen* (Stutt 2) made using the cement technique. I have analysed some white inlays which proved to be mother-of-pearl (Arrhenius 1973, 223, no. 27), while others proved to be calcium aluminium silicate, probably scolecite, a white soapstone-like material known as meerschaum (Arrhenius 1973, 223, no. 26) (cf. Webster 1976, 298). Evison (1951) reports analyses of a whitish material from English disc brooches where x-ray diffraction analysis identified magnesite and cristobalite, that is quartz which has been heated to over 1500 degrees. Evison presumes that this was an artificially produced mineral, which is not impossible, since Pliny (*Historia Naturalis* Book 37, Eichholz 1962, 325) warns against making artificial minerals. The high temperature needed to bring about the change to cristobalite—which in this case does not only apply to single grains, as is seen in the (?)paste from a garnet cloisonné object in *Uppsala Västhög* (cf. 6:2)—leads me to assume that this substance was a metamorphosed mineral of magnesite type. There is a whole range of mincrals of this kind with colours running from white to greyish-brown and green (cf. Webster 1976, 305).

Magnesite was used, for instance for beads (cf. Koch 1977) and sword beads (cf. Paulsen 1967) in the Merovingian period. More analyses are however needed to clarify this material. One problem is that the white inlays are particularly liable to decomposition and mother-of-pearl, for instance, loses its original lustre completely.

It can be stated in conclusion that in garnet cloisonné other inlays are subordinate and serve to enhance the effect of the garnets by their contrasting colours. The coloured inlays appear mainly to have been of opaque glass or coloured bone (ivory). White inlays were of mother-of-pearl, while minerals like magnesite and mixtures of calcite and cristobalite also occur.

## 1:5 Foiling

When translucent inlays were mounted with a crystalline paste they were normally foiled. However, where garnets were mounted in a gold cell with only a thin layer of a resin-like substance there is usually no foiling, suggesting that the resinous substance was originally transparent and allowed the bottom of the cell to act as a foil. The function of the foil was to increase the lustre of the garnet by reflecting the light. Sheets of foil were usually made of gold, gilt silver or, very occasionally, silver alone. Their thickness varies around 0.03 mm.

Foiling becomes most important in cloisonné where the paste would otherwise discolour the garnets. The use of patterned foil first appears in cement cloisonné with b-stepped garnets, while this type of cloisonné with a-stepped garnets usually has plain foil.

The patterns consist of waffle patterns, sometimes divided into square grids (cf. fig. 16). Avent and Leigh (1977) have comprehensively described the many varieties of foil patterns. Their microscopic measurements show that these variations are from a normal distribution graph were waffle patterns with 3.5 lines per mm predominate. In the continental material I have observed variations of the same kind as those recorded by Avent and Leigh in the Anglo-Saxon material, but I have not carried out such detailed measurements, and have only distinguished two types of the common waffle-patterned foil: coarse waffle patterns with less than 3 lines per mm and fine waffle patterns with more than 3 lines per mm. Foil with square grid patterns has not been distinguished in detail in the catalogue and the number of squares is not stated. Foil with a ring pattern is known in the catalogue as ring-foil, while cross-hatched foil forms a separate group.

The reason why I chose not to distinguish foil patterns in detail was the realisation, shared by Avent and Leigh (1977, 41 f.), that the variations are considerable even in foil on identical brooches from the same workshop.

It is therefore necessary to consider how these sheets of foil were made. Avon and Leigh postulate the use of cut stamps of wood or bone. They consider that some foil shows striations, which suggests that wood was the more common.

They further maintain that small, individual variations suggest that the individual sheets were not large. Very fine patterning on some gold foil, for instance at *Sutton Hoo,* where there are waffle patterns with six lines per mm, makes me doubtful that cut stamps were in fact commonly used. It is likely that cut stamps were indeed used to produce ring-foil and coarser cross-hatched foil, but for the more complex, finer patterns, I believe that textiles were more probably used for the stamps. According to my experiments, textiles can be used in two ways, either by stretching the material over a wooden stamp or—and I found this more successful—by using the textile as an underlay against which the foil was beaten. Silk with a rough texture was used in these experiments to produce the waffle pattern (cf. fig. 15a–b). A grid pattern could be achieved by superimposing a more open weave on the silk. The small irregularities which then appeared, and were very similar to those observed on sheets of foil, were explained by the unevenness of any woven fabric.

It is not uncommon for textiles to be associated with goldsmith's techniques, as for instance in the impressions of cloth found on the backs of Scandinavian and Avar bronzes. In these cases the cloth was used in the manufacture of the mould, but impressions of diamond twill on Scandinavian silver brooches of the Viking Age indicate an awareness of the decorative effect of the impressions of cloth.

If we accept the hypothesis that the foil patterns derive from textile impressions, Avent and Leigh's diagrams of the frequency of lines per mm become even more interesting (cf. fig. 17). The most common waffle pattern was shown to have 3.5 lines per mm, which for the textiles represents the count of threads per mm. According to Dr. Inga Hägg (personal communication) this thread count is unusual in prehistoric textiles. The most common count for fine wool and linen is 2 threads per mm, while occasionally linen may have a count of 3 threads per mm. In exceptional cases the cloth has been beaten to a count which approaches 3.5 threads per mm. It is not likely that linen cloth with this count was used for the purposes considered here, since in order to be suitable for pressing foil, it must be dressed with a starch which would cause the threads to swell; a more open weave would therefore be preferable. Because of its fine threads, silk would seem to be most suitable for use by the goldsmiths. Dr. Inga Hägg suggests that a silk taffeta most nearly corresponds to a count of 3.25 threads per mm, while finer silks could provide a higher count. Silk threads of 0.1 mm thickness may be woven to produce a count of 7 threads per mm, which was the finest early medieval silk observed by Dr. Hägg. This accords well with Avent and Leigh's diagram where the highest recorded frequency of lines is 5.5 per mm, while at *Sutton Hoo* it appears that a frequency of 6 lines occurs (Bruce-Mitford 1978, 448).

There is no reason to doubt that silk was available in the workshops where cloisonné was produced. In this context the distributions of fine waffle patterns and square grid patterns become of interest. The fine waffle

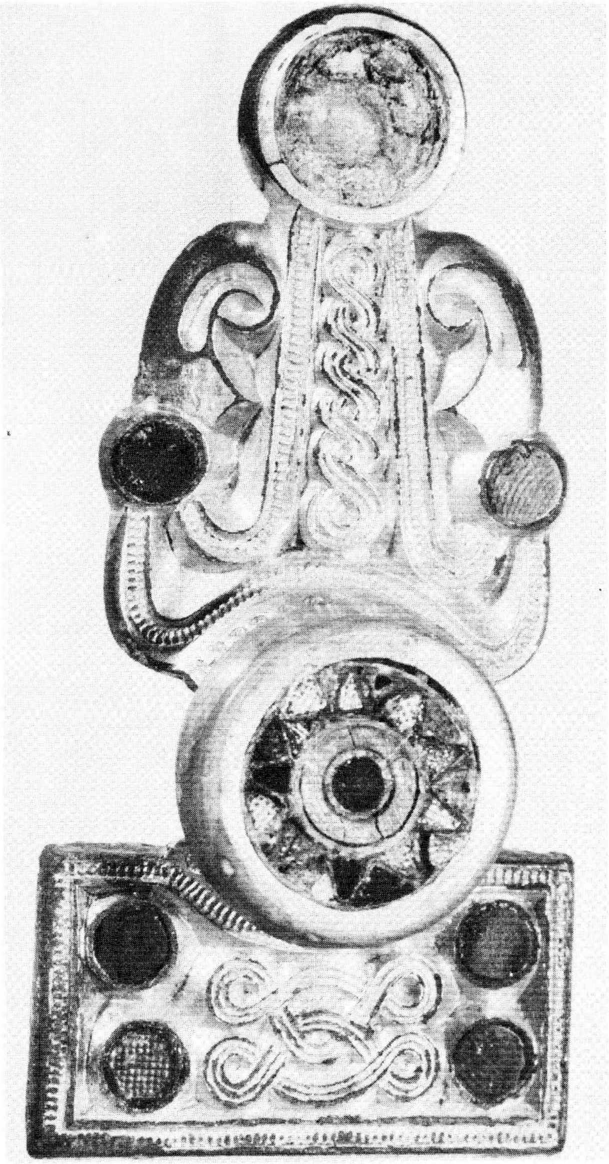
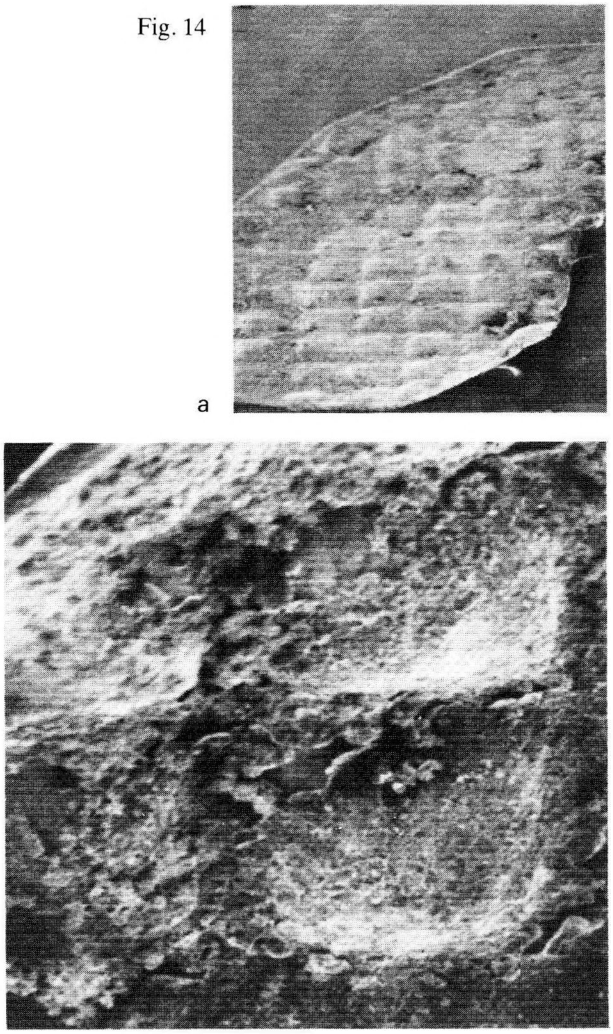


Fig. 13

Fig. 14



a

b

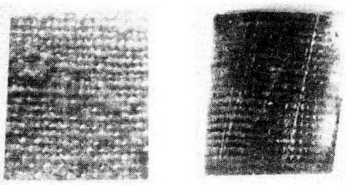


Fig. 15

a b

Fig. 13–15. Foiling.
13) Button-on-bow brooch from Alands, Hogrän, Gotland (Swed 75) with standard foil (fine waffle pattern) of gold. 2:1
14) Standard foil from a sword pommel (a) and the impressions on the cement filling (b). Valsgärde 5 (Swed 75) SEM 30:1 resp. 300:1.
15) Modern foil, aluminium beaten on silk. a: the silk, b: the foil. 2:1.

patterns are first used with cloisonné made with the cement technique, while the square grid patterns only appear in association with sand paste technique. Avent and Leigh (1977, 43) record a general trend towards coarser patterns, that is with fewer lines per mm, towards the end of the sixth century as compared with the early sixth century. I have also observed this trend, but with the exception of objects using the fused paste technique, which have fine waffle-patterned foil throughout. It was stated above that the square grid pattern was probably produced by superimposing a coarser (?)linen cloth with a more open weave over a finer cloth. It appears not to be a coincidence that the square grid pattern first occurs on the cloisonné work produced in the Frankish kingdom

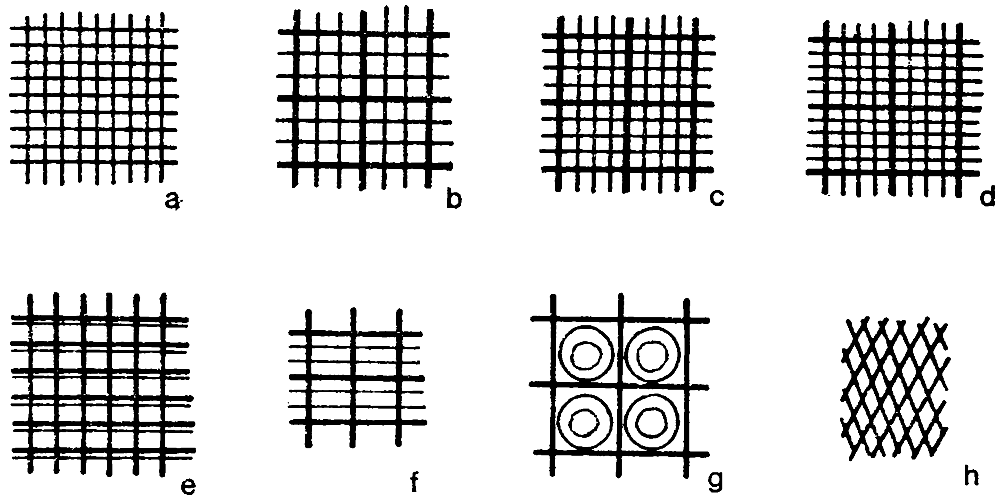



Fig. 16. Foil patterns (stylized) after Avent and Leigh (1977).
a) Fine waffle pattern (standard foil). b, c, d) Boxed grid pattern. e, f) Coarse waffle pattern. g) Ring stamped pattern. h) Lozenge pattern. 10:1.

(that is, on objects using sand putty technique, and only occasionally, as in the Cologne Cathedral grave, on objects using fused paste technique). In this area, as in Anglo-Saxon England, it was convenient to combine the silk with a coarser cloth, perhaps of local manufacture (possibly for reasons of strength). However, on objects using the cement technique, which probably came from *Constantinople* where silk was plentiful, silk alone was used in the production of foil.

Finally, the distribution of cut stamps will be considered. Ring-foil occurs very rarely but spread over a large area from the Black Sea to Hungary, the Rhineland, England and North Africa. The diameters of the rings differ and they represent individually cut stamps, characteristic of individual objects.

This is also the case with cross-hatched foil, which occurs in Anglo-Saxon England (as on a plated disc brooch, class 6, Avent 1975, no. 163) and on the later Scandinavian button-on-bow brooches. The Scandinavian foil sheets have oblique hatching which appears to have been punched on the foil without stamps. The foil sheets are silver without gilding.

Sometimes a foil pattern of broken lines preferably made by punching is found. It can be used to delineate a cross-pattern in the cloisonné as on the disc brooch from *Marilles* (Br2) but is also found as a sole pattern specially used in cement cloisonné from satellite workshops (cf. Paris 9. Algeria).

## 1:6 Further analysis of mounted garnets

After the completion of this work Mavis Bimson (1982, 1983) published analyses of mounted garnets. The analyses are made with XRF and concentrated to Fe, Ca, Mn/Si ratio using multivariate statistical discrimination analysis. Garnet analysis using trace elements in single samples is problematic because of the variations in these elements in single samples (cf. 1:1). However Bimson's method may be of some use when considering mounted garnets only, and with no attempt to discover their provenance. The fact that the gem-cutter required garnets of the same colour would have led him to a deliberate standardization of the raw material he used. Thus the mounted garnets in a given area would occur in recognizable groups, based on the commonest trace element distribution in the raw material, if this trace element distribution produced an attractive colour.

The analyses so far published by Bimson appear to confirm this. She has been able to distinguish between mounted garnets from South Russia and from the Frankish area, corresponding to the garnets classified here as type 1 and type 3. The garnets from three Gotlandic brooches seem to belong to both types, which also corresponds to the results noted here. This may be seen as relevant to the results of her analyses of the garnets from *Sutton Hoo*. Most of the garnets (124) are similar to those from the Frankish area, as might be expected (cf. chapter 5). Four of the garnets, however, apparently conform to the south Russian type, an interesting result which would confirm our hypothesis (cf. chapter 5) that some of the

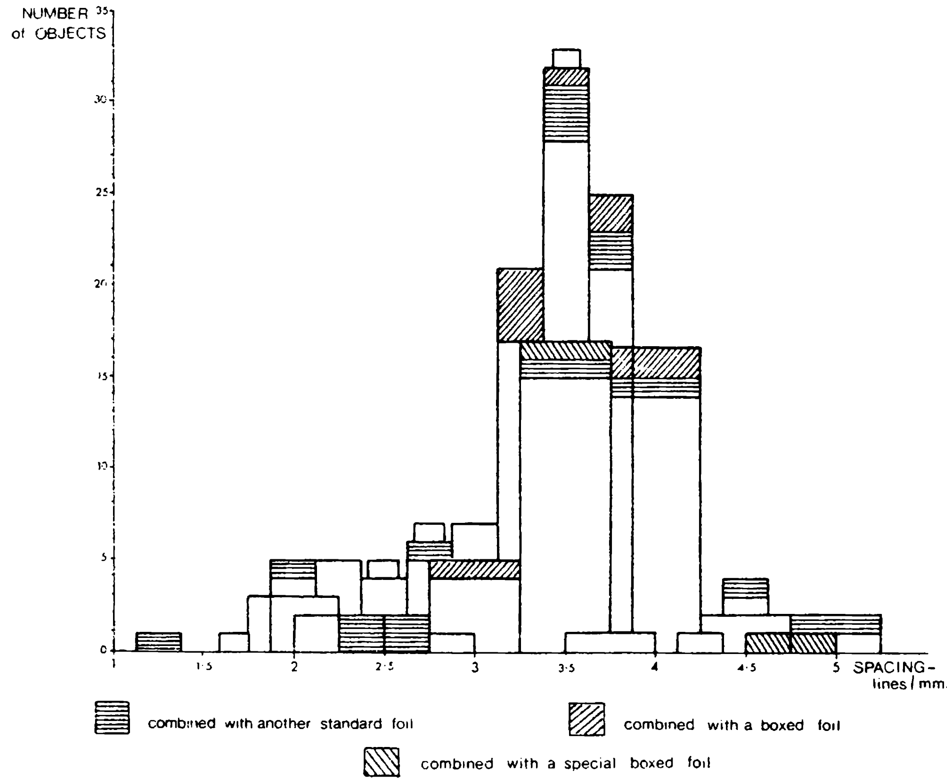



Fig. 17. Frequency of fine waffle patterns with different spacing lines. After Avent and Leigh (1977).

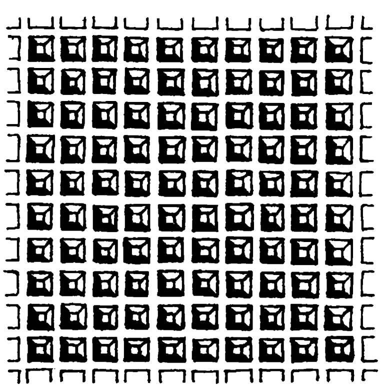


Fig. 18. Standard foil from Valsgärde 5. 30:1.

*Sutton Hoo* garnets were imported from this area. Two of these garnets seem to be the quatrefoils from the *Sutton Hoo* sword, perhaps indicating that these originated in the workshop which cut the b-stepped garnets (cf. chapter 4).

In the published papers, garnet brooches from Gotland are regarded as a homogeneous material comparable to the Paviken-garnets. Our analyses of material from Gotland have however demonstrated that garnets of class 1, 2 and 3 were used as well and also other features such as shapes and cements (discussed in the following chapters) show that workshops with quite different characteristics made button-on-bow brooches on Gotland. The distinct differences have a chronological significance. I am surprised that Bimson *et al.* have not observed more than two different garnet qualities and it may be due to the statistical methods used, that no other qualities have been recognized. I think that the grouping in future analysis has to be developed in such a way that new groups can be distinguished. In the material analysed in this study 4 different qualities were already recognized and I suspect that using Classical material more groups will emerge. As garnet qualities seem to be an important element in understanding the origin of jewellery, the nondestructive method published could however if further developed be of great value.

# Chapter 2. Gem-cutting techniques

## 2:1 Cleaving techniques

Some cut garnet gems from the Hellenistic period have perfectly flat backs. In many cases it seems that this flat surface was produced by cleaving. I have suggested above that some passages in Classical lapidaries imply knowledge of the art of cleaving garnets by heating.

In the Munich collection of gems it may be observed that the proportion of cut gem garnets with flat backs varies in different garnet minerals (Brandt 1968–72). Among gems cut from almandine garnet, convex and concave backs are most common; according to the catalogue there are no almandine gems with flat backs in this collection. 60% of gems described as pyrope and 25% of the spessartite and hessonite garnets have flat backs. I have pointed out above that metamorphosed garnets of intermediate quality are most suitable for cleaving because they are less sensitive to heat than the pure almandine garnets, in which iron easily produces a brown discoloration. However, the identifications of garnet minerals in the Brandt catalogue are exclusively visual and it is therefore likely that most of the garnets described there as pyrope, hessonite and spessartite are not pure, but belong to intermediate groups in which pyrope, hessonite and spessartite predominate. The fact that only garnets of these types are cleaved suggests that the differences between varieties of garnet minerals were already appreciated in ancient Greece. The high proportion of cleaved pyrope garnets suggests that this variety was most popular, according well with the fact that this mineral is the least heat-sensitive of the garnets.

The art of cleaving garnets by heating was therefore already known in ancient Greece, but this technique did not play as important a role at that time as it did later. Because gems cut in relief were favoured in Hellenistic art, there was little interest in the production of flat garnet plates. The thickness of these gem garnets with flat backs varies between 2.5 mm and 6 mm (a thickness rarely found in garnets in cloisonné work) and is similar to the thickness of gem garnets with convex or concave backs. The technique of cleaving was therefore not used to produce garnets which were as thin as possible. A convex or concave back creates more reflections in a stone, and this technique was used to increase luminosity, not only of garnets but also of other translucent precious stones in the Hellenistic period.

## 2:2 Keeled garnets

Garnets with a ridge, or keel, bear witness to a special development probably directly related to the technique of cleaving by heating. This type of garnet is mainly found in South-east European jewellery, constituting a characteristic element in the polychrome jewellery of the Sarmatian, Hunnish and East Germanic peoples of the late Roman and early Migration periods (cf. Parducz 1941–50 and Werner 1956). The keel is most noticeable in domed stones, while in others the keel is simply formed by two oblique facets, of which one is usually bigger than the other. Stones of this type would perhaps have been the stones which were later to be ground to produce domed, keeled stones. With few exceptions the thickness of the facetted stones varies between 1.5 mm and 2 mm. It is important to note that this thickness is considerably less than that characteristic of the Hellenistic gems. The flat back as well as the keel suggests that these stones are the products of cleaving by heating.

In my own experiments with cleaving, a piece of garnet was heated and then rapidly cooled in water. The stone broke into a large numer of keeled pieces and a smaller number of flat plates. It is likely that the proportion of keeled stones to plates depends on the degree of metamorphism in the raw material, and this may vary even within the same deposit. It is therefore possible that keeled garnets were a by-product of the process of cleaving garnets to produce flat plates. This view is supported by archaeological finds: on brooches from *Szilágy Somlyó,* for instance, there are both plates and keeled garnets. The keel on the domed garnets is produced by the edge of the crystal face. As the crystal edges are considerably harder than the surrounding mass, they will form a ridge when the stone is polished. A Greek gem-cutter would presumably have regarded the domed, cabochon-cut stones with keels as unsuccessful products; certainly no examples of such stones have been recorded in Hellenistic finds. Just as they have both flat and facetted stones, East European brooches of *Szilágy Somlyó* type

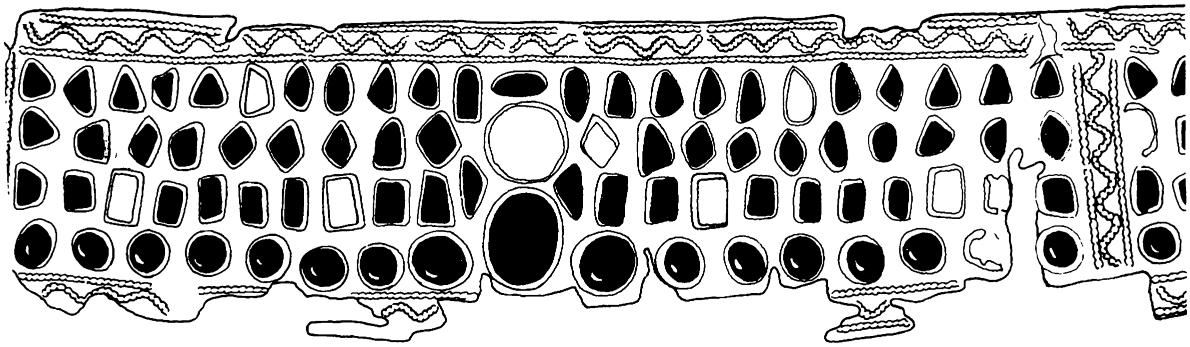


Fig. 19. Diadem from Szorna (Bud 28) with settings of garnets, mostly keeled. 1:1.

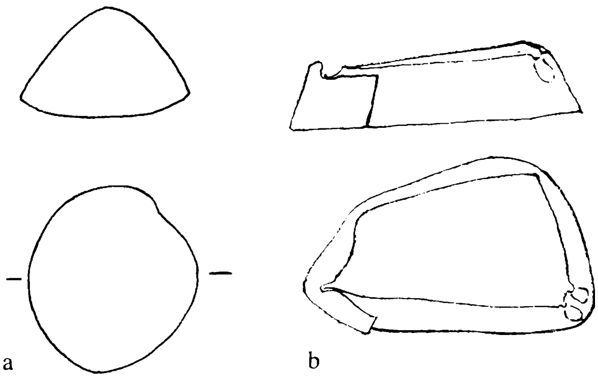



Fig. 20. Details from fig. 19. a) Keeled cabochon garnet with section. 5:1.
b) Setting with pinched corners (2 b). 5:1.

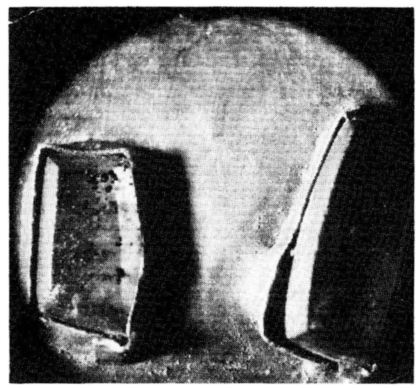


Fig. 21 Micrograph showing a setting on fig. 19.

contain both keeled and completely smooth cabochon-cut garnets, although the latter are in a minority. It is likely, therefore, that the keeled stones are a barbarian product, manufactured in workshops which had partly lost their Hellenistic traditions. However, examples such as the finger ring from *Berga Vrå* fig. 25, which has two keeled cabochon-cut garnets mounted together with a fine carnelian gem with a Greek inscription, demonstrate that the keeled garnets were not regarded as a completely inferior product. In her study of rings of *Berga Vrå* type, Beckman (1969) considers that they are of Scandinavian manufacture. The stones must therefore have been imported, and it is notable that the same mixture of high-quality stones (carnelian) and cheaper stones (keeled garnets) is present both in Scandinavia and in *Szilágy Somlyó*. But keeled garnets are not in fact particularly common in Scandinavia. An interesting example of the use of keeled garnets is the magnificent brooch from *Årslev,* which Mackeprang (1940, 90) and others have identified as an imported object from Hungary, fig. 24. Keeled garnets typically occur in large numbers on jewellery belonging to a cultural area which may perhaps best be termed Sarmatian (cf. Werner 1956, 91 who indicates a Sarmatian influence in the garnet jewellery). The garnets are scattered in random patterns on diadems and head-gear mounts (cf. fig. 19–21). This type of garnets is also found on Germanic brooches in eastern Europe. In both the Sarmatian and East European Germanic finds, keeled garnets are found along with relief-cut and flat garnets of considerably higher qulity with no traces of crystal edges. Certain differences in the cutting techniques, which will be discussed in more detail below, suggest that already at this time garnets from different workshops might occur on the same object. The keeled garnets seem to belong to a fairly well-defined period: the earliest are from the third, and the latest from the fifth century.

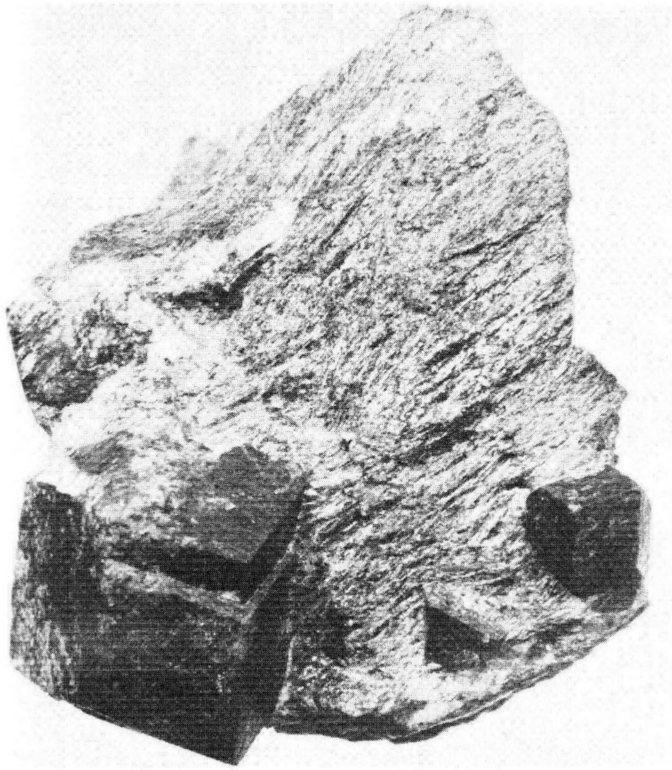


Fig. 22. Garnet rose in schistose rock.

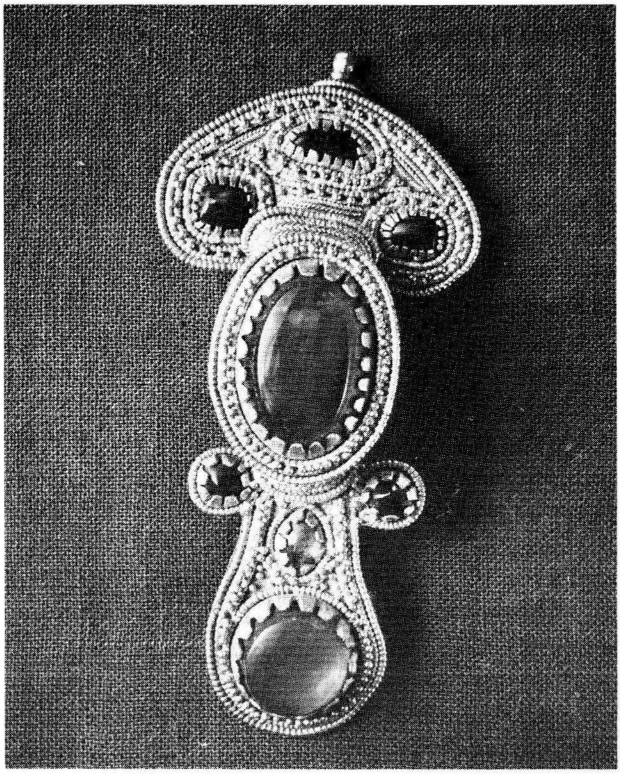


Fig. 24. Gold brooch from Årslev, Denmark (Cop 2). The settings consist of small keeled garnets and two large carnelians. 1:1.

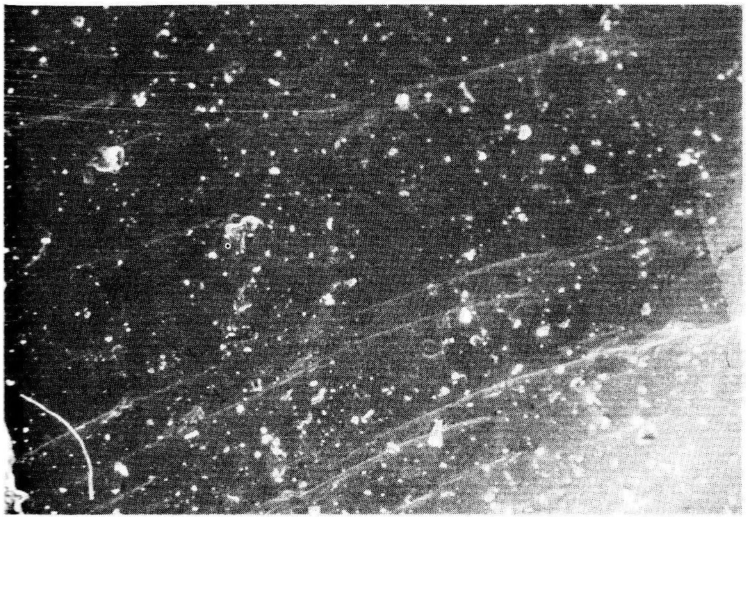


Fig. 23. The natural surface of a split garnet. SEM 500 X.

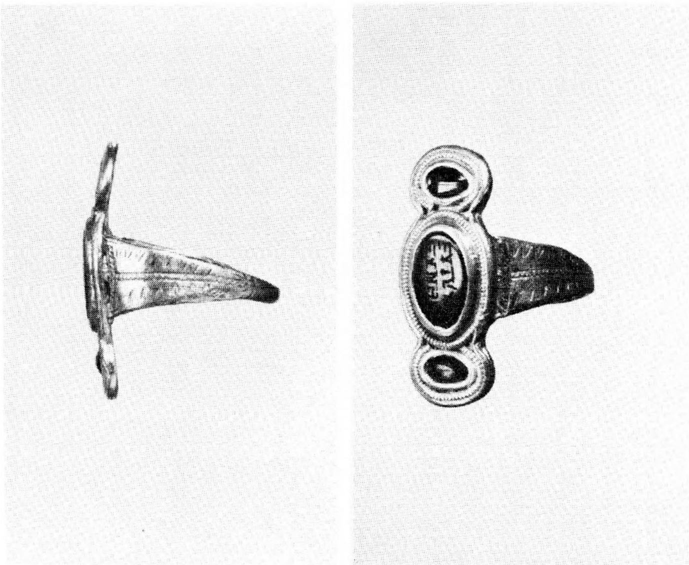


Fig. 25. Fingerring from Berga, Vrå, Sweden (Swed 5) with an inscribed carnelian (Evtyxi Evniyci) surrounded by two keeled garnets. 1:1.

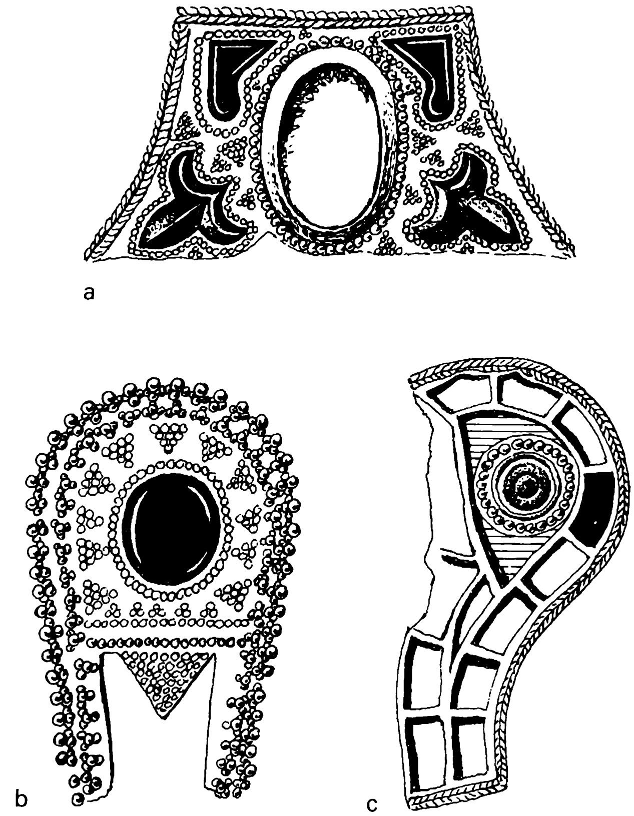



Fig. 26. Gold mounts from a seax from Borovoje, Kasakstan (Eri 7). Note the lotus-shaped, domed garnets (a); on the suspension loop lapis lazuli (c). 1:1.

## 2:3 Garnets with ornament in relief

As we have seen, domed garnets were typical of the Hellenistic period. The forms varied, the most common being rectangular, round and oval, but more complex forms sometimes occurred.

Heart-shaped garnets are typical, their shape often further emphasized by high relief work: these represent the best traditions of Hellenistic gem art. The earliest examples apparently date from the middle of the third century BC, but they continue to be produced in a more or less unchanged form up to the end of the late Roman period (cf. Minns 1913, 430 ff., Riegl 1927, 385 f. and Pl.X, *Szilágy Somlyó*). During this period, and continuing into the early Migration period, the heart-shaped relief-cut garnets appear, for instance, on Germanic brooches as at *Szilágy Somlyó*. Rupp (1937, 35 ff.) was of the opinion that the heart-shape indicated that the garnets originated in India, the heart-shape representing the leaves of the lotus and the Pippala tree, which played an important part in the Buddhist religion. However, Buddhist heart-shaped motifs are not of a particularly early date (cf. Rupp 1937, 35), while in Greek art this motif occurs on Ionic vases and terracottas with plant ornament from the period 700–525 BC (cf. Cook 1960). The heart-shape seems therefore originally to have been a kind of leaf, but its significance changed when the motif was carved in garnet; it seems likely, indeed, that the change from leaf to heart could have occurred when the motif was first applied to garnet, the colour suggesting the similarity. Heart-shaped garnets are among the earliest examples of Greek cameo art. Furtwängler (1900, 151) has demonstrated that the art of cutting and shaping hard translucent stones began to flourish with the increased contacts with India which followed Alexander's campaigns. The early garnet hearts are typically bulbous with clearly-marked lobes. Completely flat, plate-like hearts occur first in the late Roman and early Migration periods. I therefore consider it most likely that relief-ornamented garnet hearts were originally a Greek form which, together with many other stylistic traits, spread to the Orient, directly influencing the Gandhara style in India. Relief-cut garnet hearts in late Roman

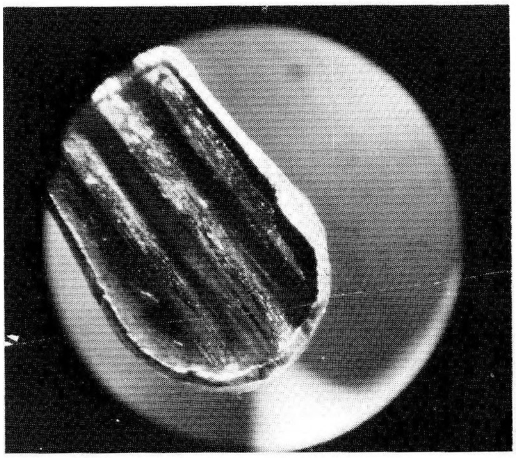


Fig. 27

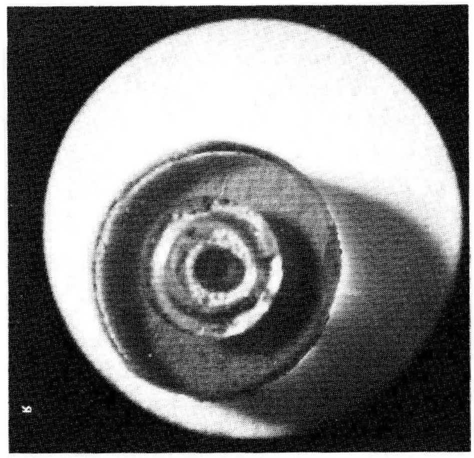


Fig. 28

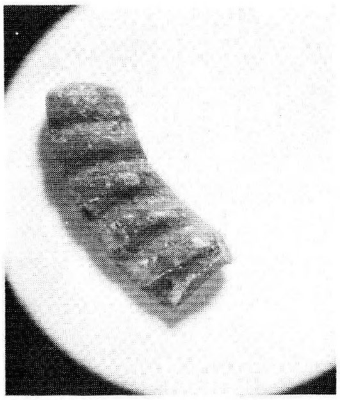


Fig. 29

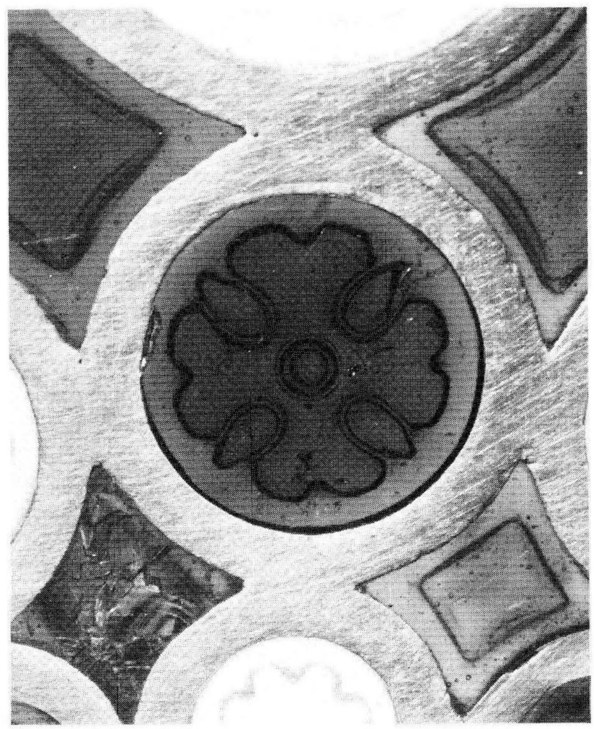


Fig. 30

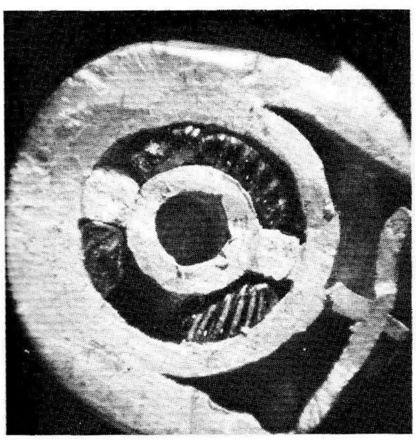


Fig. 31

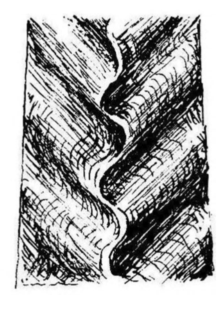


Fig. 32

Fig. 27–32. Relief-cut and engraved garnets.
27) Eagle mount Apahida II (Cluj 2). Micrograph 5:1.
28) Eagle brooch Petroassa (Buka 2), the engraved areas are inlaid with enamel. Micrograph 5:1. 2:1.
29) Beaded half-round garnet panel from the Petroassa bowl (Buka 2). Micrograph 5:1.
30) Relief-cut rosette in garnet from the Chosroe plate (Paris 10).
31) The panel, fig. 29, in situ. 4:1.
32) Drawing of a corrugated garnet from a single setting on the diadem from Verche-Jablocno (Eri 11). 5:1.

finds were presumably imported from Hellenistic workshops. When in the Migration period garnet hearts began to be produced in the Germanic area they consisted of completely flat garnet plates (cf. Altlussheim, Karlsruhe 1). I have discussed garnet hearts in some detail because they exemplify how an originally Hellenistic gem technique with relief-cut garnets was transferred with certain simplifications to the Germanic area.

Furtwängler (1900, 397 ff.) and Boardman (1970) have convincingly demonstrated that the relief work which characterized Greek cameo art originated only in the Hellenistic period. The tools for cutting the relief of the cameos were basically the same as those used earlier for intaglio and cylindrical seals. The principal tool was the bow drill to which were attached gravers of different shapes. The surface was worked with these gravers, discs and ball-shaped drills. The bow string rotated the drill and an abrasive gave it the required piercing and cutting power. It appears, however, that relief-cutting made greater demands on the tools than intaglio, as the cameos required incised lines, produced by an extremely sharp graver. It seems likely that in the Hellenistic period the point of this tool was of diamond rather than the copper or iron used earlier. The thin, sharp lines on Hellenistic gems can hardly have been produced by any tool other than a diamond drill (cf. Richter 1968, 5 ff.). Pliny mentions a graver of this kind (Book XXXVII, Eichholz *ed.* 1962, 76):

> There is such a difference in the hardness of gems that some cannot be engraved with an iron tool, others only with a blunt graver, but all may be cut with the diamonds. The heat of the drill is of great assistance in engraving. (Tantaque differentia est, ut aliae ferro scalp, non possint, aliae non nisi retuso, verum omnes adamante. Plurimum vero in his terebrarum proficit fervor).

When Pliny emphasizes the importance of the heat generated by the rotating drill, he demonstrates that it was understood that a fast drill is more powerful than one rotating slowly. There is, however, no evidence that at the time there was any other means of working a drill than by hand with a bow. Other inventions, such as the crank or water-power, were apparently not introduced until the late Roman period (see below). The use of a bow drill for relief cutting requires great manual dexterity; this type of drill does not produce a continual movement but rather a jerky motion as the drill rotates first one way and then the other. The high degree of manual skill is characteristic of Hellenistic gem art. A great deal of effort was also expended on achieving a high polish. In order to polish stones as hard as garnet, diamond powder or corundum must have been used as an abrasive. Corundum, in the form of emery, was available locally in Greece and the Near East and it is likely that emery was used to polish the garnet gems. A garnet cloisonné button from *Tibble, Badelunda,* Sweden, provides confirmation of the importance of emery for the production of garnet gems. A few grains of emery were found attached to one of the garnets and were identified as corundum by diffraction analysis (8, Table XI, I:3a, Swed 22). On the islands of *Samos* and *Naxos* in the Greek archipelago, for instance, there are readily available deposits of emery which were mentioned by Theophrastus (Caley and Richards 1956, 148), a circumstance likely to have played an important part in the development of Greek gem art.

Finds from *Armazis-Khevi* in south Georgia (Apakidze *et al.* 1958), *Kerch* (De Baye 1908), *Petroassa* (cf. fig. 33) and *Szilágy Somlyó* (Fettich 1932) enable us to study the relief-cut garnet gems available in south-east Europe in the latter half of the fourth century.

Apart from cameos with figure designs, which rarely reached Germanic areas, garnets during this period were cut in patterns which include the hearts mentioned above, as well as palmettes, rosettes, acanthus leaves and beading. The stones were cut in high relief and have flat backs. The treasure from *Petroassa* contains one of the richest collections of relief-cut garnets from this period (fig. 33); it is noteworthy that relief-cut garnets are the most common in the *Petroassa* material, while in other finds they occur as single pieces. The presence of large numbers of garnets decorated in relief suggests that much of this treasure is not of Germanic manufacture, consisting rather of imported objects, perhaps from the Bysantine area. Particular attention should be paid to the form of the relief-cut palmettes in this find, which cannot to my knowledge be paralleled elsewhere, although a comparable design in a flat version occurs on a sword from *Kerch* (De Baye 1908, pl. 1) and on a paten from *Gourdon.* These palmette designs have their prototypes in late antique enamels, such as a bracelet from *Armazis-Khevi* (Apakidze 1958 pl. 100:12–13) dating from the middle or the latter half of the fourth century. The palmette design on the bracelet from *Armazis-Khevi* is executed in green enamel and occurs together with kidney-shaped so-called bean pattern inlays. Finally, a somewhat simplified version of the palmette design in (?) malachite occurs on mounts from *Varna* (cf. Roth 1979, pl. 25b).

Böhner (1948, 229) sought the origin of the bean pattern (cf. fig. 41–42) in a semi-circular design with inturned spiral ends. He pointed out that this design, executed in enamel, occurs together with garnet inlays on a brooch from *Szilágy Somlyó* (Fettich 1932, pl. IX:3). The bean pattern is one of the few designs cut in relief on

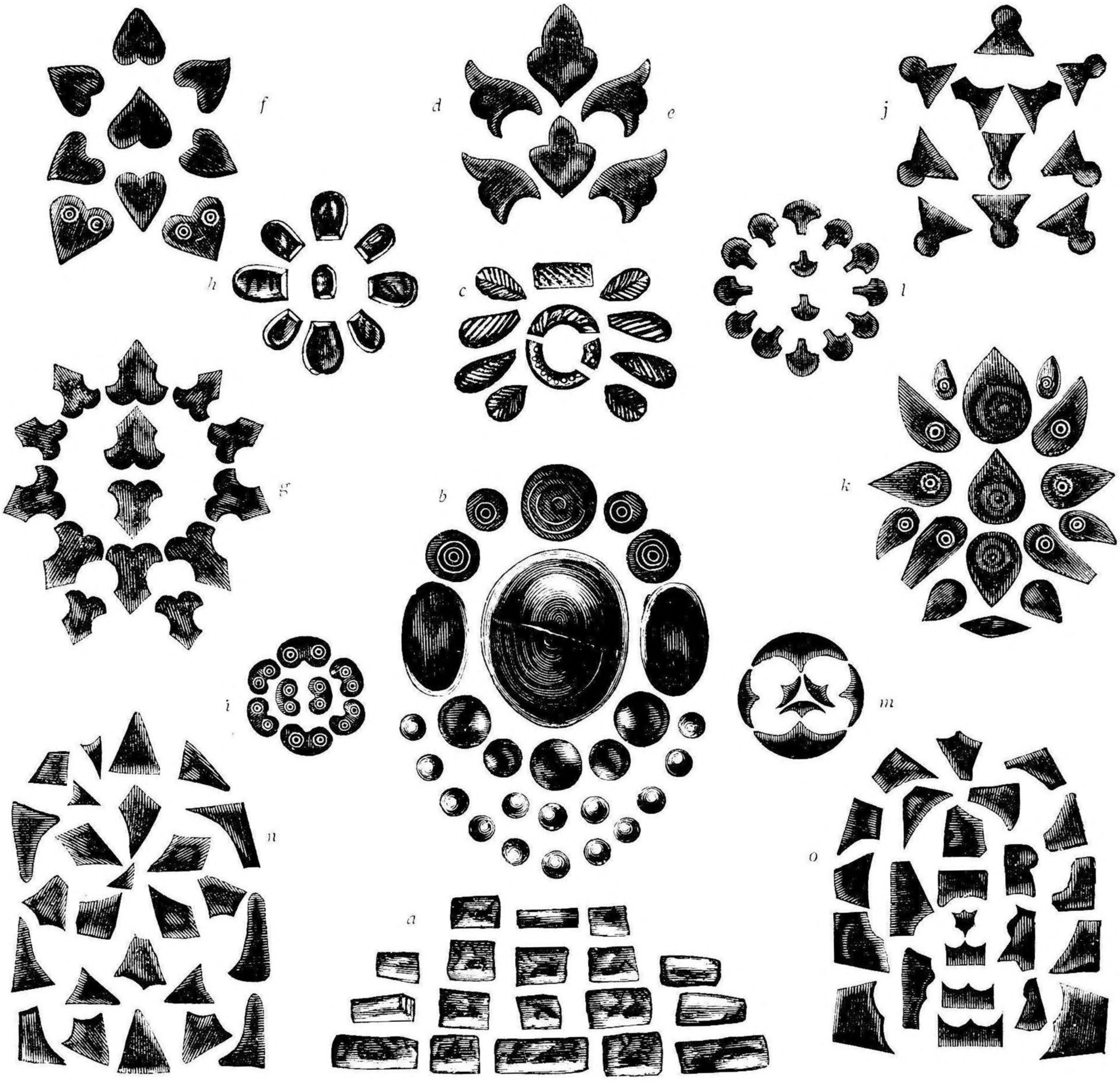



Fig. 33. Garnets of different shapes from Petroassa. After Odobesko 1889–1900. Note the irregular rectangular garnets in (a) which are shaped by grooving and breaking while other shapes are cut.

garnet gems which continued to be produced in the fifth century, and is found, for instance, on gold-hilted spathae (cf. Böhner 1948). In its Germanic form, however, the relief is considerably less sharp. On gold-hilted spathae this design also occurs in bronze (or gold) openwork; such openwork designs are also known in late antique art, sometimes associated with inlays, as for instance in the border round a large onyx from *Aleppo* in Syria (Schlunk 1939, 37). A comparable border design of bone mounted in silver surrounds the large sardonyx cameo from *Uppsala Västhög* (Arrhenius 1982).

Even the soft acanthus leaves cut in relief on the collar from *Petroassa* have their counterparts in Germanic finds, although these are flat, or almost so. In a find from Tunis this motif still retains its character of relief (fig. 104), while the acanthus leaves on the buckle in the Castellani collection in *Rome* are completely flat (Werner 1958, pl. II:13).

The polygonal bowl from *Petroassa* fig. 35 has curved garnet panels of beading inlaid on the handles. This curved beading is paralleled in the straight beading on gold-hilted spathae of Böhner's type I from *Kerch, Ta-*

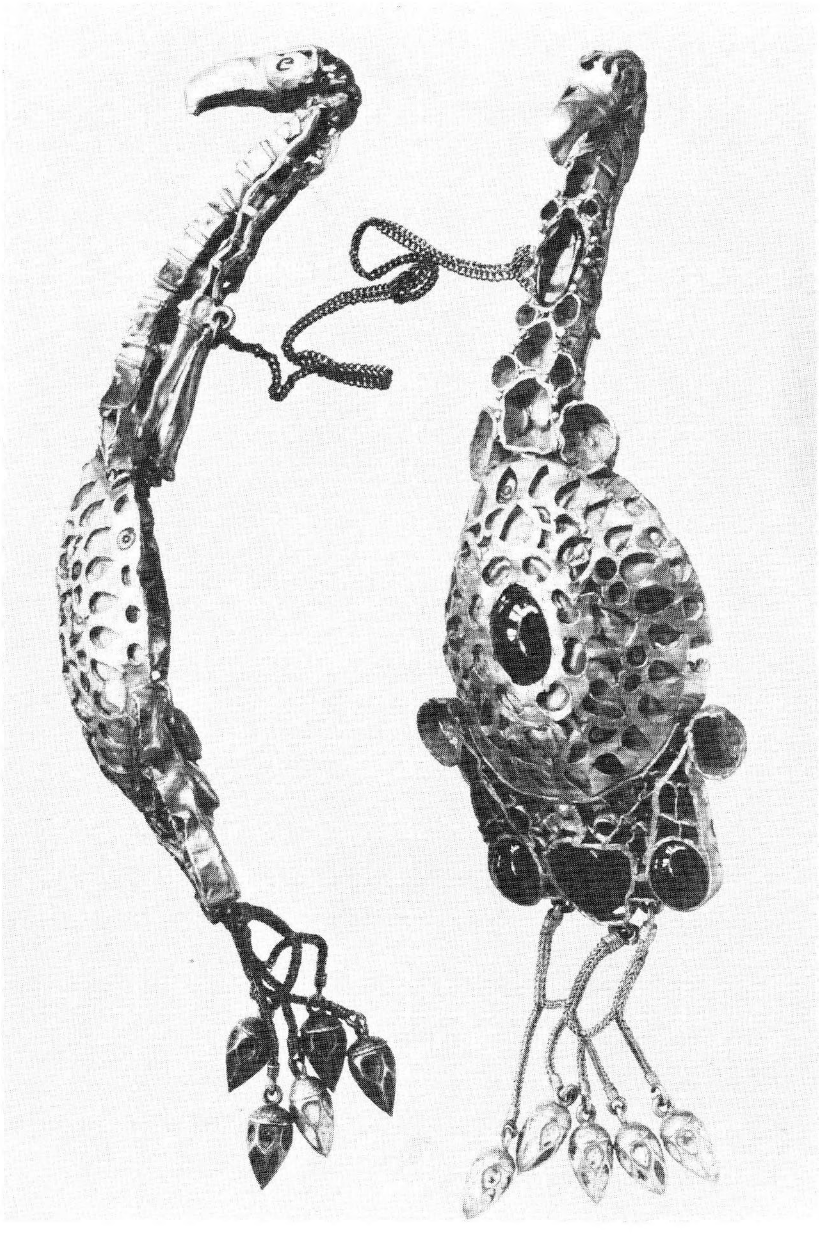


Fig. 34. Ibis brooches from Petroassa. Appr. 1:2.

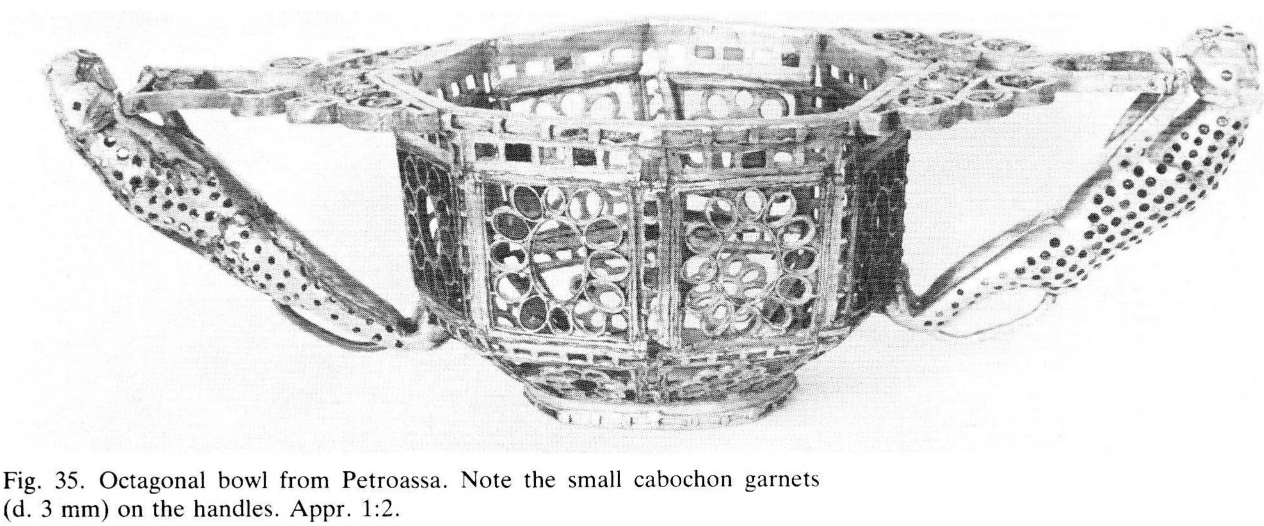


Fig. 35. Octagonal bowl from Petroassa. Note the small cabochon garnets (d. 3 mm) on the handles. Appr. 1:2.

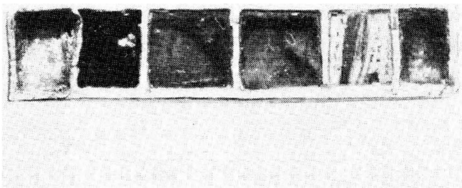


Fig. 36. Cloisonné panel from a grave in Kerch (Swed 1) with garnets and enamel. 2:1.

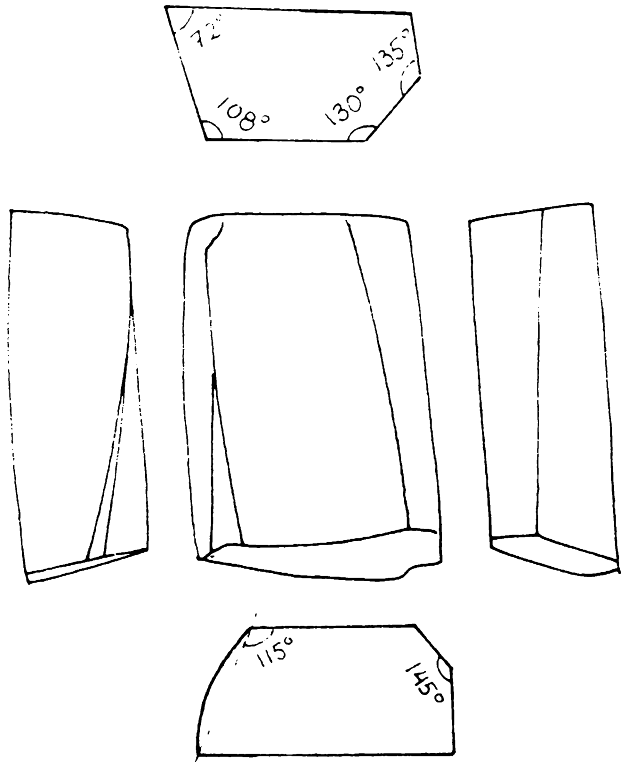



Fig. 38. Drawing of the garnet, fig. 37. 5:1.

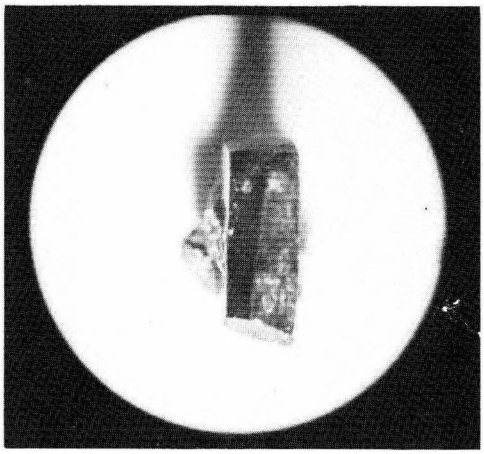


Fig. 37. One of the garnets from fig. 36. Micrograph 5:2.

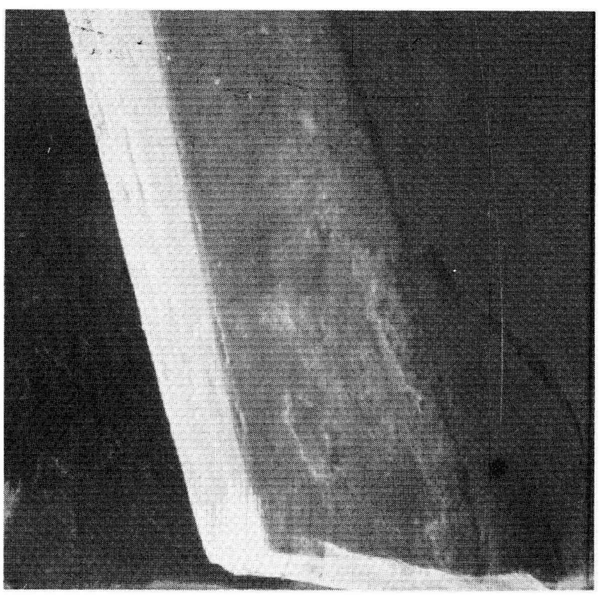


Fig. 39. SEM. of a part of the garnet, fig. 37, showing the even grooved facet on the left in contrast to the rough broken edge on the right. 30:1.

*man, Pouan, Dimitrevka* and other sites (Böhner 1948, 322), and on buckles and mounts of *Apahida* I and II, Childeric and *Tressan* type (cf. fig. 40). The curved beading from *Petroassa* (cf. fig. 31) is interestingly similar to that found on the buttons attached to the scabbard of the sword from *Sutton Hoo* (cf. Bruce-Mitford 1978, fig. 222), but the latter is thinner and more elegant than the examples from *Petroassa,* which are approximately two hundred years older.

Similar beaded designs can also be found in late Roman gagate work, including bracelets with beaded decoration bound with gold wire (cf. La Baume 1973), but, unlike these, the garnet beading is not completely round, having *flat backs* like all other garnet gems.

A large proportion of the relief-ornamented garnets from *Petroassa* (cf. fig. 33) consists of cabochon-cut stones of round, oval or pointed outline. Many oval garnets are more than 10 mm long. Garnets of similar shape and size are also found on the Gothic buckles described by Götze (1907). Such large domed garnets of oval, pointed oval or rectangular outline still occur abundantly in the fifth century but later become rare. After the end of the fifth century they are found almost exclusively on ecclesiastical objects. It is only in the Anglo-Saxon material that domed garnets of this size may still be found in the latter part of the sixth century, as for instance on a necklace from Kent (Jessup 1950, Pl. XXVIII). On the garnet jewels from *Sutton Hoo,* however, large garnets (exceeding 10 mm in length) are rare and are not domed or cut in relief. It appears that such garnets were not actually produced after the fifth century, and where found were inherited property which tended to end up in church treasuries. The production of large garnets will be discussed further in chapter 4.

Small, round, cabochon-cut garnets (Cap, cf. fig. 3) not exceeding 3 mm in diameter, replace gold rivet-heads on buckles such as those from the *Childeric* find, as well as on the seax scabbard in this find. In the *Petroassa* treasure they occur on the panther-shaped bowl-handles (cf. fig. 35). However, these pin-head sized garnets are rare and seem to have been produced in only a limited number of workshops. Rather more common are round, cabochon-cut garnets, 5 mm in diameter and 3 mm high. They are found in Frankish, Alemannic and Langobardic as well as in Kentish jewellery; in Scandinavia their distribution on Gotland demonstrates that these garnets have a limited range, suggesting that they were the product of certain specific workshops. On Gotland they are thus only found on the larger button-on-bow brooches with edging strips dated by Nerman to the end of his first and the beginning of his second period, that is about 600. On button-on-bow brooches with ribbon designs or hatched edging strips or with animal ornament of Vendel styles C, D, E and F, only flat garnets occur on Gotland, as in Scandinavia generally. The uniform diameter and height of these cabochon-cut garnets suggest that they were produced in one or more rather conservative workshops, as they appear to have a chronological range from the latter part of the fifth century to the seventh century.

## 2:4 Grooved and engraved garnets

Garnets decorated in relief, apart from cabochon-cut stones, appear to have reached their peak in the fourth century and to have disappeared at the same time as late antique gem art, with the exception of the Sassanian area, where their production apparently continued to some extent (see below). The position is different for the grooved and engraved garnets which appear in the Germanic finds of the Migration period. Grooved garnets are characterised by incised grooves, 2–3 mm wide, either set in a ray-pattern to make up rosettes or in such a manner as to form a shell design (cf. fig. 40). The grooved designs are technically similar to the oblique lines which form the beading, but the grooves are considerably wider and sharply angled at the bottom. This type of decoration depended on the availability of a mechanically-powered graver tool, that is a bow drill with a rotating wheel. To my knowledge, grooved garnets only occur in Germanic finds, having a distribution ranging from Eastern Europe to France. They can be dated to the latter part of the fifth century by their presence in *Apahida II* and *Tressan.*

Designs of engraved circles occur on both domed and flat garnets from *Petroassa* and *Szilágy Somlyó.* Such patterns must have been engraved with a diamond point, as softer tools could not have achieved such fine, sharp lines. The technique of engraving with diamond points is closely associated with gem art and was presumably first invented by a Hellenistic gem-cutter. In the fourth century, blue polyhedric glass beads decorated with engraved circles (cf. Arrhenis 1971, fig. 11) occur along with engraved garnets, particularly in Eastern Europe. The similarity between the designs which decorate both garnets and glass beads demonstrates the close relationship between gem art and glass-working. Many of the Classical writers considered glass to be the equal of precious stones, and gems were also cut in glass. Just as richly-decorated vessels were carved from precious stones, indeed even from hessonite garnet, so were vessels carved from glass, the so-called *diatreta* or cage-cups. The art of carving cage-cups spread from Greece and the Near East to the Rhenish area in the late Roman Iron Age, and they were produced, for instance, at *Cologne* and *Trier* (Doppelfeld 1960, b).

The grooved and engraved garnets have a similar distribution pattern, although with a greater chronological range, especially as regards the engraved garnets. The earliest finds of these are from the late Roman Iron Age; probably one of the earliest is the pendant from *Hesselager* Denmark (Cop 12) and the latest, a button-on-bow brooch (Swed 65), from about 600. The grooved and engraved garnets have a wider distribution than the relief-cut garnets, although they require the same technical equipment. This would suggest that there were gem-cutters equipped with bow-drills in areas other than Greece and the Black Sea region, the home of true gem art. In this context it should be noted that the art of engraving and cutting glass spread to the Danube and Rhenish areas in the late Roman period. It has been pointed out by Doppelfeld (1960, b) and others that *diatretarii* working in the Danube area and in *Cologne* originated in the Greek areas of the Roman Empire, as inscriptions in Greek are often found on cut glass vessels.

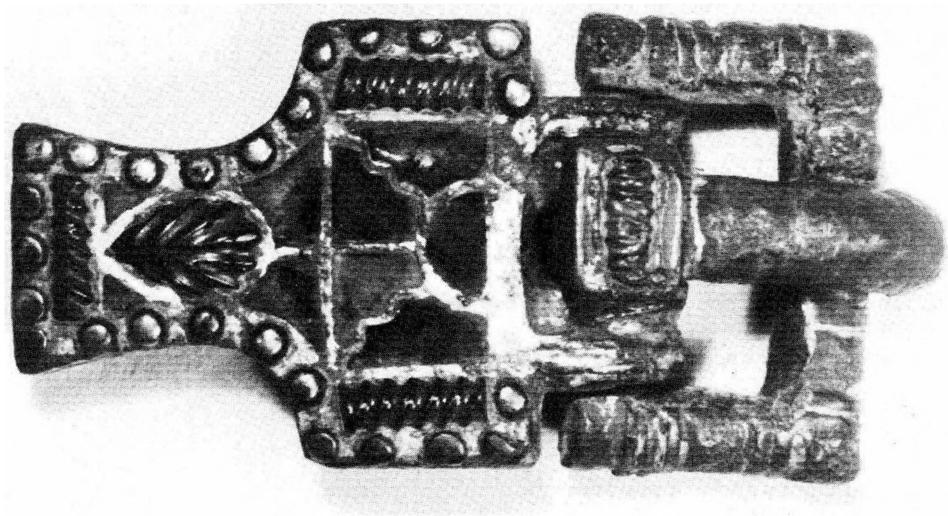


Fig. 40. Mussle-shaped garnet and b-stepped garnets on a buckle from Tressan (Paris 12). 2:1.

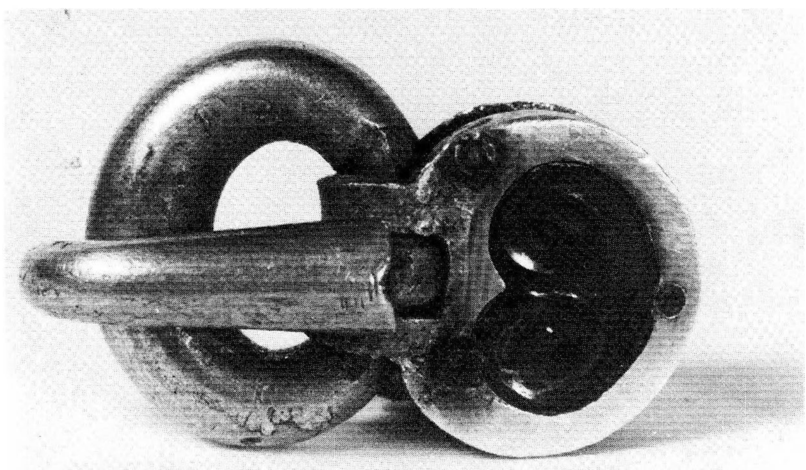


Fig. 41. Kidney-shaped garnet with grooves on a gold buckle from South Russia (Köln 31). 2:1.

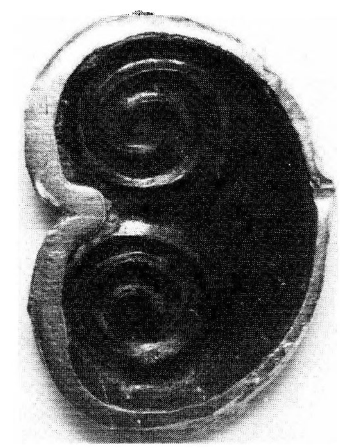


Fig. 42. Kidney-shaped garnet with grooves from South Russia (Köln 32). 4:1.

In the region of *Cologne* it would seem that the art of cutting and engraving glass died out—like the Classical gem art—in the fourth century. In the Danube area, however, this art apparently continued to be practised even after the fall of the Roman Empire. Glass with medallion-cuts of the type found in *Zuran, Brno,* Czechoslovakia and in *Tu, Klepp,* Jären, Norway (Werner 1956 and Straume 1971) seems to have been produced after the cessation of the Roman production. As the manufacture of garnet jewellery in the Danube area appears to have flourished especially in the *early Migration* period, it seems reasonable to hypothecate that in this area there was a direct continuity between the late antique art and the gem art of the cloisonné jewellery.

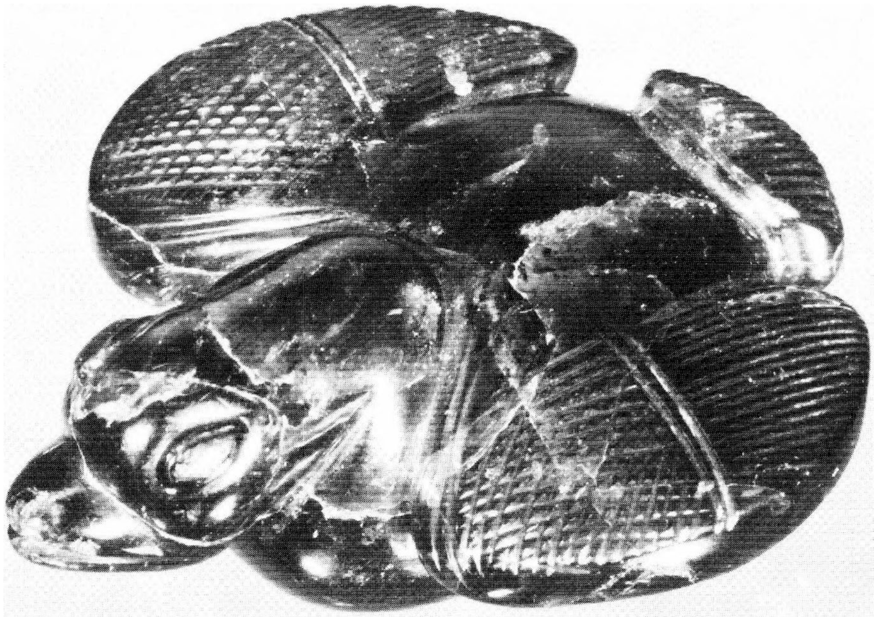


Fig. 43. Large garnet cameo in the shape of a swan. Taxila, West Pakistan. Second to third century A.D. 1:1.

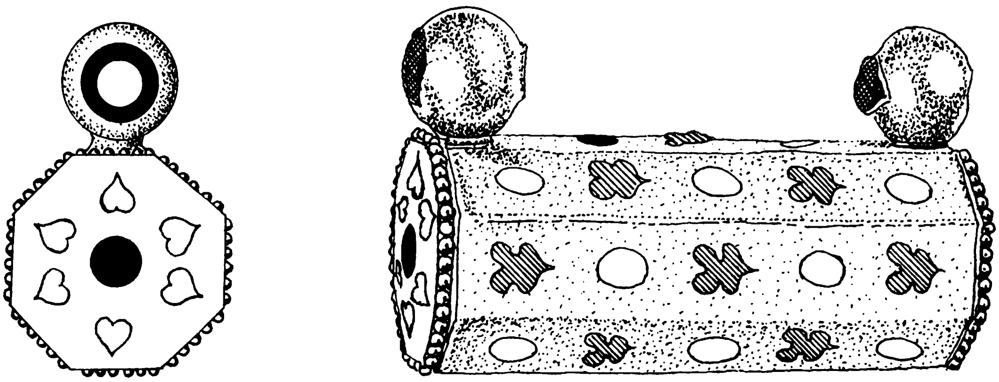


Fig. 44. Gold reliquary with inlays of green malachite (diagonal hatching) and garnets (the white fields indicate lost inlays, probably garnets). Ahin Poch, Jalalabad, Kabul (BM 18). 1:1.

## 2:5 Sassanian relief-cut garnets

The so-called Chosroe-bowl in the Bibliothèque Nationale in *Paris* (Paris 10) demonstrates that high-quality relief-cut garnets may still have been produced in the sixth century. Rock crystals and relief-cut garnets together make up a border in a rosette design which surrounds the image of Chosroe. The design is clearly Classical and could just as well have been made in the fourth century; it is indeed possible that its association with the central Chosroe panel is secondary (cf. below).

In the course of the fourth century it seems likely that gem-cutters gradually travelled from the eastern side of the Black Sea coast to the Sassanian kingdom as a consequence of the emergence of this country and the fall of the Roman Empire in the latter part of the century. It is thus clear that Sassanian gem art continued to flourish in the fifth century, as shown not least by the numerous gems portraying Sassanian officials (cf. Akermann 1938 b and Borisov 1963). Gem-cutter's commissions were of course closely linked with the upper echelons of a society's class structure and a downward turn in the economy would quickly influence the production of gems. A similar movement of gem art to the seats of power of the Germanic chieftains also occurred at the end of the fourth and in the fifth centuries. I consider that the fifth century is the key to an understanding of the continuity between Hellenistic gem art and that in Sassanian and Germanic areas.

The clear evidence of Sassanian gem art in the fifth century, however, does not prove that this art continued to flourish throughout the sixth century and later. Apart from the Chosroe-plate (Paris 10), which probably belongs to the early part of the sixth century, there are very few known examples of this kind of high quality gem-cutting in the Sassanian Empire from the sixth and the seventh centuries. The decline in the gem-cutter's art which started in the Roman Empire thus seems to reach the Sassanian Empire in the later part of the sixth century. As Cottevielle-Giraudet has shown (1938) is probably the king depicted on the (so-called) Chosroe-bowl the Sassanian king Kavad (483–532) and the famous carnelian cameo in Bibliothèque Nationale, *Paris,* is also dedicated to this king. There is also evidence of fifth-century imports of Sassanian gems to Western Europe. The chieftains' grave from *Wolfsheim* (Wiesbaden 3–5), for instance, has a garnet pendant with a Sassanian inscription, found together with a mount with an inlaid relief-cut garnet heart and a buckle with cloisonné with stepped cells (cf. 2:7). Of further interest is an English find, a cameo cut in garnet and mounted in a pendant of Anglo-Saxon type (cf. fig. 10). This cameo, which is 38.5 mm long, portrays in profile a man in a Phrygian cap. The Oriental origin of this gem is indisputable and its association with Sassanian gems (Borisov 1963) makes a Sassanian provenance likely (but see also Henig 1974, no. 734, who refers it to an Armenian area). The gem is set in an Anglo-Saxon mount typical of the period around 600, and suggests the existence of trade with the Orient at this time, which presumably was particularly significant for Germanic garnet art-work. I have had occasion to discuss this Oriental trade elsewhere (Arrhenius 1982); this trade was probably brought by the Svear via Russia from the Black Sea, and it seems that cut gems, including garnets, were an important item. Apart from the cameo already mentioned, the Anglo-Saxon material includes another cut garnet gem, of poor quality but presumably of late Sassanian origin. The gem, which comes from *Silbertswold,* Kent, is decorated with a (?) lion in intaglio (cf. Fausset 1856, 130, no. 172). In this context I would like to mention certain large cabochon garnets which may possibly have Sassanian origins e.g. coming from the Black sea area. They occur as pendants, often in a Christian context, such as the Anglo-Saxon gold jewel from *Desborough* with its large cabochon garnets and gold cross (cf. Jessup 1950 pl. XXVIII). A comparable jewel in the National Museum in *Budapest* was found in the grave of an Avar princess at *Kiasköros-Vágohid* and dates from the seventh century (cf. Lazlo 1974). The very large cabochon garnets on these pieces are unique in that they cannot be paralleled in contemporary Germanic and Byzantine goldsmith's art. I will describe in more detail below the gradual diminution in the size of garnets used in Germanic art in the sixth century, a trend which continued in the seventh century. The stones discussed above are at variance with this trend, and must presumably suggest the availability of raw material from a different source from that common in contemporary Europe.

Finally, we must consider the garnet gems found in India and decorated in the Hellenistically-influenced Gandara style. It has been pointed out above that these gems are of a late date compared with Greek-Hellenistic gem art, but they are of obvious interest in the context of a discussion of late Hellenistic and Sassanian gem art. Judging by the collection I have been able to study in the British Museum and the Victoria & Albert Museum there is among the Indian cameos and intaglios a conspicuous group of very large garnet gems, for example a cameo 100 mm long, showing a carved swan in the round (fig. 43). An amulet case with oval garnets and green palmette-shaped inlays found in a stupa at *Ahin Posh* near *Jalalabad* (fig. 44), Afganistan (BM 18) should also be mentioned.

## 2:6 Shaped garnets: cutting techniques

On some keeled, but also on some irregularly-shaped and thicker flat garnets (i.e. 1.5 mm in thickness), it can be observed that there are irregular facets on the lower edges, unless these have been polished. The angle between the base plane and the facets varies between 130°C and 140°, and above the facets is a fractured surface (cf. fig. 36–39). I have interpreted this facet as a trace of a deep groove, cut with a diamond point in the garnet plate, along which the stone was broken. The irregular outlines of the garnets are due to the use of the technique of grooving and breaking. Garnet plates shaped in this manner are found in the earliest cloisonné work, but it is more commonly associated with single settings as it is difficult to achieve accurate shapes with this technique (cf. 3:1). In the *Petroassa* treasure *most* of the more irregularly shaped three- and four-sided garnets are shaped by grooving and breaking, while all other garnets are *cut*. In the cut garnets the irregular facets of the lower edges disappear and the whole of each edge is uniformly and obliquely facetted, fig. 47, 48–50.

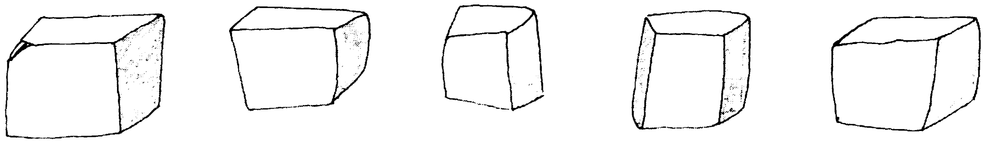


Fig. 45. Tesserae of stone with oblique facets from the cutting 1:1.

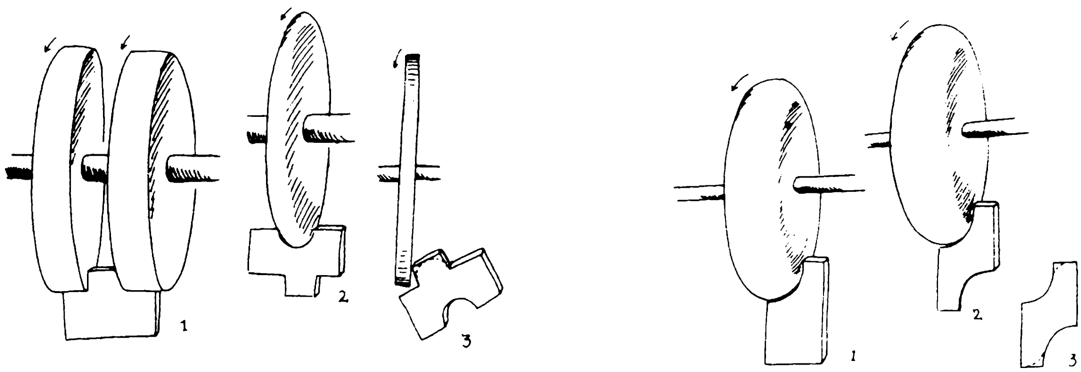



Fig. 46. Wheels with differently shaped edges used for modelling rounded shapes. 2:1.

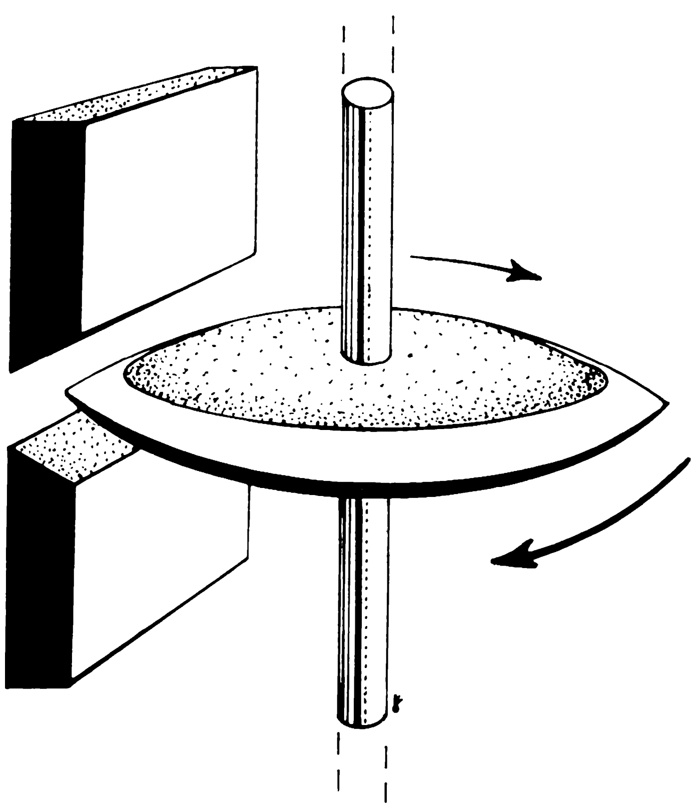


Fig. 47. Cutting wheel with tapering edge.

The well-defined edge facets on garnet plates were produced by a wheel with a tapering edge (cf. fig. 47). Pazaurek (1932) believes that a wheel-shaped cutting disc was used in gem-cutting as early as pre-Roman times. A representation on a Roman tombstone from the first century AD illustrates a cutting wheel together with a bow, tools which symbolise gem-cutters (cf. Furtwängler 1900, 319 and Charleston 1964, 86). The bow string was placed round the spindle of the wheel which was then rotated by twisting the bow backwards and forwards. The bow-powered wheel has been used from the early Neolithic to the present day for turning and drilling (cf. Charleston 1964, 83 ff.). In the course of time the technique has been improved by the addition of an attachment for the bow string (cf. Charleston 1964, fig. 3). The use of the bow as a source of power has the drawback that the movement is *not continuous* but *spasmodic,* as the bow moves back and forth.

Heron, the Alexandrian inventor who lived in the first century AD, made many attempts to solve the problem of continual motion (cf. Gille 1956, 635), and has been credited with the invention of the connecting-rod. However, this device has no transmission and can therefore only be used for grinding larger objects, as a large wheel is required to achieve acceptable speeds. The apparently rather grotesque drawing in the *Utrecht psalter* (Gille 1956, fig. 593), showing a sword being ground with the aid of an enormous wheel, illustrated this technique. The invention of the driving-belt, with which transmission could be achieved, seems to have been introduced only in the high Middle Ages, when it occurs on spinning wheels. In the course of the fifteenth century the driving-belt was used to provide transmission for small grinding and cutting tools for gem work. They are described by Leonardo da Vinci and in the contemporary Swedish lapidary by Peder Månsson (cf. Arrhenius 1969). It is during this period that gem art and the art of engraving glass expanded, as it had done in the Roman period (cf. Charleston 1964, 90).

Furtwängler saw the increased use of the cutting-wheel in the late Roman period as a cause of the decline in gem art. Some large sardonyx cameos from this period bear witness to a comparatively coarse wheel-cutting technique (cf. Furtwängler 1900). However, the cutting-wheel was not only used for gem work in the late Roman period: the technique played an important part in work on glass. The cage-cups in particular demonstrate an extremely highly developed technical skill in the use of the cutting-wheel at this time (cf. Röder 1965).

It seems likely, however, that the most important use of the cutting-disc was in the production of tesserae of semi-precious and coarser stones. Glass tesserae, cast in long strips, could then as now easily be fractured with the aid of a groove, but the cutting of stone into regular square shapes required the use of a rotating wheel. Oblique facets like those observed on garnets can also be seen on square stone tesserae (fig. 45), but in this case these facets lie parallel to allow as close a fit as possible. The shaping of tesserae was apparently done by eye; the size of an individual tessera did not need to be absolutely accurate, as it could be made to fit with the aid of cement. In cloisonné work, where garnets of complicated design were fitted into a continuous pattern between rigid metal walls, the use of templets was probably a technical necessity. At first the templets consisted of complete design units, such as the freely-shaped acanthus leaves at *Petroassa* (fig. 33e), but these were probably later replaced by composite templets (see below 2:7).

The more complicated cutting processes carried out on garnet plates often less than one square centimetre in size presumably required a fast wheel with continual motion. The use of bow-powered wheels would have left scars resulting from the unavoidable breaks in the cutting action. However, it is characteristic of garnet plates cut to more complicated patterns that the edges are completely smooth with no trace of irregularities. I have observed the same phenomenon in Roman tesserae, from the Black Sea and Tunisia for instance. I therefore suggest the hypothesis that *a cutting wheel with continual traction* was available, that is, that the bow was not used as a source of power.

What, then, could the power source have been? We know that water-powered mills, saws, etc. developed in the late Roman period when the use of water power caused large-scale slave revolts (cf. Forbes 1956, 605 ff.). Indeed, Heron of *Alexandria* is said to have played an important part in developing water-powered machines. In the Hellenistic cities by the Black Sea water power was introduced at a very early stage (Forbes 1956, 593 ff.), and the technique also appears to have spread to other Roman provinces. It continued in use as late as the Migration period, but only in isolated localities with strong Roman traditions. I imagine that the production of tesserae was also mechanized with the aid of water-powered cutting-wheels; tesserae were an important item of trade in the Roman period (cf. R.J.A. Wilson 1982). It is my opinion that garnets were similarly cut in larger quantities at certain specialized workshops where water-powered tools were available (cf. Dworakowska 1983, 151 about Roman workshops outside the quarries using water-powered saws).

Flat garnet plates cut by grooving and breaking occur throughout the whole period in which such garnets were used, but they are most common in the earliest type of garnet cloisonné (cf. chapter 3). Shaped, wheel-cut garnets first occur at the end of the late Roman period: those found at *Petroassa* and *Szilágy Somlyó,* together with garnets cut by grooving and breaking, probably represent the initial stages of the wheel-cutting technique.

## 2:7 Shaped garnets: templets

The assumption that garnets were shaped with the aid of templets is based on the close similarity in size between stones of the same shape, a similarity which could hardly have been achieved other than by the use of templets. The deviations in size between such stones is at most 0.2 mm (except where there is secondary damage), which is no more than would be caused by the application of differing pressures on the cutting-wheel.

It is clear that stencils, sometimes made of lead, were used in late antique mosaic work in order to produce regular patterns. It has been demonstrated by many scholars (cf. Schoppa 1956, Parlasca 1959) that more complicated mosaic designs were assembled in special workshops, later to be mounted as complete units in plainer wall or floor mosaics. These mosaic design units, known as *emblemata,* were traded over large areas. Parlasca (1959, 132), for instance, records a design unit consisting of opposed pelta-motifs—a pelta cross—produced in *Trier* and found throughout the Rhineland.

In mosaics the individual tesserae consists of more or less regular squares which together make up more complicated designs, but the complex shapes into which garnets were cut were in themselves a kind of *emblema.* Like the composed *emblemata* of mosaic, shaped garnets required a surround to fit their design. In garnet cloisonné, therefore, a complex shape was always accompanied by a complementary shape with which it would form a complete design. Rather than using templets for the whole of the positive element in the design, it was advantageous to use part-templets for both the positive and negative elements of the design.

The use of complicated individual shapes when cloisonné art was in its infancy can be explained by the development of this art-form more or less directly from late antique gem art, where individual stones were cut in cameo or intaglio. It is important to emphasize that this applies only to garnet cloisonné work; there was another, different Egyptian and Sumerian cloisonné tradition using uniform inlays (cf. fig. 132–135). I am referring to the scale-liked inlays of lapis lazuli, carnelian and later glass flux and enamel which occur in the art of these cultures. These inlays are not wheel-cut and the shapes are rather inaccurate. The cell walls, on the other hand, are adaptable and the inlays secured with adhesive (cf. chapter 3). The scale-like inlays here serve the same purpose as the square tesserae. Therefore it is important to establish that garnet cloisonné, with its varied cell shapes, is fundamentally different from mosaic art, even if this art became an important source of inspiration for the development of the step patterns, the cloisonné *emblemata* which achieved the widest distribution both geographically and chronologically.

Step-patterned cells with enamel inlay occurred in the art of the Hellenistic goldsmith, as for instance on a Greek bracelet from the first century BC (Hoffman 1965, no. 56). It is likely that the step-patterned cells originate more or less directly in mosaic art. This pattern occurred naturally in mosaic when irregular stones were replaced by square tesserae of glass or stone (Nordhagen 1958, 44 ff.). This change took place in the first century BC, and step motifs in black and white or polychrome were extremely common in this and the following century.

This step pattern also developed naturally in textile art, but evidence of its emergence in Coptic textiles is of a later date (cf. Dimand 1924). Associated with these patterns in textiles are step-patterned gold mounts which were applied to textiles in the late antique period: a mount of this kind was found in a church at *Turburbo Majus* in Tunisia together with two brooches and ear rings of drop-shaped amethysts (Merlin 1912, 358 ff. and fig. 3). This was presumably a Vandal grave of the fifth century, contemporary with the earliest examples of garnet plates cut to this pattern. Termini of step design were also very popular in late antique goldsmith's art from the Danube to the Black Sea area, as seen for instance on ear rings from *Armazis-Khevi* (fig. 9) and brooches from *Szilágy Somlyó.* Finally, stepped features are typical of Sassanian architecture (Reuther 1938, 522).

The complete motif, in the form of a stepped rhomboid, has a rather more limited distribution, even though it is naturally closely associated with the stepped borders. It is likely that the stepped rhomboid was interpreted as a cross symbol at an early stage; this design is characteristic of mosaics in Byzantine churches of the middle and second half of the fourth century, as for instance the church at *Misis* in Asia Minor. According to Budde (1969, 76), the mosaics at *Misis* were laid towards the end of the fourth century. The designs of these mosaics reflect a rich symbolism, with sacred vessels alternating with cross ornaments; the stepped rhomboid is the most common motif, being often surrounded by borders of running spirals (Budde 1969, pl. 45–52).

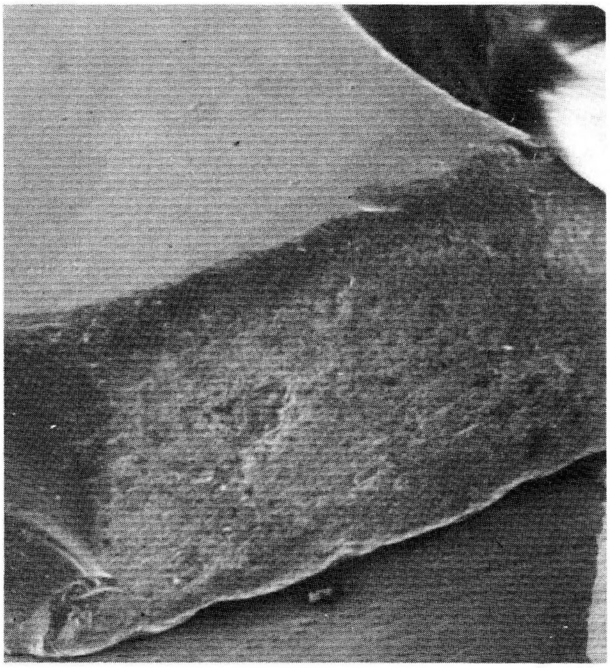


Fig. 48. SEM. micrograph of a garnet showing a facet produced by wheel cutting. 30:1.

Fig. 49. SEM. micrograph of the edge of the garnet, fig. 50. 50:1.

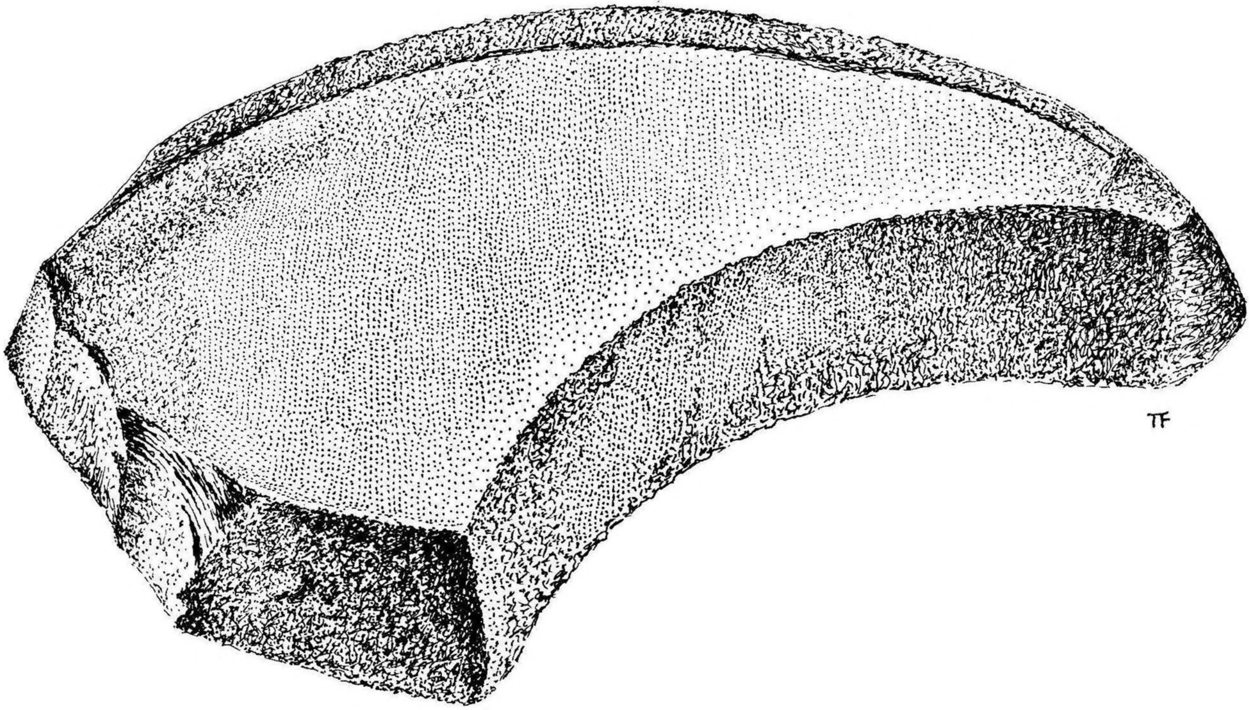


Fig. 50. Drawing from the SEM. of a garnet from Skrävsta, Sweden (Swed 26, probably from a buckle). 30:1.

Fig. 51. Micrograph of the garnet, fig. 52. 10:1.

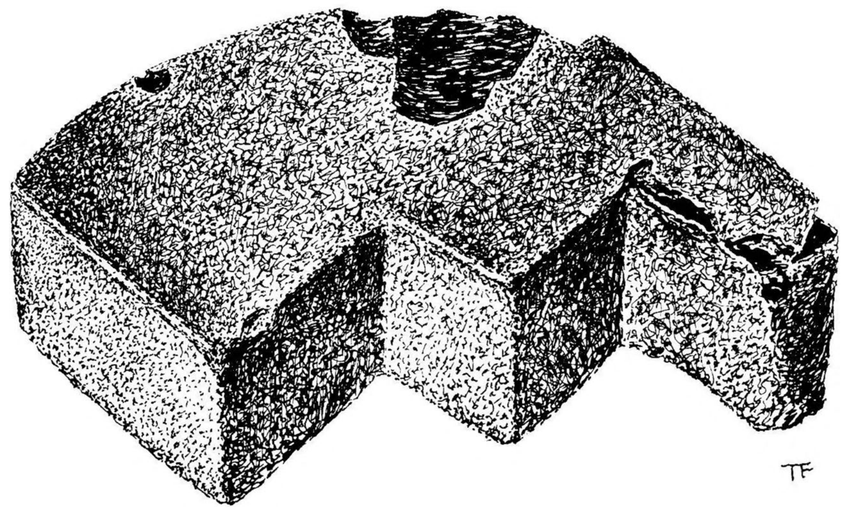



Fig. 52. Drawing from the SEM. of a garnet from the sword pommel from Skrävsta (Swed 26). 30:1.

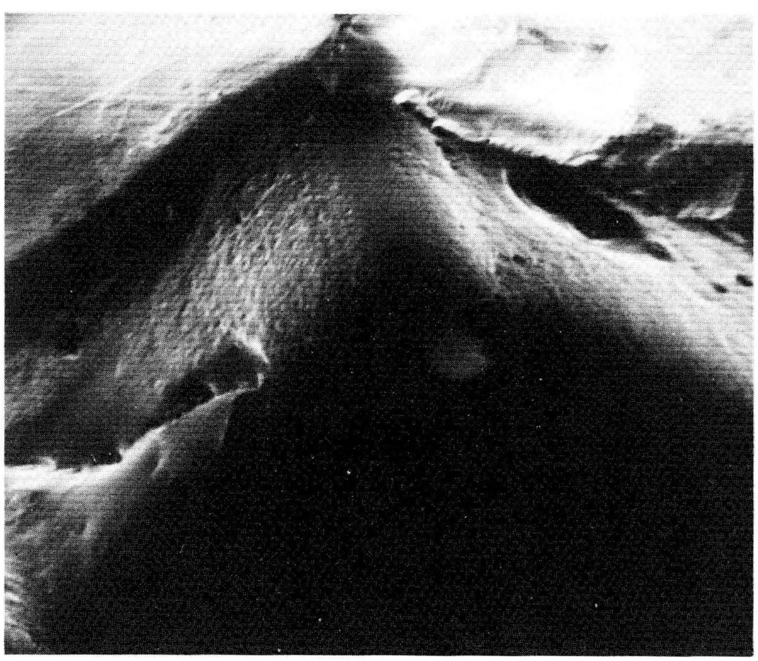


Fig. 53. Detail from the narrow part of the steps of the garnet, fig. 52. SEM. 150:1.

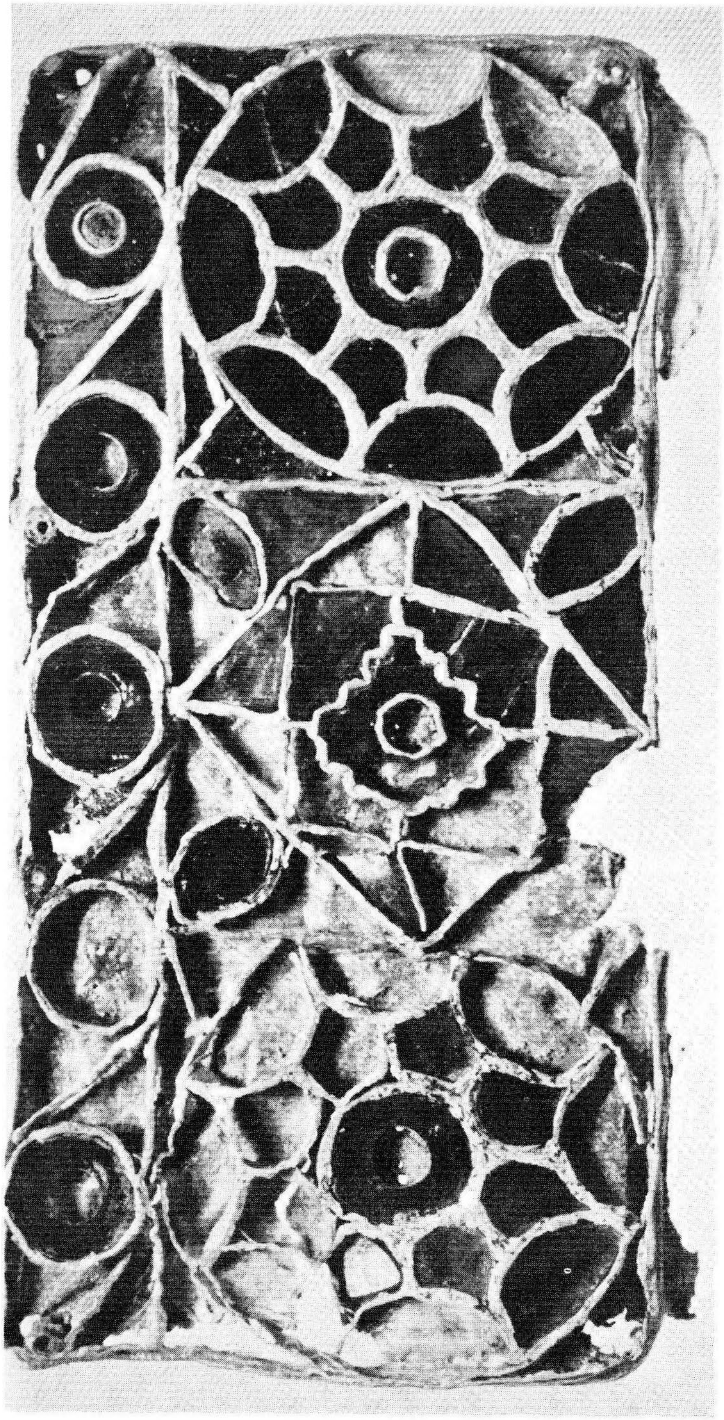


Fig. 54. Gold mount from Vienna (Wien 1) with stepped and pierced garnets. Green glass cabochons were originally set in the centre of the pierced garnets. 2:1.

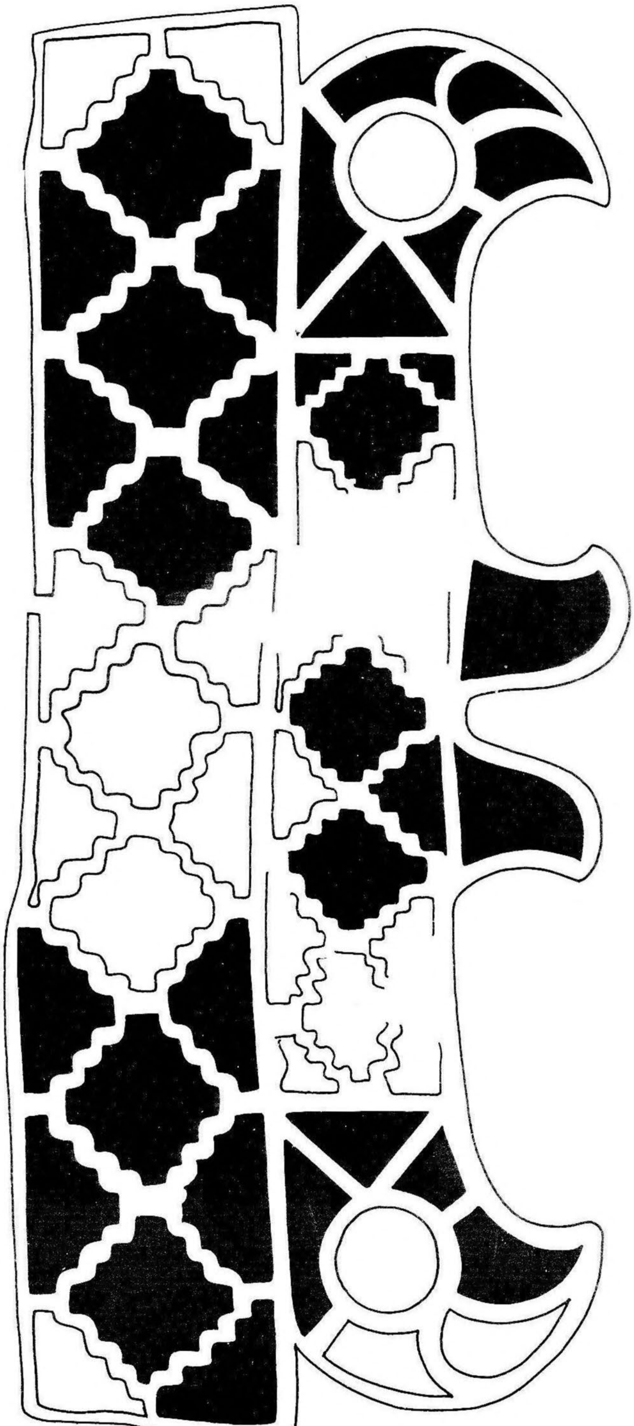


Fig. 55. Moutpiece from a sword scabbard from Pokrovsk-Vochod with a-stepped and b-stepped garnets. 2:1.

The flourishing Byzantine church art with its magnificent mosaics probably served as a powerful inspiration for the contemporary goldsmith's and textile art. A little later this influence can be seen in manuscripts. Kendrick (1938, 34) has pointed out that Byzantine floor mosaics must have played an important part in the development of the ornament in the Book of Durrow, for instance. In his work *The Occident and the Orient in the Art of the Seventh Century* (1943), Åberg emphasizes the importance of Oriental or East Byzantine art in the development of many manuscript motifs. Several of these motifs, however, already existed in the polychrome cloisonné art of the period between the fifth and the seventh centuries, thus forming an important intermediate link between Byzantine mosaic art and the insular manuscript ornament.

A rectangular mount, perhaps from *Vienna* (Wien 1, cf. fig. 54), is of particular interest in this context; it has a cloisonné inlay which is very similar to a floor mosaic of the same type as that at *Misis*. In the centre of the design is a large garnet (over 1 $cm^2$) cut as a stepped rhomboid. On either side of the rhomboid are rosette motifs built up of garnets with curved sides surrounding a central circular garnet. Along one edge is a border of circular garnets set in a pattern very closely resembling a running spiral. In the centre of each garnet was a hole containing glass flux which, where it is preserved, is green in colour. The stones on this mount are among the earliest examples of garnet plates cut with the use of composite templets.

The main reason for assigning the cloisonné work on the *Vienna* mount to such an early period is the large size of the individual garnet plates. They all belong to size groups 2–4, that is each stone is between 50 and 125 $mm^2$, a size typical of the earliest templet-cut garnets. If we compare the average sizes of garnets from a number of finds of known date, from Childeric to *Sutton Hoo* (cf. diagram fig. 70), it can be observed that there was a general diminution in the size of garnets cut after Childeric's time, that is after 480. This difference is particularly noticeable in stepped rhomboids. If we compare garnets of this design on the *Vienna* mount with those from *Sutton Hoo,* the former are four times the size of the latter. We have seen above (chapter 1) that the difference in size can presumably be attributed to a change in the source of the garnets. Before discussing further the shapes of the templet-cut garnets on the *Vienna* mount, I wish to emphasize that the dating of this mount to before 480 is corroborated by the mounting technique in which neither gold foil nor crystalline paste was used.

The stepped rhomboid on the *Vienna* mount is characterized by a certain inequality between the two halves. This suggests that the templet used in cutting this stone probably only comprised half the design. The same templet was presumably also used to shape the four interlocking pieces which surround the rhomboid. All these pieces share the same measurements for the height and depth of the individual steps, although the surrounding pieces have one more step than the central rhomboid. The templet therefore probably included the extra step, as it is simpler to cut out a smaller or shortened version from a larger templet than *vice versa*. The slight increase in the width at the ends of the stepped rhomboids probably resulted from the use of a shortened templet. Step patterns with these measurements also occur on other objects. For cataloguing purposes the templet used to produce this design has been given the code letter a. St (step pattern):the letter a denotes that the steps on the templet are 1.8 mm in height and width, although as a rule the last step is extended a little further. Some deviations from the templet sometimes occur because of mistakes in the cutting etc., but such deviations do not exceed 0.1 mm and only affect individual steps.

The stepped patterns have emerged as important elements for characterizing garnet-cutting workshops as the complicated shapes clearly demonstrate that the same templets were used. With deviations of less than 0.1 mm it is very improbable that templets of this type were used in workshops which were independent of each other. In the cataloguing therefore templets for stepped garnets have been specially measured and noted. The different templets (cf. fig. 71–73) are described according to a system which is explained in the reader's manual.

The templet a. St is rare and the distribution of objects with garnets cut to this design is very wide. I know of two such finds from South Russia, one from the Danubian area, one each from the Rhineland, France and Sweden. The templet was used for cloisonné work on scabbards in the two finds from South Russia – and it is also possible that the *Vienna*-mount originally had this function. Further it is used on a buckle and a paten respectively in the finds from the Rhineland and France. The use of the garnets found in Sweden (Husby Långhundra to be published by B. Almgren *et al.)* cannot be determined, but is is likely that they were from ornaments on a saddle. A common feature of all these objects is the mounting technique, where no crystalline paste was used (cf. chapter 3). It is likely that garnets such as these were produced in south-east Europe near the Black Sea. This provenance is indicated by the fact that most of the objects containing garnets cut from an a. St-templet have an association with this area. The two south Russian swords, from *Kerch* and *Pokrovsk-Voschod* (Werner 1956, 41, pl.

Fig. 56–60. Pierced garnets from 400–600 A.D. 2:1. 56) Gilton (Liver 1/D). 57–58) Klepsau (Karl 13/D). 59) Ravlunda (Swed 6/L). 60) Rom 4/Eb)

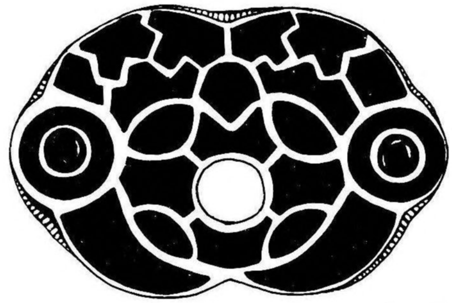


Fig. 57

Fig. 58

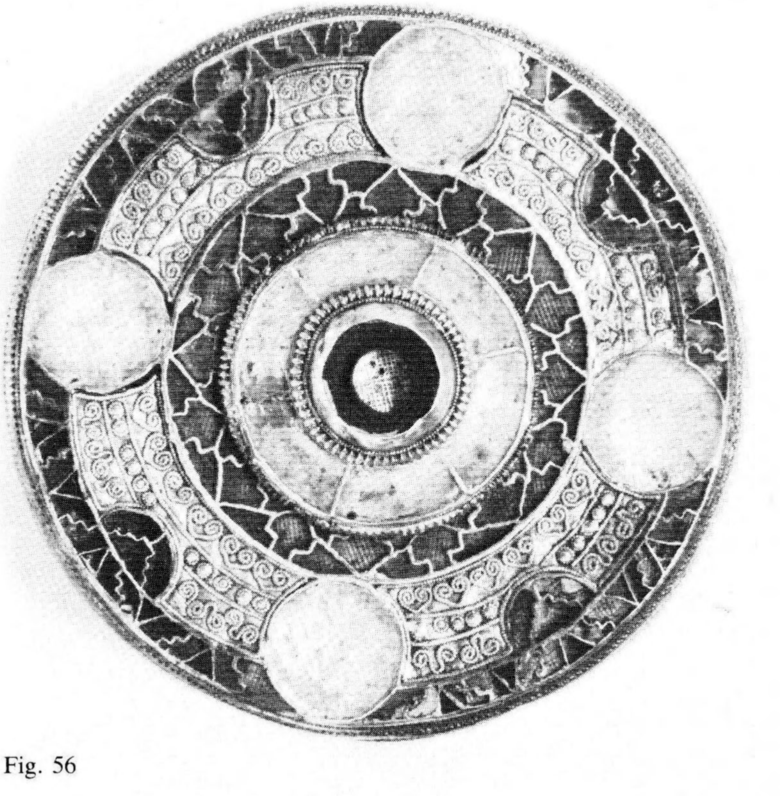


Fig. 56

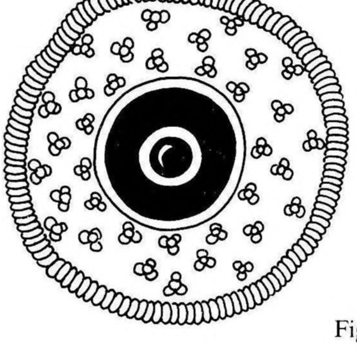


Fig. 59

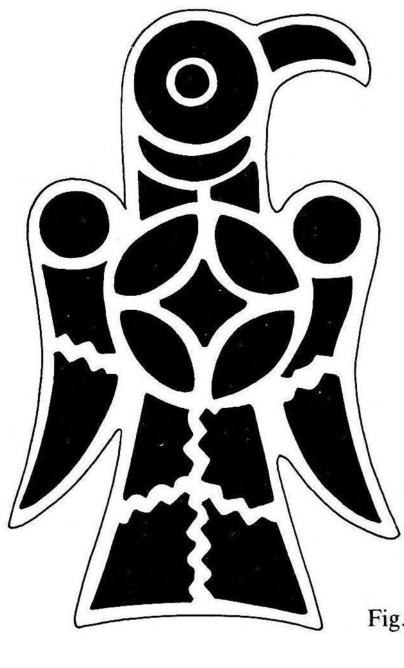


Fig. 60

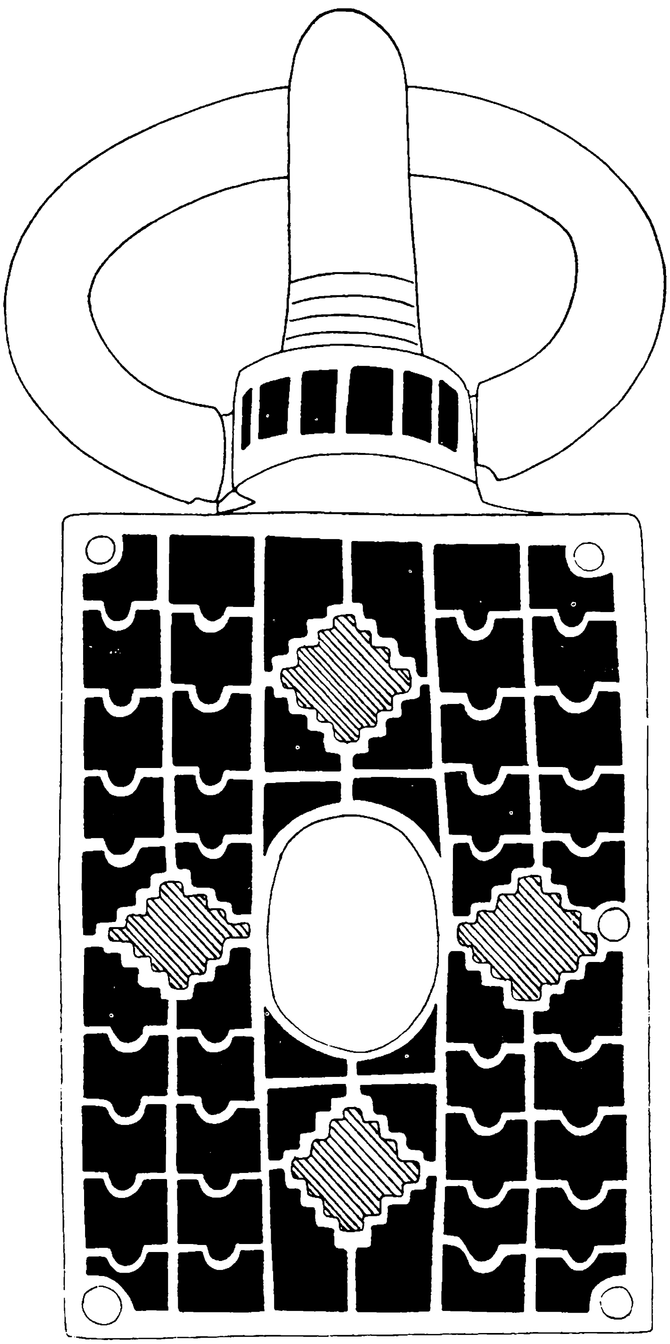


Fig. 61. Buckle with garnet cloisonné and green glass; in the centre b-stepped rhomboids (BM 7/Bu). 2:1.

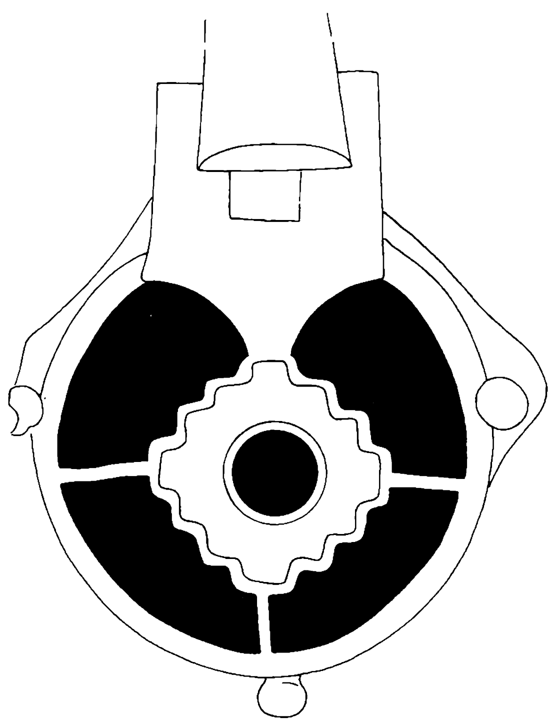


Fig. 62. Cloisonné with a-stepped garnets on a buckle from Wolfsheim (Wiesbaden 4). 2:1.

40: 2), are of a design which is associated with Byzantine and Sassanian swords (cf. chapter 4.).

The buckle from *Wolfsheim* (fig. 62), the only Rhenish find with a. St-shaped garnets, also contained a pendant with garnet inlay and a Sassanian inscription. In south-east Europe, the north and west coasts of the Black Sea seem to have been the most important points of entry for Sassanian influences, probably in connection with trade across the Black Sea. The routes of communication between Europe and Asia Minor across the Black Sea went back to Greek times. It is likely, therefore, that Sassanian imports reached western Europe via the Black Sea region.

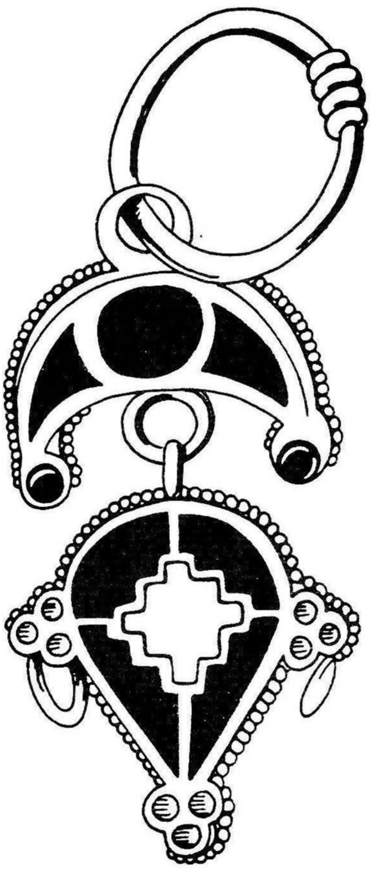
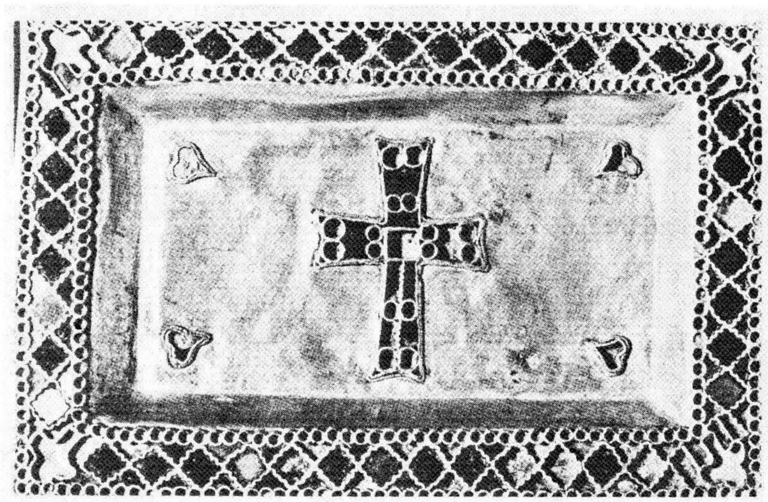
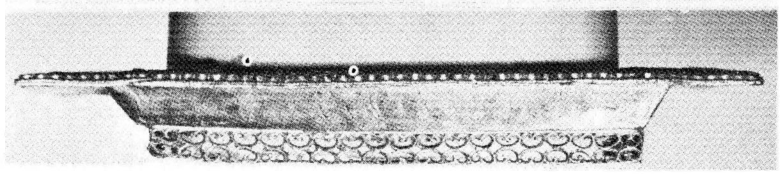


Fig. 63–64. The Olbia treasure (Wash 1/Ea; Wash 2/P). 63) 2:1. 64) 1:1.





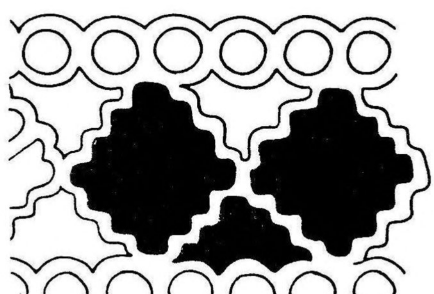


Fig. 65–68. The paten and chalice from Gourdon (Paris 11/Bo). 65–67) 1:2. 68) Drawing of the cloisonné pattern on the paten. 2:1.

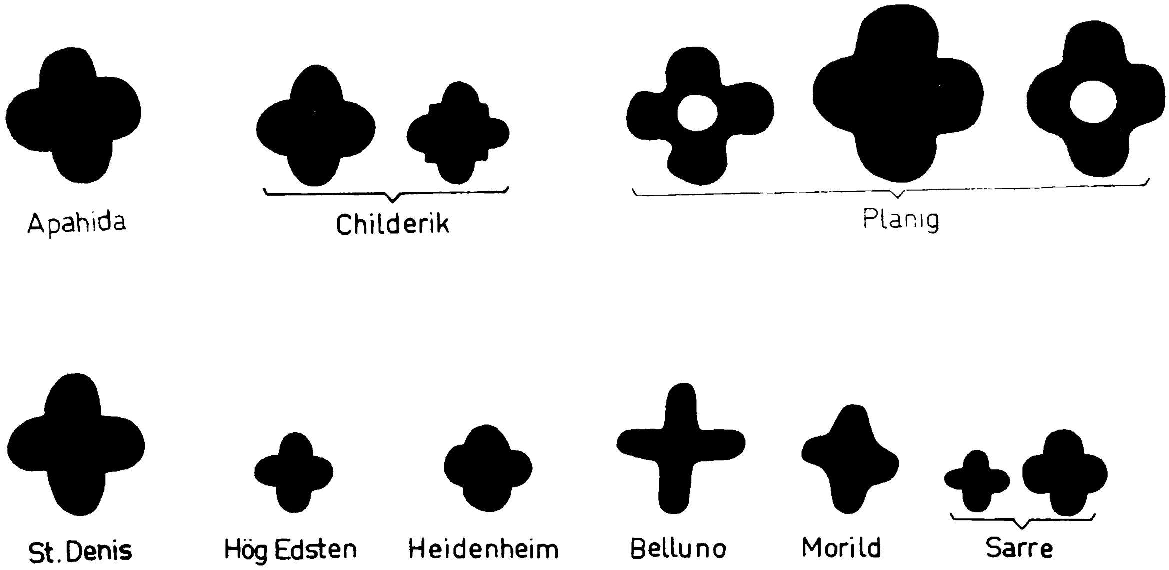



Fig. 69. Quatrefoil shapes from different objects. 2:1.

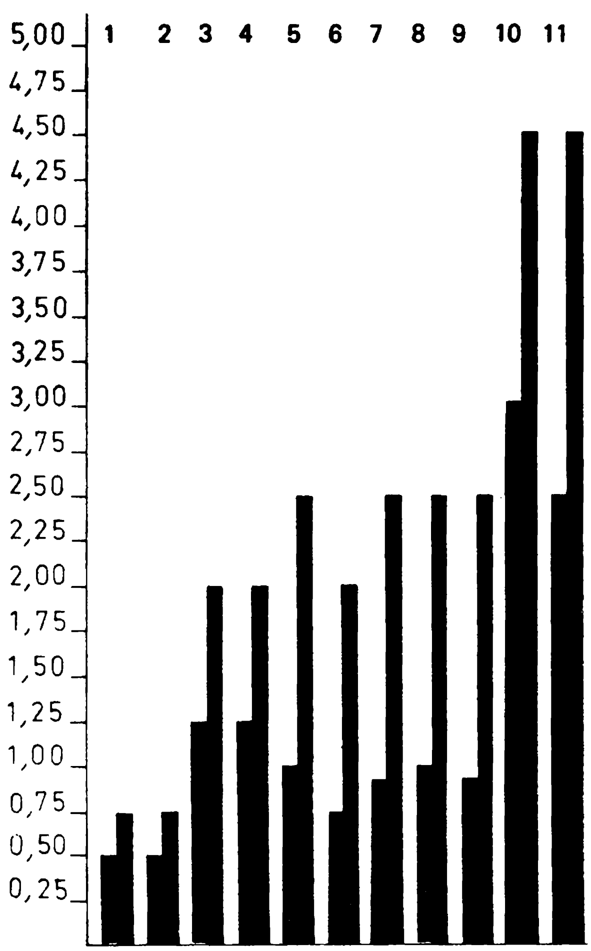



Fig. 70. Diagram showing the highest and the lowest number of garnets pro 25 $mm^2$ on different objects.
1) Bird-shaped mount, Apahida II (Cluj 2)
2) Sword, Childeric (Paris 1)
3) Sword pommel, Krefeld-Gellep (Krefeld 1)
4) Sword pommel, Väsby (Swed 13)
5) Pendant, Cologne Cathedral grave (Köln 7)
6) Disc brooch, St Denis (Paris 14)
7) Sword pommel, Vallstenarum (Swed 65)
8) Disc brooch, Marilles (Br 2)
9) Sword pommel, Sutton Hoo.
10) Sword pommel, Skrävsta (Swed 26)
11) Disc brooch, Reinstrup (Cop 3)

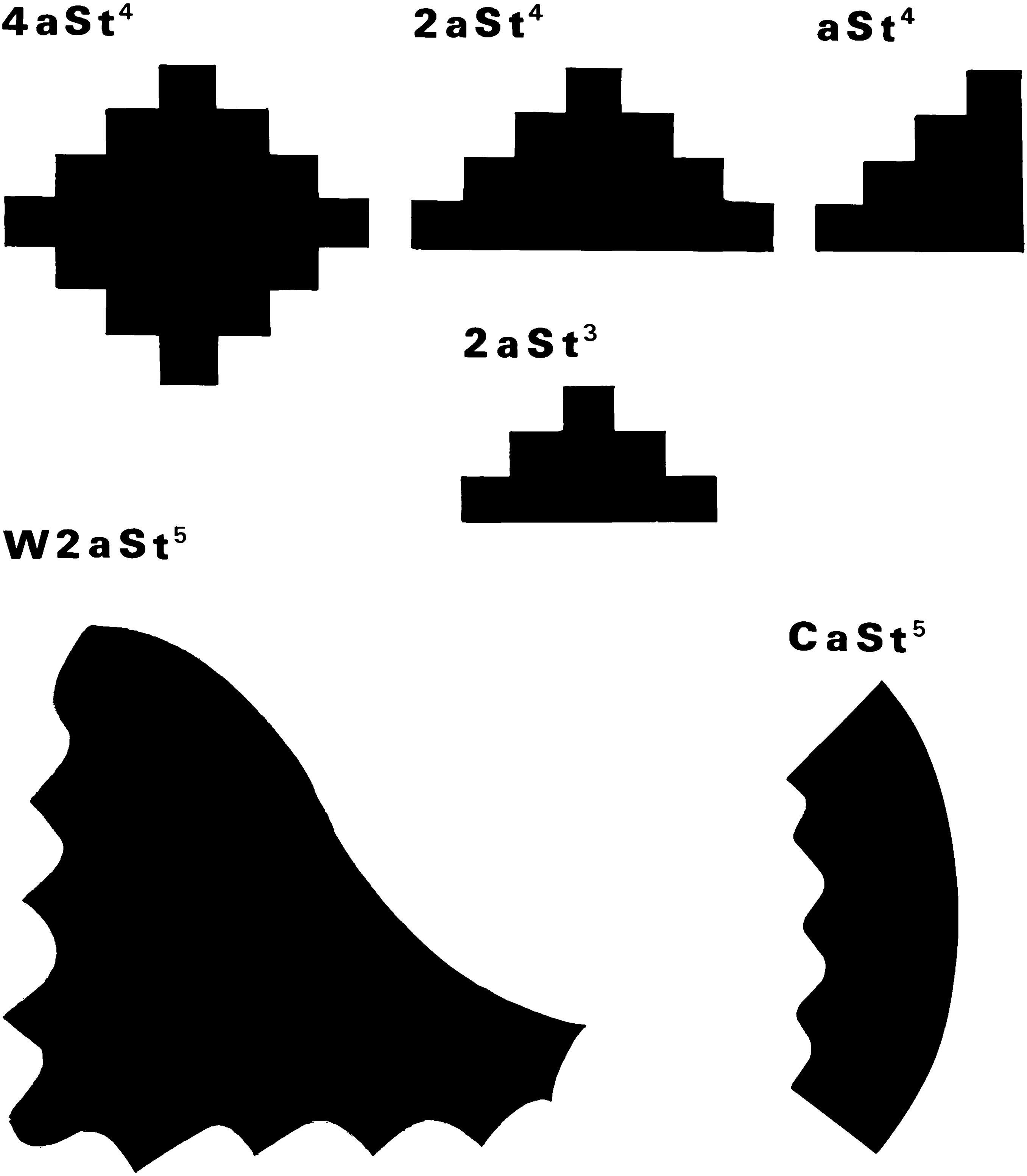



Fig. 71. The principal a-stepped shapes. 5:1.

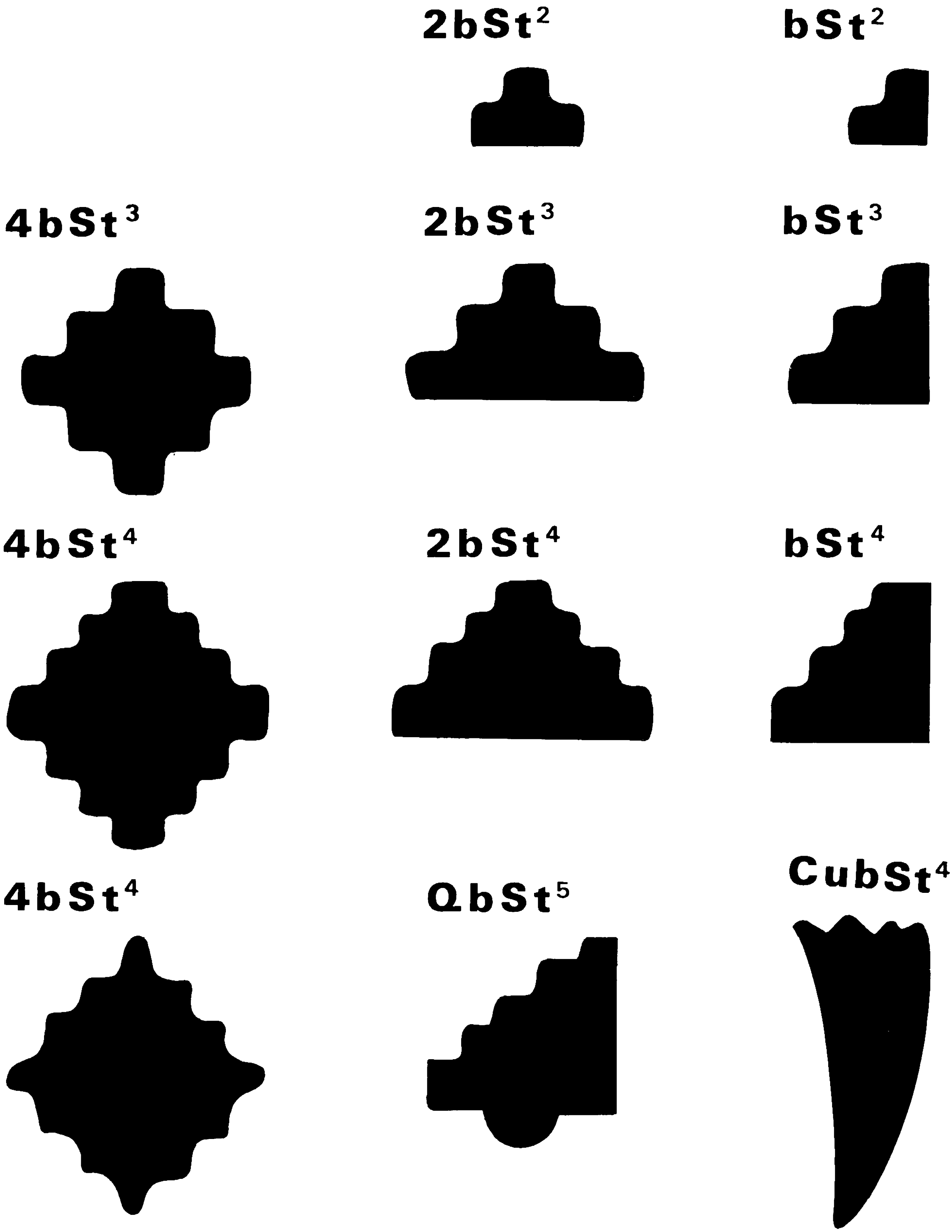



Fig. 72. Variations on the principal b-stepped shapes. 5:1.

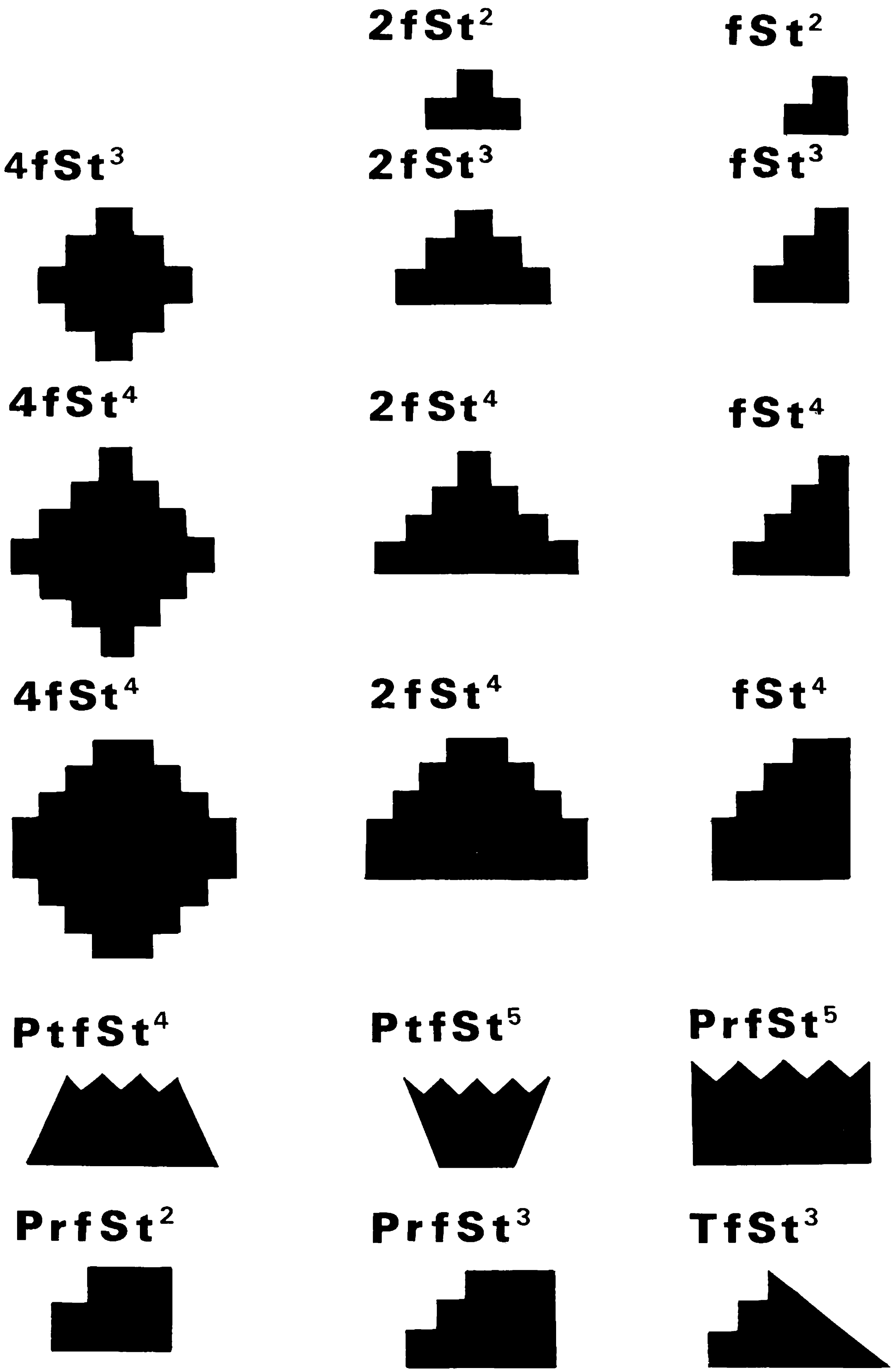



Fig. 73. The principal f-stepped shapes. 5:1.

The rectangular paten from *Gourdon,* fig. 65; 66, is paralleled in Roman silver dishes of the type found in the hoard from *Esquiline* (Dalton 1901, no. 312). The square silver dish from *Mileham* with heavy beaded rim (Kent and Painter 1977, no. 103) should also be remembered in this connection. The heavy beaded rim of the latter may indicate an origin from the Black Sea (Painter 1977, 19).

The find with garnets cut from the a. St templet from the unpublished mound at *Husby Långhundra* in Sweden, was found i a rich cremation burial which included objects decorated with animal ornament in Vendel styles A and B. The garnets, among which wing shape is especially note worthy (cf. fig. 71, W2 a $St^5$ drawn from this find), may have belonged to a saddle mount with a bird motif of a similar type to that found at *Apahida II* (fig. 133) in Rumania. The presence of antique objects from the East—that is, from South Russia—in chieftains' graves in Svealand has been discussed in more detail elsewhere (cf. Arrhenius 1982).

Garnets from the a. St-templet are therefore rare. This in itself suggests that they are older than other step-patterned templets which will be discussed below. Further evidence for the greater age of the a. St-templet is the fact that it was replaced by a new type of step-pattern, the b. St-templet. On two objects with garnets cut from the a. St-templet there are secondary additions cut from the b. St-templet. On the bottom of the *Gourdon* paten (fig. 65), a cross with garnet inlay thus includes stones cut from the b. St-templet. The cross, together with the green hearts in the corners, was probably added when the paten was adapted to ecclesiastical use. We have seen that rectangular plates were part of late Roman tableware and this plate probably became a Christian paten at a later date. This probably took place at the same time as the chalice (fig. 67) was made, since this has the same green turquoise hearts as the paten. A unique feature of the paten is that even the garnets cut from the b-templet are set without patterned foil, which is otherwise almost invariably the rule. The additions to the paten were therefore probably carried out at an early stage of the production of garnets from the b.St-templets. The handles of the chalice are ibis-shaped, with eyes of inlaid, cabochon-cut garnets. As these garnets are not backed by patterned gold foil, it is likely that the chalice is also considerably older than the period of deposition. The ibis-like birds are reminiscent of the bird brooches from *Petroassa.* The paten and chalice were found together with 104 coins (36 solidi, 68 tremisses from Leo (457–474) and Justinian (500–527)). The treasure has been attributed to the Burgundian king Sigismund († 524) (cf. Lafaurie 1958).

Another object with secondary b.St-garnets is the scabbard-mount from *Pokrovsk-Voschod (cf. fig. 55).* The mount at the month of the scabbard has garnets cut from the a.St-templet, while underneath there is another mount with bird-shaped terminals at each end. It is likely that this mount is secondary, given that the early Russian swords usually only have one narrow mount at the scabbard mouth (cf. Werner 1956, 40). A row of garnets at the centre of this mount are all cut from the b.St-templet. The rather simple shapes of the garnets which make up the bird-heads at the terminals are typical of the shapes which accompany garnets from the b-templet, while garnets from the a.St-templet are usually found with more complicated forms.

The more complicated shapes which occur together with garnets cut from the a-templet include circular garnet plates with pierced centres. On the *Vienna* mount (Wien1), for instance, they form part of the running spiral design. The holes in the centre originally held cabochon glass beads, which seems to be typical of these garnets. Garnets cut to this pattern are technical masterpieces, as the drilling of the central hole made great demands on the strength of the plate. It appears that several of these garnets from different finds were cut from the same templet: certainly they have been found in identical form on a neck-ring from *Ravlunda* in Sweden and on a bird brooch from *Rome,* cf. fig. 59 and 60. The neck-ring from *Ravlunda* belongs to a type with a box-shaped catch dating from the latter part of the fourth century or the early fifth century (cf. Beniger 1931, who describes a neck-ring of this type from *Czeke-Cejkow;* also a later ring from *Ransern,* La Baume 1934, fig. 73c, which Werner, 1956, 84, assigns to the Hunnish period). It is therefore probably more or less contemporary with the *Vienna* mount, while the circular, pierced garnet on the bird from *Rome* must have been taken from an older work and remounted in the bird design, where other garnets include stones cut from the b-templet. The pierced garnets on other brooches (fig. 56, 57, 60) are probably also antique.

Other shapes which typically occur with a-stepped garnets include curved shapes like lentoid segments of circles and triangular shapes with curved sides. The garnets are typically very large in area (sizes 6—>6) and approximately 1.3 mm thick. A particular type of polish, here called feather-polish (cf. 76), distinguishes the garnets from this workshop group. The a-stepped garnets, finally, are usually set without foil backing, and where foil is used, it is plain. The chronology of a-stepped garnets and their attribution to workshops will be discussed in chapter 4.

The important difference between the a- and b-step patterns is the height of the steps, which in the case of the a-templets is 1.8 mm and for b-templets 1.2 mm cf. fig. 71–72. This may seem a very minor difference, but it means that a rhomboid with four steps cut from an a-templet has sides just over 9 mm in length, while when cut from a b-templet the sides are 7 mm long. The difference becomes even more marked when considering the area of a rhomboid; the area of an a-rhomboid is about 81 $mm^2$, and of a b-rhomboid only 49 $mm^2$.

With the b-templet, an important innovation in cutting technique was also introduced: the use of a cutting-wheel with a concave or convex edge (cf. fig. 46). The convex edge in particular seems to have been previously unknown. These wheels were used to produce not only step-patterns but also the U-shaped projections and indentations for the omega cell ladder pattern. The garnets produced in the workshop group which used the b-templet are characterized by their U-shaped curves. It is unusual to find whole rhomboids cut from the b-templet, but rectangular or triangular shapes often have as many as ten steps or more on one or two sides. It is unlikely that larger templets were used in these cases: repeated cuts were probably made, at regular intervals and to the same depth. The step-patterns demonstrate a very advanced technique and are found on some of the best cloisonné works, such as those from Childeric's grave and *Apahida I and II* (cf. chapter 4).

The omega-shaped garnets, the Q shape which, along with the b-stepped patterns, are such a typical feature, are entirely based on the Classical tradition, where this motif is common, for instance in the mosaics which covered floores and also, though less frequently, walls and ceilings. Werner (1958) has pointed out the importance of the omega motif for the late antique goldsmith's art in Egypt, as for instance on the enamelled work in a find from *Balana* in *Nubia* (Emery 1948). A Vandal bronze brooch from *Algeria* (Paris 9) (fig. 12), which takes the form of a bow-brooch with a semi-circular head plate, was inlaid with b-stepped garnets and an omega-shaped onyx. The chape of the seax in Childeric's grave also had a large sardonyx which terminates in an omega shape. Onyx and sardonyx were among the most valued stones in the late antique period, and they seem to have been produced in Byzantium, (cf. chapter 4).

Quatrefoils, (fig. 69) either simple or composite, were another garnet shape which first appeared along with the b-stepped patterns. Quatrefoils occur in a number of different sizes and the templets cannot be as easily identified as those for step-patterns. This is because they were usually cut more or less freehand, probably from a round, flat disc, the only constraint being that the lobes were the same width as the concave edge of the wheel with which they were cut. This would explain the fact that they are often slightly assymetrical.

The garnets which occur in association with b-stepped patterns were frequently engraved with circles or wavy relief patterns. These engravings also indicate the skill with which the cutting wheel was controlled. In conclusion, it can be stated that the gem-cutters who produced the b-stepped garnets and the other shapes with which they are associated displayed a very advanced technique.

The objects with garnets cut in b-stepped patterns occur in South Russia, Central and Western Europe, Spain and North Africa. The largely uniform character of these garnets is very striking. With very few exceptions these garnets are mounted with a backing of patterned foil. Similarly, with few exceptions they are mounted using the cement technique, that is with very hard paste (cf. chapters 3 and 4).

Most b-stepped garnets are the same thickness as the a-stepped stones, but some are much thinner, less than 1 mm, cf. diagram 102. This may be due to the continued production of some b-stepped garnets later than the fifth century and perhaps on into the seventh century; it must be empasized, however, that an important and innovatory phase of the production took place in the fifth century.

The later production appears to consist of simple step-patterns (i.e. $St^1$- and $St^2$-shapes) cut with the concave and convex wheel of other b-patterns. When these shapes occur *on objects produced after 600,* they are identified as e-shapes, cf. fig. 226. Some of these were contemporary productions, while others were b-shapes which had been re-cut and used secondarily. This can be observed on garnets with projecting lobes which are also found in association with later forms. With these, the lobed stones may be original, while their interlocking pieces are newly made (cf. the sword from *Valsgärde* 7, fig. 231). It is probably correct to identify e. St-shapes as b. $St^1$- and b. $St^2$-shapes cut from thin garnets. In chapter 4 it will be demonstrated that it is the *garnet type* which distinguishes the late e-stepped shapes from the f-stepped shapes. However, towards the end of the production of garnets, e-stepped shapes may in some cases have been produced in the same workshop as the f-stepped shapes, perhaps providing an alternative and in these cases the same type of garnet would be used. Where it has been possible to examine e-stepped garnets under very high magnification, it has however been observed that, unlike f-stepped garnets, they have more rounded and less sharply cut edges (cf. fig. 75). E-stepped garnets will be discussed further below (cf. 2:8).

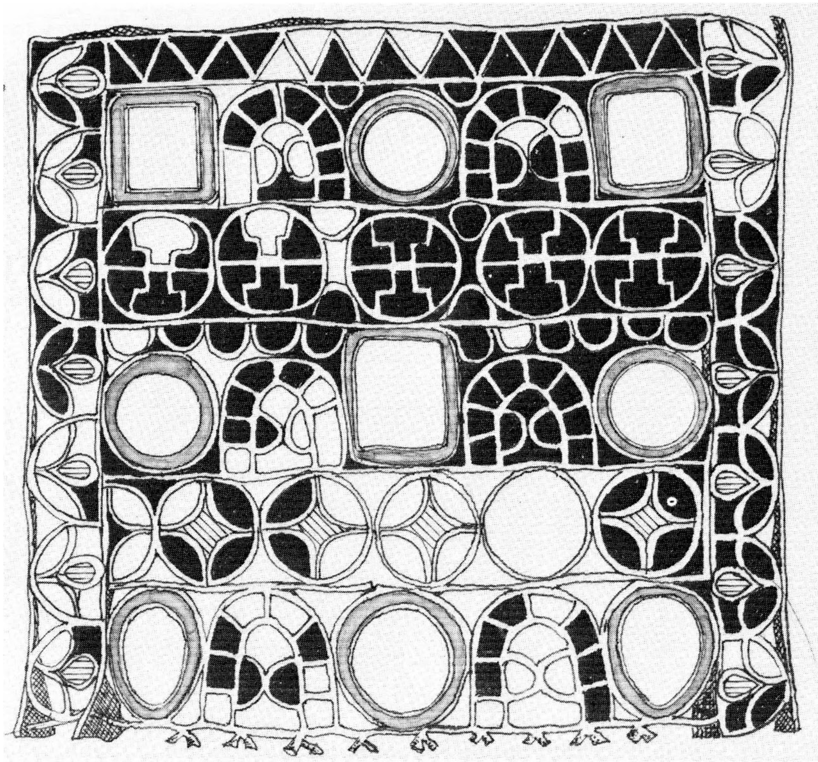


Fig. 74. Plaque with e-stepped garnets and green and blue glass from St Denis (Paris 13/M). 1:1.

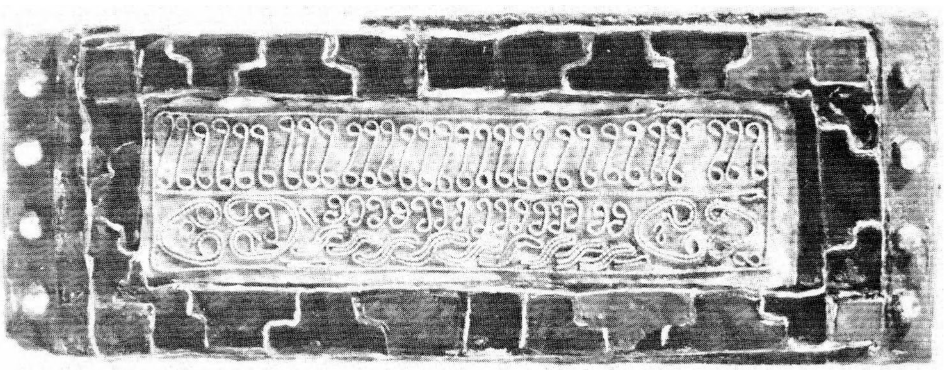


Fig. 75. Rectangular mount with e-stepped garnets from Gilton, Kent (Liver 1/M). 2:1.

The f-templet (fig. 73) produced one of the closest step-patterns I have examined. There are only a few examples of closer patterns (g-stepped patterns), all of which are found in association with f-stepped stones. It appears that the g-stepped patterns occur mainly on high-quality work mounted by the fused paste technique (cf. chapter 6). With the introduction of the f-templet, the garnets become thinner, less than 1 mm and usually about 0.8–0.9 mm in thickness. A different quality of garnet is used (cf. chapter 1) and the area diminishes considerably; sizes exceeding 2 and 3 are rare in f-stepped garnets.

The height of the steps is 0.8 mm for the f-templet and 0.5–0.6 mm for the g-templet. It follows that the length of the side of the rhomboid. f. $St^4$ is 4 mm and the area 16 $mm^2$. The g-stepped patterns are primarily used in mushroom shapes, along with their interlocking shapes, and comb-shapes, which will be discussed below. The f- and g-stepped shapes have sharply cut edges, unlike b. St-shaped stones. The cutting wheel did not have a concave or convex edge and the cuts are geometrically exact with hardly a trace of grades. The f-stepped cuts are impressively precise, showing a mastery of technique which is surprising given that they were produced long after the late Classical period.

The garnets with f. St-patterns demonstrate a greater variety of shapes than at any previous period; many of these may be seen in the cloisonné work from *Sutton Hoo.* However, it is important to note that there are f-stepped shapes not represented there. Some, like the mushroom, have been considered as particularly typical of *Sutton Hoo,* but these also occur elsewhere, including on the Continent. Although this great variety is characteristic of garnets with f- and g-stepped patterns, it is striking that the variations are based on a small number of motifs and that the same shapes are distributed throughout a wide area. For instance, there are motifs which fit together to form complete borders or panels, while their separate components become part of other designs. A typical example is the stepped rhomboid: together these rhomboids compose a carpet-like design as seen on the shoulder-clasps from *Sutton Hoo* (Bruce-Mitford 1978, fig. 386) or the sword pommel from *Sturkö* (fig. 166), but a single stepped rhomboid can also occur as the central feature of designs on disc brooches, for instance (cf. the brooch from grave 26, *Schretzheim,* fig. 239).

Another typical example is the mushroom-shaped garnet. These probably originated from a quatrefoil motif that was divided into four parts. During the period when f-stepped garnets were in fashion there was a shortage of large stones and it became necessary to divide shapes into smaller parts which were assembled into *emblemata*, each comprising a number of stones. The idea that the mushroom shapes developed from the quatrefoil motif is supported by the fact that they are found composing this motif on objects probably made in the area where the mushroom shape originated, such as the plaque from Egbert's shrine in *Trier* (fig. 204) and the sword pommel from *Skrävsta* (fig. 213). The very shape itself suggests that it originated from the quatrefoil: if the quatrefoil is divided, two different mushroom shapes naturally result, one with a wide stem and low cap and another with a narrow stem and high cap (fig. 197). Both types occur, for instance, at *Sutton Hoo* (cf. Bruce-Mitford 1978, 447 ff.) The difficulties which could arise in using these shapes are demonstrated in the plaque from Egbert's shrine, (fig. 204) where not only are the quatrefoil designs a little irregular, but also they have become oval because the caps of the wide-stemmed mushroom-shaped units were too low. On the pommel from *Skrävsta* (fig. 213) the quatrefoil has been further sub-divided by the insertion of an arrowhead-shaped piece between the lobes of the quatrefoil, making it easier to achieve symmetry. Along the bottom of the pommel variations on this theme have produced half-quatrefoil designs. On the Continent, and particularly in the Frankish area, the popularity of this type of quatrefoil design is shown by the many variations which are found, occurring even in the metal inlay which imitates cloisonné. However, in the material from *Sutton Hoo,* where there are more mushroom-shaped garnets than in all the other finds put together, none of them are part of the quatrefoil design for which this shape was originally intended.

The mushroom shapes in the *Sutton Hoo* material were used instead as continuous borders and panels. There are even mushroom shapes with fine g-stepped patterns from this find.

In the cloisonné from *Sutton Hoo,* half-mushroom shapes are common, found, for instance, in borders of opposed pairs or in association with stepped triangular shapes (cf. Bruce-Mitford 1978, fig. 337).

The half-mushroom shape, which can be regarded as a new motif, was first encountered on the disc brooches from *St Denis* (fig. 157), with opposed pairs making up a circular border. Thus the earliest examples of this motif are also found in the Rhineland. A variation on the half-mushroom shape, found at *Sutton Hoo,* has a gently curving outline the so called wing shape (WfSt). The wing shape (cf. fig. 192, 1–4) was also used in various contexts on objects produced on the Continent, such as the sword pommel from *Hög Edsten* (fig. 169–170) and the disc brooches from *Parma* (fig. 161), *Heidenheim* (fig. 158) and *Reinstrup* (fig. 221). The wing shape is interesting, as it may be used either as part of a composite border pattern (cf. fig. 161) or as part of a representational composition (cf. fig. 170).

Another shape with multiple uses was the comb shape, M (cf. fig. 203); this was a narrow triangular shape, one long side of which was stepped, sometimes with the close g-stepped pattern. It was perhaps originally designed to produce ray-patterns, such as those seen on the disc brooch from grave 106, *Soest* (cf. fig. 212), but was also used in many other designs (cf. fig. 221). Objects featuring the comb shape were frequently made with the fused paste technique.

It may be deduced, therefore, that f- and g-stepped garnet shapes are contemporary, but that the g-stepped patterns are only applied to certain shapes (and their interlocking shapes), such as mushroom and comb shapes, and are not found with complete rhomboids, for instance. It might seem sensible to assume that the g-stepped patterns represent a later refinement of the f-stepped patterns, but g-stepped garnets are found already at an early stage, such as on the sword pommel

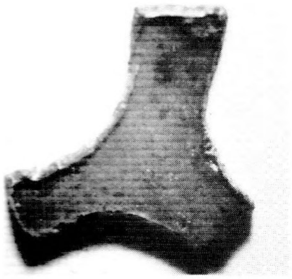


Fig. 76–77. Retouched garnet from Klinta (Swed 41/G). 76) Micrograph 5:1. 77) 10:1.

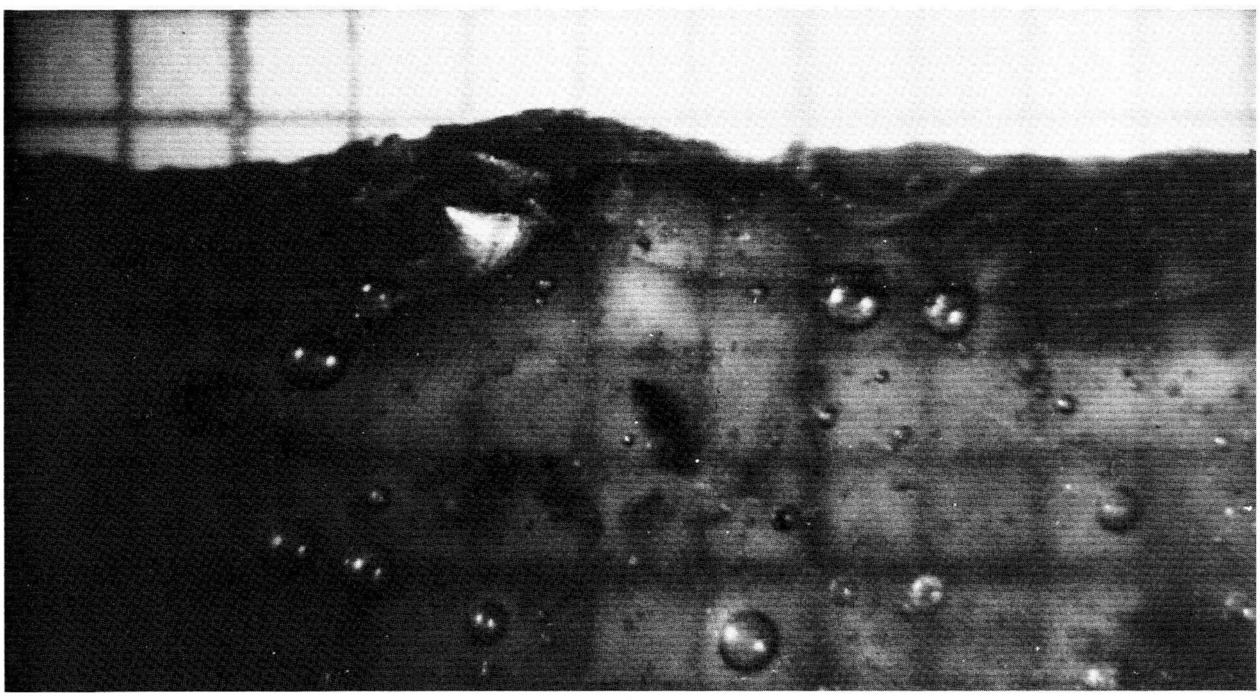


Fig. 78. Piece of window glass with retouches from the Early Medieval monastic site at Jarrow. 15:1.

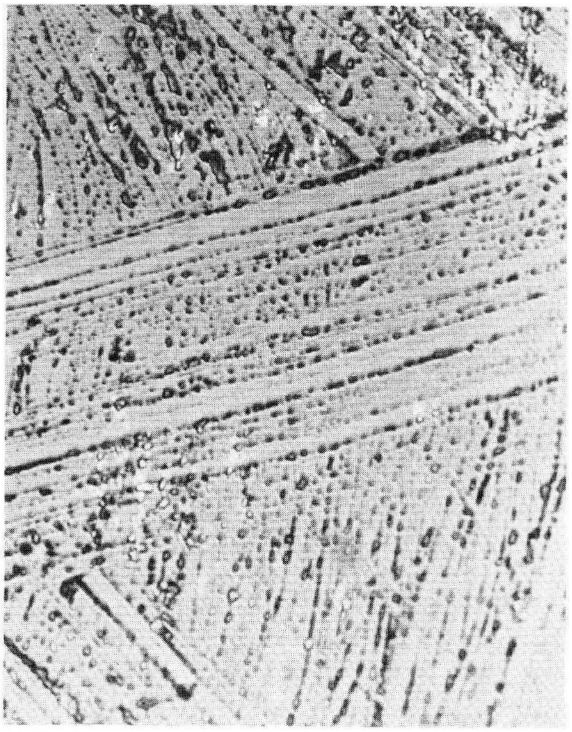


Fig. 79

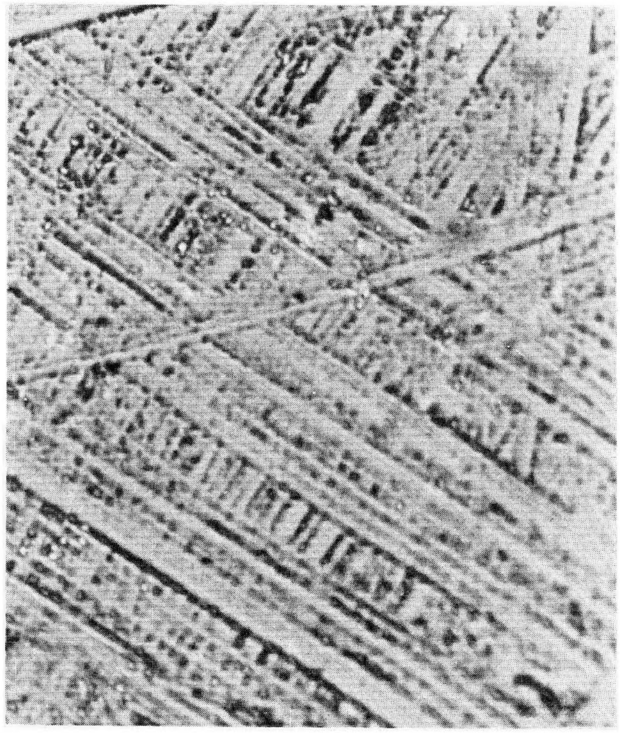


Fig. 80

Fig. 79–81. Traces of polishing scars on garnets. 79–80) Garnets from the Black Sea area showing feather polishing. 79) (Swed 8/Bu). 80) (Swed 1/M). 81) Germany (Swed 2/D). SEM 600X.

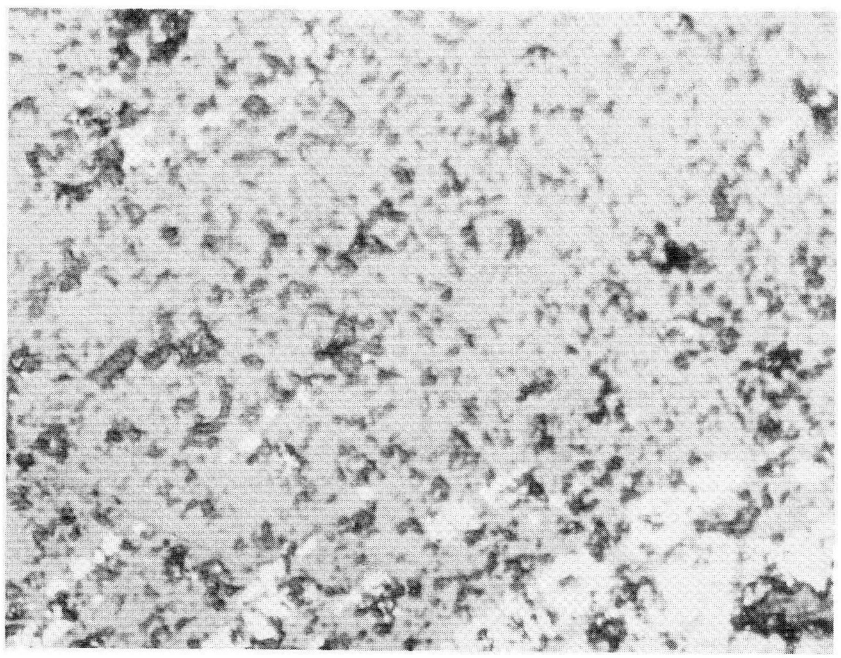


Fig. 81

from *Krefeld-Gellep* (Kre 1) (fig. 177). However, the g-stepped garnets on this pommel are unique in my experience both in size and form, and I would interpret them as an early attempt to achieve a closer step-pattern before the breakthrough of the f-templet. When this closer patterning was again introduced at a later date, one may speculate that the old templet had been preserved in the workshop and was brought into use again to provide a greater variety in the designs.

## 2:8 Freehand-cut garnets

In the description of b-stepped garnets it was pointed out that certain shapes, such as the indented or projecting lobes, were probably shaped by the concave or convex edge of the cutting wheel itself. Garnets with e-stepped shapes—with the coarser step-patterns which occur on objects of the late sixth and seventh centuries from *Byzantium* (cf. the strap-mounts from the *Crimea*, fig. 217), Christian objects from Western Europe (cf. the so-called Eligius' cross from *St Denis*, fig. 74) and the Scandinavian objects (cf. fig. 226)—appear to have been mainly shaped with the wheel, templets being less frequently used. Two or three garnets would apparently be fitted together to form a semicircle, oval or triangle, and it was these larger shapes which were determined by the templet. This can be observed on the Eligius cross (fig. 74) and to some extent also on the *Delsbjerg* staff (Haseloff 1955) and the reliquary from *St Maurice* (cf. Vierck 1974, pl. 32:1). I have chosen to call these garnets freehand-cut because they were much less dependent on the templets which characterized the earlier techniques described here. It is possible, although it cannot be proved, that this method merely indicates a simpler production technique. It is typical of freehand-cut garnets found outside Scandinavia that they occur along with green, blue or pale red coloured glass. One cannot therefore exclude the possibility that the freehand cutting was due to some of the production being taken over by glass-cutters. The material analysed suggests that the oriental type 3 garnets were used, as they were for the retouched garnets.

## 2:9 Retouched garnets

Finally, in the Scandinavian material from the later Vendel period and the early Viking Age there are garnets which were not cut by a wheel but shaped by hand. On some disc brooches (Rupp 1937, 65), for instance, occasional garnets have one retouched side, which is probably the result of modifications made to templet-cut stones by a local goldsmith.

Late Scandinavian garnets were entirely shaped by retouching and there are no traces of the use of a cutting wheel. The garnets were probably roughly divided by grooving and breaking in the same way as in the late Roman period (cf. 2:6), but there are no traces of the grooving because the garnets are very thin (0.5–0.7 mm). The final form was achieved by very fine trimming which produced three- or four-sided shapes with straight or curved sides (cf. fig. 76–78). The retouching can be compared with that on window glass found in early Medieval monasteries (Cramp 1970) for instance from *Jarrow* (cf. fig. 78). The retouched garnets may well reflect the influence of glass-making on the last phase of garnet cloisonné. Garnet plates were thus brought from the East (as it appears that they are of type 2 and 3) and were given their final form during the mounting process.

## 2:10 The treatment of the surface

At the beginning of this chapter (2:1) it was stated that most garnets were probably cleaved. In order to achieve the high gloss typical of the garnet plates the surface had to be polished further. This was not done to make the stones *flat*, but only to bring up the lustre. It is often stated in books on lapidary work (cf. for instance Webster 1976, 434) that the polishing agent must be a little softer than the stone it is intended to polish and that it must be very fine in order to avoid scarring the surface. Under very high magnification, by scanning electron microscope, polishing scars can be observed on the garnet plates, which were usually polished on both sides. A typical pattern of such markings consists of close, parallel lines in the shape of a feather: for the purposes of this study I have called this feather-polishing (cf. fig. 79–80). I have observed this type of marking on the material which was available to me in *Stockholm*, and it appears from this that feather-polishing was particularly typical of the oriental type 3 garnets, both domed and flat, and cut with a- and e-stepped patterns. This type of polish achieves a very high gloss, but is also delicate, as damage was sometimes caused, particularly on e-stepped garnets. It is striking that f-stepped garnets, and type 1 garnets in general (cf. fig. 81), have no scars of this kind. It is possible that feather-polishing was performed by lapping on a fast-moving wheel, while garnets of type 1 were hand-polished after initial lapping. As I have not been able to study the surfaces of a sufficient number of garnets, feather-polish has not been used as an analytical criterion, although this would probably have been very significant. Feather-polishing suggests highly mechanized production techniques, and the difference between oriental and type 1 garnets is therefore of particular interest. As regards the actual cutting, it is noticeable that f-stepped garnets show fewer signs of grades than other step-cut stones, indicating the high speed of the cutting wheel. The absence of polishing scars on type 1 garnets does not therefore necessarily imply hand-polishing, but could also suggest that polishing was carried out more carefully by lapping, and that polishing agents of different hardnesses were used.

Polishing agents have not been identified, unless the talc which was present in several paste samples can be interpreted as traces of such substances. Traces of carborundum in one sample (no. 13, Table XI, 1:3, *Tibble*) probably represented the grinding powder used in the cutting.

# Chapter 3. Mounting techniques

## 3.1 Single settings

Several methods of mounting precious stones in single settings were known in the Classical world. Three main types can be distinguished.

*1. Flush settings.* In the *flush,* or *Gypsy setting* the cavity was either formed in the casting (fig. 82a) or was made by drilling (fig. 82b). A ledge was cut with a chisel at the top edge of the cavity and the metal was driven over the edges of the mounted stone (fig. 82 c–d). This technique requires the use of a fairly soft metal like gold, silver or copper; harder bronze alloys are less suitable because the pressure needed to force the metal over the stone may cause it to crack. In order to minimize this risk, inlaid garnets were often first surrounded by a gold or silver casing which was then inserted into the bronze cavity.

Round cavities were usually drilled (identified by a small central hole in the bottom, fig. 85), while triangular and square cavities were usually cast. In this respect Scandinavia was exceptional, for drilled cavities only became common in the early Vendel period. Cast cavities were usually worked over with a chisel or punch, particularly at the corners, where the stones were secured by overlapping edges. In this detail there is a certain similarity with the method described below as 2b.

*2. Band settings.* To produce these settings the edges of the collet must be soldered. Until the present day it was impossible to produce stable soldered seams except by the use of gold or silver solder, although soft solders of tin and lead could be used on band settings of bronze. While soft solder is adequate for cloisonné work, where the paste gives the object added stability, it is not sufficiently strong for single settings, where the top of the collet must be a little narrower than the actual size of the stone. When the stone is mounted, the setting is heated, the stone is forced into place, and when the metal cools the stone is set fast (fig. 83a–d). The need for secure soldered seams is therefore obvious. For the purposes of this study, this method will be known as *2a.* Where the stone is mounted without heating and the rim of the setting is pressed over the edge of the stone, the method will be known as *2b.* This method produces a setting of somewhat irregular appearance (fig. 84c). It was used in Pontic jewellery, mainly to set three- or four-sided or other irregularly-shaped garnets. The inlays were secured at the corners where the walls could be turned over, dispensing with the need for hard-soldering the edges of the setting; it was, of course, necessary to solder on the back plate with continuous seams. Bands were often joined by overlapping the ends at one corner, where they could be secured by a simple spot-solder (fig. 84a-b). The pinched corners on this type of setting are very characteristic and can be seen on Pontic, and in particular on Sarmatian, jewels and diadems (cf. fig. 19). However, this method also became widespread in Germanic art of the Migration period.

This is particularly the case in the East-Germanic and Nordic areas where this kind of setting became almost a hall-mark for the provincial Germanic goldsmith's art of the fourth and fifth centuries.

The more elaborate ways of band-setting which was fully developed in Roman jewellery seems however to return to the Germanic area in connection with the development of the bossed disc brooches (Goldsheibenfibeln) in the late sixth century. On these brooches, for instance, all the bandsettings are usually joined in the centre of one side (fig. 84e). The settings also have rather high walls which could easily be turned over the edges of the inlays.

In a variant of the band-setting found on bossed disc brooches the upper part of the cell is folded over the stone with a sharply defined shoulder (fig. 84f). The collets on these settings are joined with a tongued seam. In another variant the upper part of the collets are cut into segments, ranging from simple points to arched, highly complex patterns (fig. 84d). Many variations of the band-setting are found in both the Greek and in the Roman goldsmith's art. In Germanic jewellery, band-settings with cut segments occur in the late Roman period, but in the Migration period circular collets are most common, along with settings secured at the corners, both usually of precious metal.

*3.* A third method consists of securing pierced bead-shaped inlays with metal wire, or setting stones in basket-like wire mounts. As this type of mount occurs exceedingly rarely in garnet jewellery, it is not relevant to the present study.

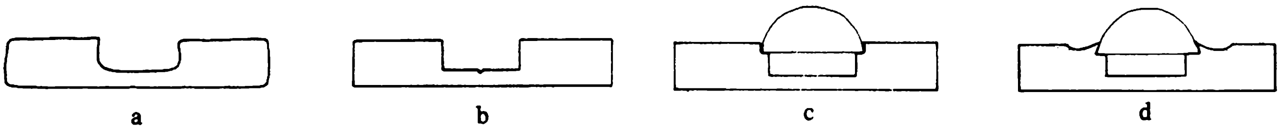



Fig. 82. Different stages of a gipsy setting. a) A cast cavity. b) A drilled cavity. c) A ledge is cut round the edge of the cavity and the stone is mounted. d) The stone is secured by driving the metal over its edges.

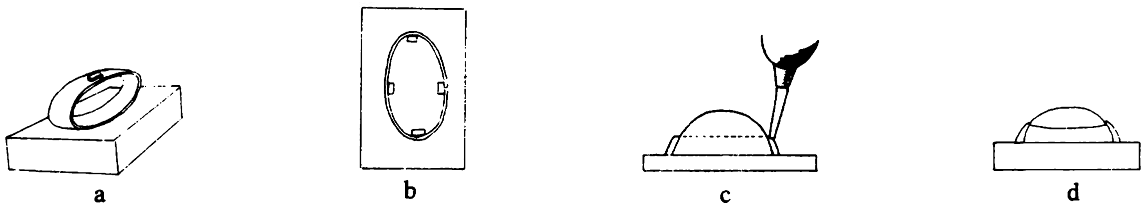



Fig. 83. Different stages of a normal band setting, (2a).
a) The band is bent into a collet and secured with a hard solder.
b) The collet is soldered to the back-plate with spot-soldering or with a continuous seam.
c) A stone is pressed into the heated setting.
d) The rims of the collet are forced over the stone.

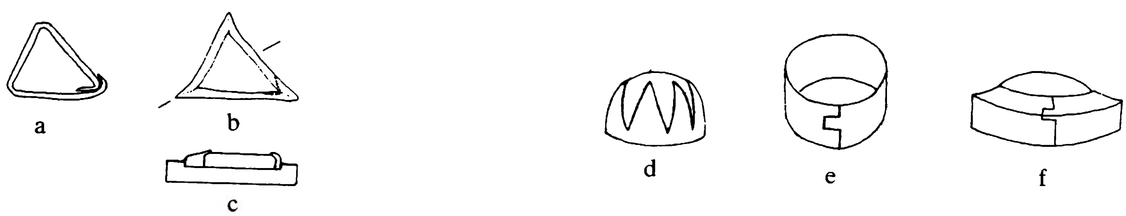



Fig. 84. Less common variations on band settings.
a–c) A pinched setting (2b), with the overlapping bands of the collet (a), pinched corners (b) and a section (c).
d) Star setting.
e–f) Shoulder setting, different stages.

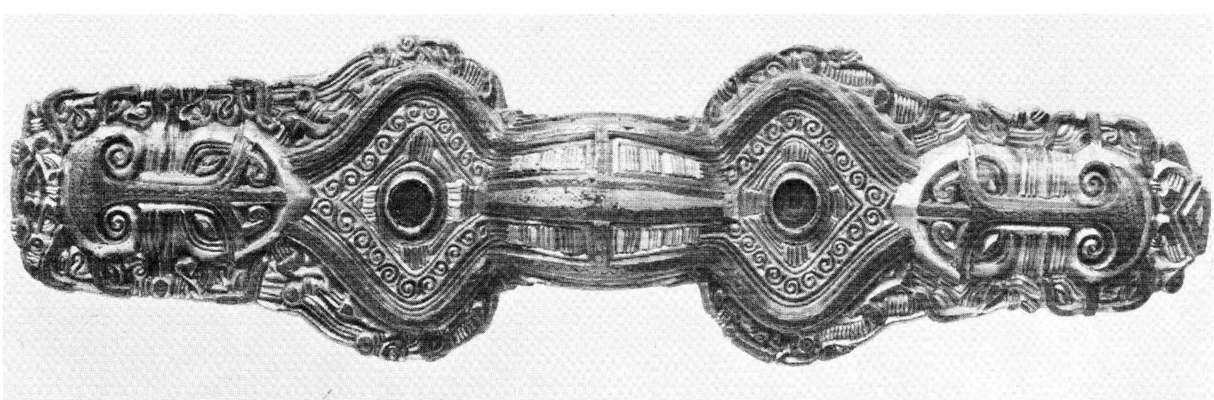


Fig. 85. Brooch with drilled cavities from Gillberga, Sweden. 1:1.

## 3:2. Garnet cloisonné

The main difference between cloisonné and single settings is that in cloisonné an area is totally covered with cell work and only the outside edges are free-standing. In order to cover an area in this way, it is necessary to proceed step by step, soldering each cell into position individually. Cloisonné of the kind produced in Egypt at the time of the Old Kingdom (Aldred 1971, 113), and by the Sumerians, is in fact only a series of single settings, soldered at the bottom and along the edges and placed side by side with joint walls. The stones, usually lapis lazuli and carnelian, were cemented into the cells with a paste consisting of resin and lime, in the form of powdered limestone or gypsum (cf. Aldred 1971, 127 and Lucas 1948, 13). The cement was probably heated and poured into the cells, the stones were set into the openings and when the work had cooled the whole surface was rubbed down and polished. This caused the tops of the cell walls to spread a little, which served to secure the stones further. In the New Kingdom the semi-precious stones were replaced by glass flux. When melted this could be poured straight into the cells, thus saving a great deal of effort. However, this type of cloisonné enamel is not very common, and there are several examples of glass flux attached with cement by the old method. It appears that the introduction of cloisonné enamel only gradually won acceptance (cf. Aldred 1971, 128). Cloisonné enamel is common in the Hellenistic goldsmith's art, the single setting being almost exclusively reserved for precious stones.

Technically there are few differences between Egyptian cloisonné and the early type of garnet cloisonné. However, the colour of the garnet was important and lime cement could not be used, as the white colour behind the stone produced the wrong effect. Garnets were therefore backed by foil, or the cell itself provided the background colour.

There are examples of attempts to counteract the dulling effect of the paste by colouring it red, but the colour was better enhanced by gold foil backing; after a time patterned foil was used. Although it was possible to stick the foil to the back of the garnet—with egg white for instance—the bond was not strong enough to allow the inlay to be attached using paste alone. It is characteristic of early garnet cloisonné that the cell walls served to hold the stône, as the paste did not secure either the inlay or the cell walls. For the purposes of this study, this type of cloisonné is called *clasped cloisonné* (cf. diagram fig. 86 and fig. 92).

*Clasped cloisonné* is usually made in gold or silver, gold being more common. Precious metals were used to provide stable soldering seams as the cell walls were not only soldered together at the sides but also attached to the back plate by soldering. The paste consists only of organic substances like resin, sometimes mixed with very small quantities of charcoal or crystalline material (cf. 3:3 and 3:4). The purpose of the paste was to form a yielding foundation for the stone when the tops of the cell walls were turned in. It is likely that the paste was originally transparent unless the garnets were backed by foil, which is unusual in clasped cloisonné. The inlays, mainly garnets, had a thickness almost as great as the height of the cells (garnets vary from 1.5 to 2 mm thick and are sometimes thicker). This method required careful soldering, with each cell securely attached to its neighbour; in consequence the pattern units tend to be endlessly repeated.

The following technical features are characteristic of clasped cloisonné. The cells are soldered together and to the back plate, and are between 1.5 and 2.5 mm high. The garnets almost fill the cells, leaving only an empty space

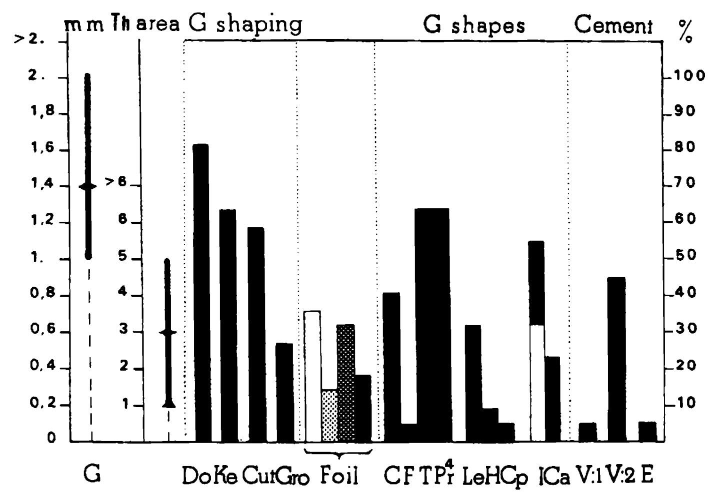
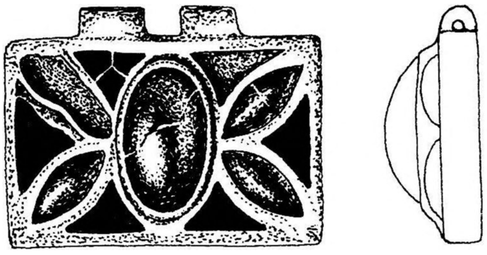



Fig. 86. Diagram showing the technical features of clasped cloisonné and single settings from the third to the fifth centuries. The diagram is based on objects from the Black Sea, the Orient and central Europe where the treasure from Szilágy Somlyó (Simleuli Silvaniei) is dominating. The objects are Ba 1, Bud 9–11, Bud 15–23, Bud 25, Bud 28, Bud 35, Köln 42, Szeg 6, 8, Szek 3–4, Swed 1. Noteworthy features are the thickness of the garnets which are mostly domed. In this group only a few garnets (13%) show engravings contrary to the Petroassa garnets, where engravings predominate. Otherwise the Petroassa garnets have the same features as this group, although with greater variability of the shapes. An important feature is the high frequency of inlays other than garnets often of green colour (white section in bar "I").

Fig. 87



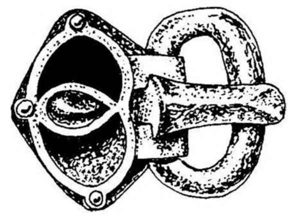


Fig. 88

Fig. 87–88. Mount and a buckle from the Black Sea area. (Swed 8) with garnet cloisonné in cement technique (with wax), and domed garnets in the centre. 1:1.

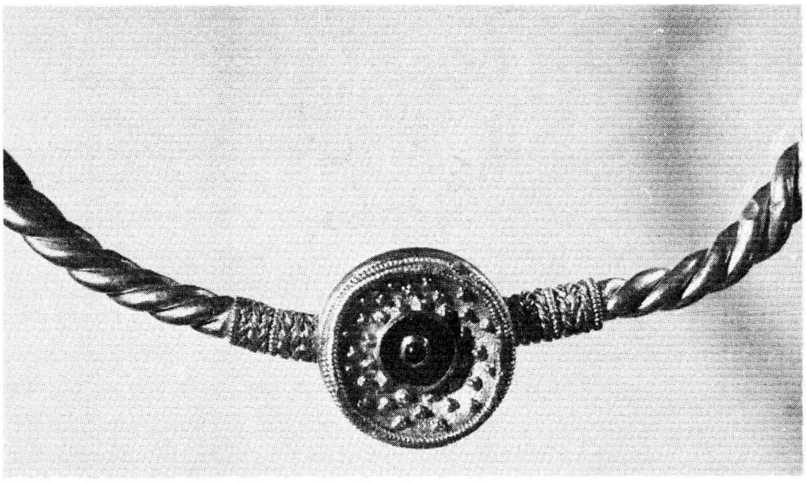


Fig. 89. Central pendant from a necklace from Ravlunda (Swed 6). The pierced garnet has a cabochon-cut garnet set in the centre. 1:1.

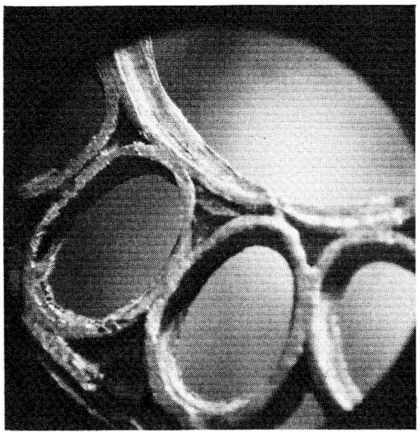


Fig. 90. Detail of the Petroassa bowl, fig. 35, showing a cloisonné setting à jour. Micrograph.

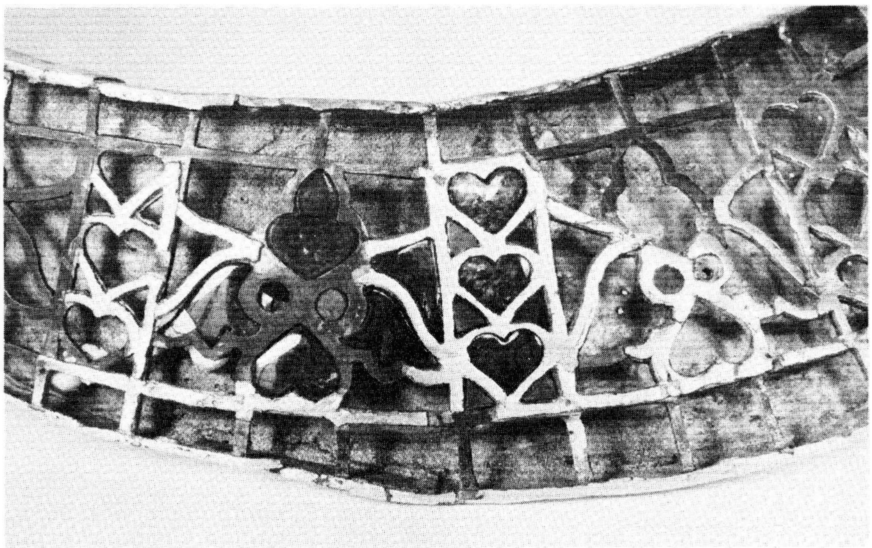


Fig. 91. Detail of a necklace from Petroassa (Buka 5) with a cloisonné-setting à jour. 1:1.

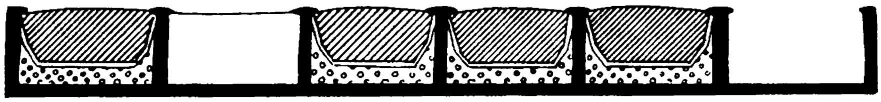


Fig. 92. Section through the mount, fig. 36, showing a typical clasped cloisonné. 4:1.

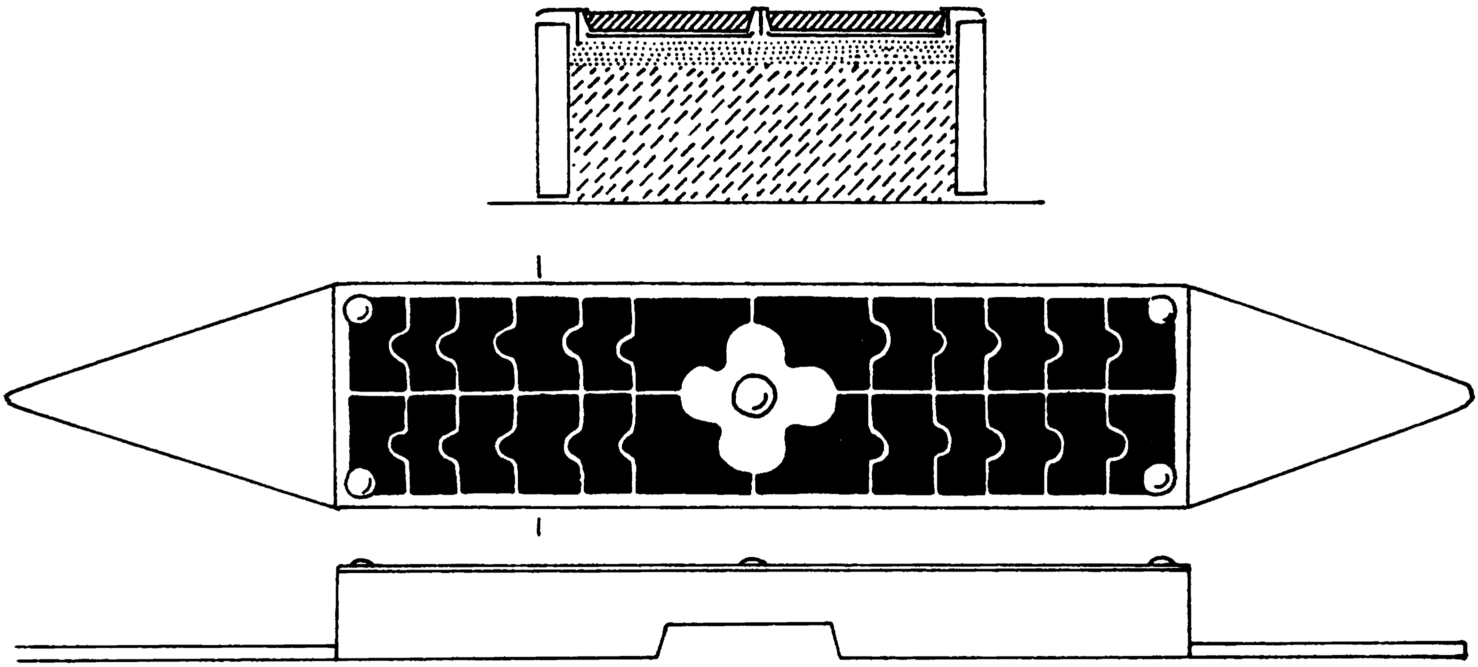


Fig. 93. Section through the cloisonné on the suspension loop from the Planig sword (Mainz 1) showing a typical cement cloisonné. The section 4:1, otherwise 2:1.

at the bottom about 0.1 to 0.3 mm high, which was presumably originally filled with an organic paste, such as resin. The only purpose of the paste was to form a yielding foundation. Foil backing is not usually present, but where it exists it is plain. Clasped cloisonné is normally made of gold. The cell chapes form a running repeat pattern which often make up narrow borders on small settings.

*Cement cloisonné.* The soldered seams between the cell walls and the back plate were difficult to produce and there was therefore a tendency to develop techniques to obviate these. One solution was to produce cell work which was not attached to the back plate but formed an independent panel to be mounted in a larger setting. Cement cloisonné, (cf. fig. 93) probably developed from the technique of pierced single settings, a kind of cloisonné *à jour*. This method occurs on objects from *Petroassa,* such as the bowls (cf. fig. 35). Holes were cut in a thick metal sheet, in the shape of the stones to be mounted, but of a slightly smaller size. Strips of metal applied to the back secured the stones. This device served to make the stones on the bowl appear translucent. Pierced settings of this type frequently occur together with cloisonné set by the cement technique. On the collar from *Petroassa,* for instance, the cloisonné in a pierced setting has a layer of cement between the stone and the back plate. This paste could not be identified by x-ray diffraction as it was not chrystalline and was therefore probably of organic origin. In the fully-developed cement technique, as for instance on the gold-hilted spathae, the cement is crystalline and consists of lime hardened with (?)linseed oil or gypsum (see below chapter 4). The cement forms a rock-hard deposit in the bottom of the cloisonné cells.

As the cement was soft at the time of application, it seems likely that the inlays were mounted from behind and the cement poured on top, subsequently setting hard. Traces of wax immediately behind the garnets and the foil backing suggest that a brushed-on layer served to prevent the cement from penetrating between the inlays. With this mounting technique dished panels of cloisonné inlay were introduced. During the actual positioning of the inlay it would have been practical to place the object on a concave surface shaped to correspond to the desired convex form. As the stones were fitted from behind their angle in the cells could be adjusted to fit the dished shape. Each stone was ground to a slightly domed shape, but the curvature could be fairly uniform provided the angle at which they were set in the cells was variable.

In conclusion, the cement method required the use of a crystalline paste which was applied while soft and hardened later. It is likely that the inlays were mounted from behind and that the work was finished by rubbing down the surface, thus slightly flattening the cell walls at the top. The cell work is low, the height of the cells varying between 1.5 and 3 mm; the cells were apparently usually produced by piercing holes in a metal sheet. Along the edges of the cell work panel a wider border serves to attach the whole design to the back plate, which is therefore not attached to individual cell walls. This plate is often of a baser metal and may even be of iron. Single tubular cells are sometimes found on objects produced by the cement technique. These often occur in the centre of the design and have higher cell walls and well-executed soldering; they are in fact true settings, attached to the cell work but penetrating through the cement between the cell work and the base plate. If the base plate is of precious metal the tubular cells are soldered on; otherwise they are held by the cement. Cement cloisonné is therefore *a combination* of the presumably earlier clasped cloisonné method and a new method using cement. The use of patterned gold foil behind the garnets is also characteristic of the cement method.

The cement method has a wide distribution from Eastern Europe to Spain, but its chronological distribution seems to be limited to the period from the end of the fourth century to the time of Childeric with its final phase in the first half of the sixth century. The cement method is found mainly on weapons and buckles, bow brooches, pendants and occasionally also on small disc brooches. A discussion of the workshops and the distribution of work in this technique follows in chapter 4.

*Sand putty technique.* This method is a further development of cement cloisonné, with sand putty replacing the slowly hardening cement. The cell walls are no longer cut from sheet metal, but are true cells, as in clasped cloisonné, except that they are only soldered to the back plate, where they serve as support. The height of the walls usually exceeds 3 mm. The method can best be described by examining the structure of a disc brooch of typical Rhenish type (cf. fig. 94–96). Three concentric rings of sheet metal were first soldered to a silver back plate. The outer and inner rings were more firmly attached to the base than the middle ring, which was only soldered in places. The spaces between the rings had transverse cell walls which, while soldered to the rings, did not reach as far down as the back plate. The piece was filled with sand putty, perhaps mixed with egg white. The garnets with their foil backing, which was often turned up along the edges of the stones, were pressed into the openings from the top. After drying in an oven the paste set and the cell walls became firmly fixed. The tops of the walls were flattened with a punch and secured the stones. Thus the sand putty technique was a further development of both the earlier clasped method and the cement method.

Sand putty was predominant in the Merovingian garnet cloisonné art, being used on jewellery, horse-trappings and weapons. There are many variants of sand putty (cf. chapter 5), probably reflecting different workshops. The sand putty method replaces the cement method throughout the Germanic area, in the Merovingian, Anglo-Saxon and Gothic Langobardic workshops, and continues until the end of cloisonné production. This method often corresponds to what is known in the literature as *enge Zellenwerk* (cf. Werner 1935).

The possibility that the location of workshops can be identified on the basis of the pastes used will be discussed in chapter 5.

*Fused paste technique* is the last of the methods described here. Unlike the sand putty, the fused paste is strongly adhesive and shrinks as it sets, pulling the cell walls inwards to form a tightly-fitting setting for the garnets. No subsequent tooling is therefore necessary, and the cell walls need only be smoothed down after the inlays have been placed in position and the paste has set. In fused paste work, the cell walls are usually not soldered to the base plate, but held by the paste and by a soldered seam along the edges of the piece. The cell walls are usually of the same height as in sand putty work, but often rather thinner.

The fused paste method is the most technically advanced of the cloisonné techniques, but represents nevertheless a degeneration of the art, since work carried out by this method becomes brittle. Its advantage lies primarily in the fact that it requires few soldered seams. The technique belongs chronologically to the final stages of Germanic cloisonné art. It seems originally to have been a Byzantine innovation, closely related to cloisonné

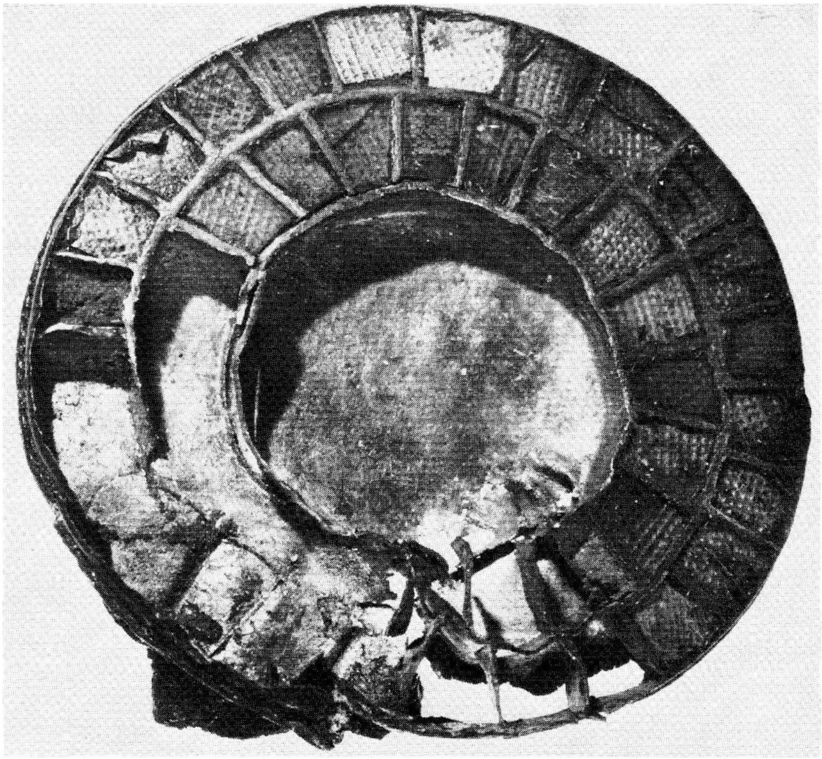


Fig. 94–96. Stages of the manufacture of a Rhenish disc brooch. 94) The brooch (Swed 2) enlarged 4 times. Note the traces of the soldering of the walls to the bottom plate.

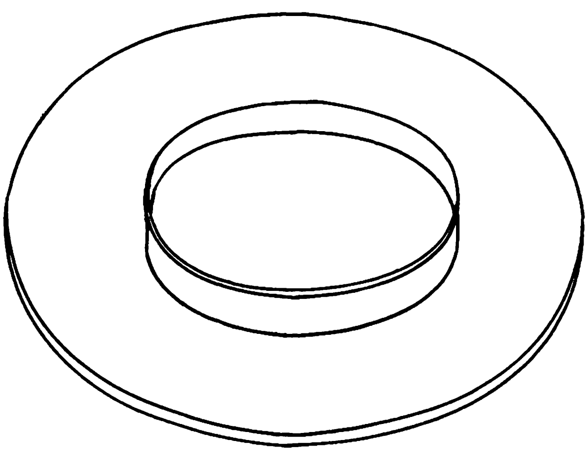


Fig. 95. The bottom plate from the brooch, fig. 94, with the central collet attached. 2:1.

Fig. 96. Section through the brooch, fig. 94. 2:1.

enamel. Sulphur, the substance originally used for fused paste, presumably came from the volcanic regions of Southern Europe, but as the technique spread northwards, sulphur was replaced by wax mixed with a crystalline opening agent.

## 3:3 Paste in cloisonné work

*(cf. Table XI, chapter 8)*

a) The material
b) Early mounting technique and clasped cloisonné
c) Cement technique
d) Sand putty technique
e) Secondary uses of sand and calcite putty
f) Fused paste technique
g) Soft putty where wax predominates
h) Atypical organic pastes.

### *3:3a The material*

The pastes used in cloisonné work have been used here as criteria in the analysis of mounting techniques. Pastes were analysed by x-ray diffraction (cf. Carlström's report 3:4) and examined by scanning electron microscope, ordinary stereo microscope and magnifier. The samples chosen for analysis were collected in the following manner. Where possible, a garnet was removed, but it was sometimes more convenient to collect samples where garnets were already missing. In these cases it was necessary for the gold foil beneath the garnet to be intact, or for the paste to bear the impression of the waffle-pattern of the gold foil, to ensure that the sample represented the original paste (cf. fig. 14b). The top layer was usually scraped away to remove any possible secondary contamination, and the sample was taken from below the surface layer (but see also 3:3c). The samples were placed in small, numbered glass tubes. While carrying out the paste analyses Carlström did not possess any information about the provenance of the samples and his results were independent of the archaeological analysis of the objects.

### *3:3b Early mounting technique and clasped cloisonné. Paste: carbon with various secondary constituents. Paste type Table XI, V:2*

In the earliest garnet cloisonné work the same mounting technique was used as for single settings, that is each garnet was placed in a small enclosed cell and secured by turning the cell walls over the edges of the garnet, a technique here called *clasped cloisonné*. The paste served as a yielding underlay which prevented the garnet cracking when the cell walls were turned over. It is likely that the present analysed carbon-like material was originally pitch or resin of a fairly glutinous or soft texture. Calcite or dolomite were often added to the paste, presumably to make it harder.

### *3:3c. Cement cloisonné. Paste: gypsum or other sulphates, hardened aragonite or calcite (calcium oxalate) probably also heulandite with a covering of wax. Paste types, Table XI, I:1 b, 2 c, 3 c, 5 a, 5 b, and III:1,2,3,4 and probably II:2c*

Cloisonné à jour (cf. 3:2) developed into a cloisonné, where a thick layer of paste was used as a foundation for the cloisonné work, a technique here called *cement cloisonné*. The inlay was set in from the back and was covered with a liquid cement which subsequently hardened. With this technique the individual garnets were still mainly held by the broad cell walls, but the cement gave the work added stability.

Beneath the garnets and the gold foil a thin layer of wax is often encountered in cloisonné executed in cement technique. This layer can be explained by reference to the mounting technique. As I have described, the garnets with their foils were set in from the back, after which the work was filled with a cement which was initially soft and pliable, but became hard as it dried. The wax layer probably served to prevent the soft cement from penetrating between the gold foil and the garnet. The technique, involving a layer of wax over a hard cement, can be found on several of the objects with cloisonné in cement technique and, when it is missing, this is probable due to my sampling as I was not aware of this layer when I started this study. For example on the pommel of Childeric's sword (Paris 1 a) the filling had wax at the top, showing the imprint of the foil, but I missed this layer by my sampling on the Childeric-seax. This was mainly due to the fact that I particularly scratched away the surface layer because the gypsum cement gave a dirty impression.

It appeared that the gypsum cement in all the Childeric finds was a mixture of gypsum and quartz-sand. The same gypsum mixture was recorded on objects from *Apahida II* (Cluj 1–2). Modern gypsum is usually pure and we must therefore ask why the gypsum found in these objects with garnet cloisonné is so impure. A very impure gypsum is recorded from ancient Egypt, which in the past was thought to consist of a deliberately produced mixture (Lucas 1948, 97 ff.). Lucas demonstrates, however, that this gypsum occurs naturally in the desert areas around Cairo and Alexandria, which contain considerable admixtures of quartz-sand and some calcium and other carbonates. It would seem that the special properties of gypsum were insufficiently understood and it was therefore not used as a hardening paste to its full potential. This is also reflected in the analyses of gypsum in cloisonné work: in Childeric's grave (analysis no. 116) part of the gypsum was slaked and changed into anhydrite and therefore no longer usable as a paste; on a belt mount from Syria (BM 1) the presence of slaked gypsum demonstrates that insufficient amounts of water had been added to the mixture; in samples from *Apahida* (Cluj 1 and 2) the crystallization indicates that the transformation into gypsum was not quite complete.

There are a few further objects with gypsum paste. In a buckle with rectangular plate of so-called Gothic type (BM 7) the paste was layered, with a thin covering of wax over the gypsum paste. The melted wax had been applied against the gold foil, the ring pattern of which was clearly impressed on the wax. There were a few quartz grains embedded in the wax (analysis no. 49), but there were apparently no foreign substances in the gypsum (no. 42).

Apart from gypsum, other minerals mixed with liquid which hardened the paste have been used in the cement technique. Wax has also been encountered in this cement presumably serving the same purpose. It formed a protective layer which prevented the liquid cement from penetrating between the garnets. Although wax has not been found in all examples of this technique, it was presumably always present and its absence in our tests is due to incomplete sampling.

The sword from *Altlussheim* (Karlsruhe 1) and *Eich* (Worms 33) have inlays using the cement technique with a cement of aragonite. When samples were collected from cloisonné inlays on these swords, the usual thin upper layer about 0.5 mm in thickness could be observed; it was almost white in colour and had a wax-like appearanced. Below this was a layer of cement of a more pronounced yellowish-white colour, approximately 5 mm thick. On the mount from *Eich* the top layer was noticed and a sample taken just below it (analysis no. 62), after which I collected a sample from the layer further down (analysis no. 61). The lower layer was noticeably hard and consisted entirely of calcium oxalate dihydrate with traces of quartz grains. The upper layer, however, consisted of aragonite and calcium oxalate dihydrate. No wax could be traced. The same layering was observed on the sword from *Planig* (Mainz 1). In this case it was actually found that the top layer contained wax, which however was not mixed in with the aragonite cement. It was thus clearly proved, that the wax formed a thin layer at the very top underneath the gold foil. Below the wax in the upper layer (analyses nos. 88 and 89), the aragonite was mixed with some calcite, while in the bottom layer (analysis no. 60) there was aragonite alone. Carlström has pointed out that aragonite easily changes into calcite, and it is therefore most likely that the calcite in the *Planig* samples is the product of decomposition. This explanation presumably also applies to the calcite found mixed with aragonite paste in samples nos. 90 and 91 from *Altlussheim*, where the top layer was destroyed. (It should be noted that the sulphur mentioned by Garscha 1936 was not found and is probably a mistake.) The samples from *Planig* are probably the most representative as they were collected from below the gold foil; the gold foil was missing from the sampled cells in the cloisonné work from *Eich* and *Altlussheim*. Carlström (cf. 3:4) points out that the calcium oxalate occurred in several of the samples recorded here may be a result of the action of aragonite on oxalic acid, probably of plant origin. It is particularly noticeable that these samples all have a hardness reminiscent of gypsum. It seems, however, that not only aragonite could be hardened with oxalic acid as is demonstrated on a disc brooch from *Baumgarten* (Wien 2). In this case only calcite and calcium oxalate were found (Table XI, 1:1b, no. 177).

In other cases where the calcite appears to be very hard, but where no oxalate is found, it seems probable that another hardening agent was used. In modern putty used to set window panes the hardening agent is linseed oil mixed with calcite, and it is quite probable that this type of cement was also used in our samples, although this has not been demonstrated in the analyses. The very hard texture of the calcite is here taken as an indication that a hardening agent was used. Some typical examples are described below. The cement underneath the garnet inlays on a buckle with striped metal inlay on the sides from *Stammheim* (Stutt 21) (Table XI, I:1b, no. 73) consisted of very hard calcite and traces of wax. The proportion of wax was so small that it did not render the sample water-resistant. It is therefore likely that this was a layered deposit of the type found at *Planig,* with a thin layer of wax on top of hardened calcite cement. The buckle from *Stammheim* is almost certainly Frankish, as seen for instance by the metal inlay, a decorative feature which also often occurs on the small Frankish circular brooches. In the Childeric's assemblage there was also found examples of hardened calcite cement, in this case also covered with a thin layer of wax. The calcite cement was found on the two guards of the sword hilt (Table XI, 1:1b, 1:2c, no. 1, 118, 145 cf. fig. 106) while the sword panel had gypsum cement (Table XI:III, no. 116). Two fish-shaped brooches from *Bülach* (fig. 128) are described as having a hard white calcite cement, the texture of which is said by Gugolz (in Werner 1953a, 135) to be due to hardening with linseed oil.

Closely related to the cement technique is the characteristic and well-defined group of large eagle-shaped brooches, usually thought to be West Gothic. I have stated above (2:3), that these objects have the typical cell-shapes characteristic of the cement technique, that is S-, omega- and foil-shapes. The paste in these works is white and hard. Analysis Table XI, I:1b, no. 68 (Köln 1) produced calcite and weak traces of wax, too insignificant to render the sample water-resistant. It is likely that the wax formed an upper layer, as on the buckle from *Stammheim*. If the wax had been mixed in with the calcite, as in fused pastes (cf. below) a certain softness and greasy sheen would have been noted at the time of sampling.

Finally, on two objects from Hungary (Bud 34/Eb and Szeg 3/Bu), the unusual mineral heulandite ($CaAl_2Si_7O_8$ 6 $H_2O$, a calcium aluminium silicate) was used in cement technique. Its texture suggested that it had been hardened, Table XI, II:2d, nos. 176 and 205.

*3:3d. Sand putty technique. Paste: quartz, calcite or a quartz and calcite mixture. Paste types Table XI, I:2a, 3a, 4a, 4b, 4c, 4d; II:2a, 2b, 2c*

One of the sand putties, II:2a in the silicate group, is easily distinguished visually because of the reddish-brown quartz sand which is its main constituent. Other sand putties vary in colour from greyish-brown to pure white. The binding agent was presumably some organic material, as there are no traces of wax or any crystalline medium. The proportion of plant fragments in samples nos. 10, 19 and 87 was so small in comparison to that of other pastes with binding agents that this is unlikely to have been their function (cf. Carlström 3:4). It is possible that these plant fragments occurred naturally in sand from a river deposit, for instance. Analysis of sand of the same rust red colour from the *Krefeld* area produced exactly the same diffraction pattern as the sand paste samples, although the individual grains were larger and the material generally much coarser and more heterogeneous. Carlström points out that there are no signs of quartz grains having been crushed; the uniform size of the fine quartz grains therefore suggests that sifted sand was used. The deliberate sifting would also have removed any plant fragments which would originally have been larger than the sand grains. Their presence in the form of small plant particles can be interpreted as a sign of decomposition, suggesting that the material used for the paste was sand mixed with mud. The texture of the sand paste is, however, quite firm and as the plant fragments seem to be insufficient to serve as a binding agent, the identity of this medium is still open to suspicion. I have experimented with mixing egg white with the sand. Carlström has pointed out that the presence of considerable quantities of egg white would be detected under an ordinary microscope. My experiments show, however, that only very small amounts of egg white are needed to achieve a binding effect if the paste is heated to about 100–200°C. It is particularly interesting to note that, when thus heated, a deposit on the grains of the paste can be observed under the scanning electron microscope (1000X), which is similar in appearance to deposits seen on ancient sand paste (cf. fig. 97–98 and 99). It seems, therefore, that a binding agent, probably based on albumen, was added to the sand paste, which was, however, largely burnt away as the work was heated during the mounting of the inlays (cf. 3b).

This type of paste was mainly used on circular disc brooches of Frankish type with one, two or three zones, but also on S-shaped brooches and small rosette brooches. It is characteristic that the paste fills a considerable part of the object. The sand pastes differ from the cement pastes in that they are softer and lack the hardened character of the cements. It therefore became necessary to solder most of the cell walls to the base plate, which in turn necessitated mounting the inlays from the front and not from the back, as when the cement technique was used. The lower degree of stability given by the paste probably also caused the raising of the cell walls in order to make room for more paste. These cell walls were thin and easy to shape compared with those in the border cloisonné of the early clasped settings. The cell walls have a considerable overlap over the edges of the garnets and, in order to strengthen the mounting further, the underlying gold foil was also often turned over the edges of the stones.

The sand putty technique had several advantages compared with the clasped cloisonné from which it presumably developed. When the paste became a support medium, not only in connection with the turning over of the cell walls, but as a means of stabilizing the work generally, the complicated soldering typical of the early mounting technique became superfluous.

Apart from their main components, sand putties also contain smaller amounts of minerals like dolomite etc. The presence of these minerals has made it possible to identify the location of at least six different workshops where cloisonné of this type was produced. This will be discussed further in chapter 5.

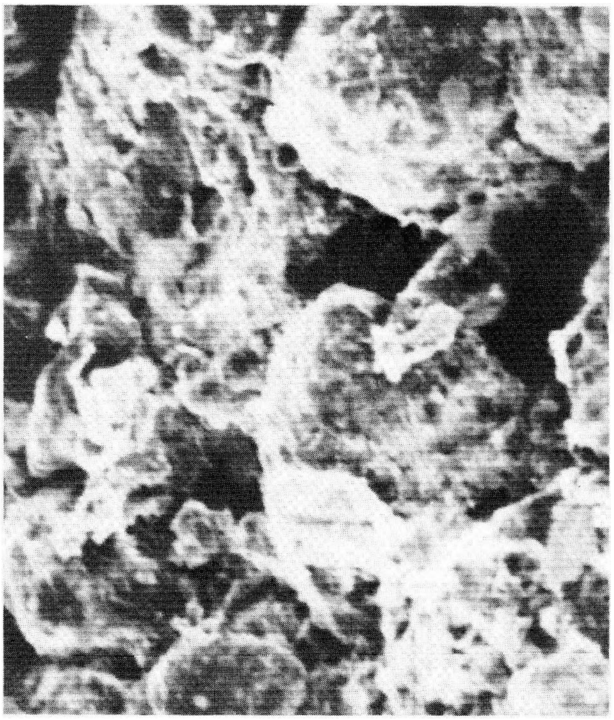


Fig. 97

Fig. 98

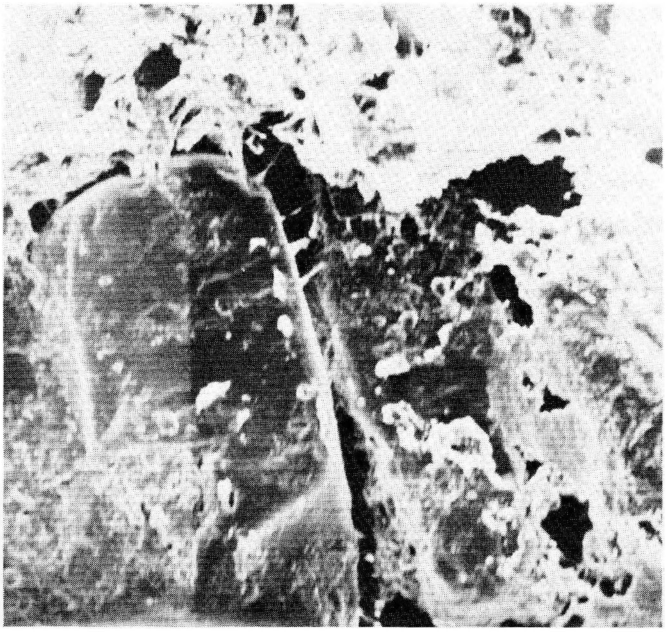


Fig. 99

Fig. 97–99. SEM. showing sand putty with traces of (?) albumen. 97) Quartz putty from the Cologne-Trier workshop (Swed 2). 98) Calcite and quartz putty from the Mainz workshop (Mainz 13). 99) Modern quartz putty mixed with albumen and heated. All 1000:1.

### *3:3e. Secondary uses of sand and calcite putty*

1. As inlay material.
2. As filling in bossed disc brooches, *pressblech* and other brooches.

1. The central zone of a three-zoned disc brooch from *Sprendlingen* (Worms 32) is decorated with three opposed stepped cells. The work is different from that described above: the cell walls are extremely thin and before the results of the analysis were available I judged the brooch to be enamelled, the blue colour of the paste lending credibility to this view. Two samples of the paste were taken in different places (analyses nos. 64 and 93) and the results of the analyses clearly showed that they consisted of quartz and calcite with the addition of brochantite, presumably the colouring agent. A brooch from grave 168, *Castel Trosino* (Rom 3), with a central design reminiscent of the *Sprendlingen* brooch, also con-

tained a similar paste, although without any observable colouring agent. Several scholars maintain that the brooch from *Castel Trosino* never had stone inlays. This would seem very unlikely as cell walls without inlays would easily be bent and damaged. A brooch from *Faversham* (BM 16) is also thought not to have had inlays, but like the *Castel Trosino* brooch it does contain paste. It seems likely that in this case the paste was again used as the actual inlay, although it has now disintegrated. This interpretation is indicated by the definite colouring of the paste in the *Sprendlingen* brooch. A late button-on-bow brooch from Gotland contained paste of this kind (Swed 59, cf. Arrhenius 1971, 217, analysis no. 100). The surface of the paste had a slight sheen, with traces of blue colouring. Along the edge were drops of sintered yellow enamel, like glass flux, which were presumably formed during the cremation. The yellow enamel indicates that the surface of the paste originally contained a flux, for instance NaCl, which caused the paste to sinter on heating. The flux may have been applied to the surface in order to produce a thin glaze. This technique was used on Egyptian faïence beads (Lucas 1948, 199 ff.). The glaze is produced by heating the object after the paste has been placed in position, whereby the flux on the surface changes into thin enamel. This technique is thus closely related to enamelling. It is therefore likely that brooches with paste but no inlays were cheap reproductions of expensive enamelled brooches like the Castellani brooch (BM 4). The close association between the art of enamelling and garnet cloisonné is demonstrated by these brooches. Further evidence of these contacts is provided by the fused pastes described below.

2. The results of the analyses of samples from two gold bossed disc brooches in the Castellani collection (BM10) and from grave 115, *Castel Trosino* (Rom 2) show that these pastes belong to the quartz/calcite group. Rademacher (1940) demonstrates that the pastes in the large gold bossed disc brooches may vary, but they seem generally to consist of brown or greyish-white paste of the type described here as calcite putty or quartz and calcite putty.

Objects with pure calcite putty (groups I, 2a and 3a), or calcite with occasional quartz grains, form a comparatively small group among the analysed samples. This is probably due to the susceptibility of this paste to corrosion (cf. chapter 5). In describing the cement technique it was demonstrated that calcite, like aragonite, could be used as a bottom layer covered with wax. In these cases the texture of the calcite indicated that it had been hardened. But calcite was probably also used purely as filling in the same way as the quartz sand, as demonstrated by the analyses of samples from two *pressblech* brooches from Gotland (Swed 115 and 116).

*3:3f. Fused paste technique. Paste: pure sulphur, calcite or quartz mixed with wax. Table XI, I:1a, II:1a and IV.*

Sulphur becomes liquid when heated and adheres to metal; when cooled, it sets firm. The Romans were familiar with the adhesive properties of sulphur on metal, and sulphur paste was extensively used. Sulphur has indeed been used in this way until the present day. Sulphur was used, for instance, on the saddle mounts from *Apahida II,* to secure the inlaid work to the base.

Sulphur generally occurs in volcanic areas and Sicily was an important source from Classical antiquity. In Egypt sulphur was collected from the areas around the Red Sea (Lucas 1948, 305 ff.). With the exception of Iceland, there are no important sources of sulphur north of the Alps. Sulphur from Iceland was used in the Middle Ages, but this is not relevant to the period treated here. This is a question of importance for the origins of the sulphur paste technique, which seem to lie in the Mediterranean world.

The inlay work described here is all technically similar to work where fused paste with wax was used, in that the gold cells are paper-thin and there is no indication that they were hammered out at the top edges.

Fused pastes of wax mixed with calcite or quartz served the same function as pure sulphur pastes. Wax was mixed with pure calcite or pure quartz or with a mixture of the two.

The composition of the constituents varies as with the crystalline pastes without wax. This may be explained by the raw material being more or less available, or the use of different techniques in the workshops. On heating, the wax, which was opened by the admixtures, became a thick and viscous mass which adhered to the metal; when cooled the volume was reduced sligthly as the paste set, drawing together the cell walls to form a close-fitting mount. The contraction often made the upper surface slightly domed. The cell work was made as thin and flexible as possible and the hot paste, the gold foil and the garnets were placed in position together. As the work cooled, the paste shrank, pulling the cell walls together to form a hermetic seal around the garnets. Practical experiments with paste of this type, cell walls of thin aluminium foil and glass inlay, have demonstrated that the adhesive and contractive properties of this paste produced a very efficient mount, and one that was easy to make.

However, as the cell work must be flexible for the wax paste to work satisfactorily, the cell walls were made as thin as possible. In this respect the technique is similar to that used for enamelled work: in both types of work the metal base plate is usually loosely attached and only spot soldered to the cell work. The base, cell walls and inlays are finally secured by the paste or enamel. The wax/calcite paste is thus the equivalent of the bottom layer of enamel in enamelled cell work (Myrhed 1961). In the manufacture of cell enamel a small quantity of the enamel is poured into the cell work to secure the walls, after which the coloured enamel is added to the individual cell. It is probable that his technique was transferred from Byzantine enamel art to garnet cloisonné. Brooches of the *Sprendlingen* type show that attempts were made to copy the Byzantine enamelled work in the Germanic area. It is significant that fused paste of this type has been found in Byzantine contexts and in association with enamelled inlays, as for instance on the *Castellani* brooch (BM 4) (Table XI, I:1a, no. 31). The paste used to attach the enamel cloisonné to the brooch consisted of coarsely-ground calcite mixed with wax (analysis no. 31). The same type of paste was very occasionally used on the base plate of gold bossed disc brooches, as on the brooch BM 16 (Table XI, I:1a no. 29). However, the paste on these brooches usually consists of either pure calcite or of calcite and quartz, apparently without the addition of any binding agent. Fused paste with calcite has also been identified in the inlay on a bracelet of Byzantine type from *Turin*, (Table XI, I:1a, no. 30, cf. fig. 208). Unlike all the other fused pastes analysed, the calcite in the pastes from the Byzantine buckle mounts and the enamelled disc brooch in the Castellani collection was very coarse-grained.

Finally, it is likely that fused paste was also used in church art. Rademacher (1936, 147) describes a paste of mixed beeswax and lime from Egbert's shrine in *Trier,* where fused paste had obviously been used to secure the inlays of both enamel and garnet cloisonné (cf. chapter 6).

The use of fused paste with wax can be followed from Byzantine art, through disc brooches of Byzantine-Frankish type, and on to Anglo-Saxon cloisonné art. But it was in Scandinavian cloisonné work that this type of paste predominated and reached its greatest importance; indeed, this technique was probably a prerequisite for the flowering of cloisonné art here. It was due to the wax/calcite paste that simpler metals like alloys with low silver content could be used for cell walls instead of silver and gold. Spot soldering alone was adequate, as the paste firmed up the whole work as opposed to the continuous soldering seams which could best be done in gold or alloys with a high silver content.

Some objects with cloisonné were found in Scandinavian cremation-graves. In these cases the wax has burnt away leaving a characteristic blistering. It is likely, therefore, that the paste in the cloisonné of the gold pommel from *Skrävsta* (Swed 26) originally consisted of calcite and wax, the wax having disappeared, leaving behind only vesicles in the calcite. Blistered samples are listed in Table XI, 1:2b.

Work was mixed with quartz sand instead of calcite in one group of Scandinavian objects (Table XI, II:1). The purpose of this paste was the same as that of the wax/calcite paste, although its adhesive properties were probably somewhat reduced. In Scandinavia the use of quartz paste seems to have been limited to a certain period. The paste is first found in Gotland in perid VII:3 and only occurs on the mainland with button-on-bow brooches decorated in Vendel style D, cf. diagram 223.

We have seen that the composition of pastes with wax may differ. The finds from Gotland demonstrate that the determining factor is not necessarily the availability of raw materials. It is not possible to distinguish between finds from Gotland and from the rest of Scandinavia by means of the paste, a fact which suggests that the addition of calcite or quartz as opening agents was primarily a chronological factor. Although the paste is the same, the form and the cell shapes used in the cloisonné work on button-on-bow brooches from Gotland differ in many respects from those from the mainland. The production of these will be discussed in more detail in chapter 5.

### *3:3g Soft putty where wax predominates (Table XI V:1)*

Finally, there were some examples of fused paste where the wax almost completely predominates. Wax paste with insufficient opening material becomes too soft to secure larger areas of cell work and garnet inlays. The result of using such paste through carelessness or by mistake is demonstrated by a button-on-bow brooch from Gotland (Swed 112), where all the inlays and gold foil are missing, although the brooch was not burnt. This primitive technique is also seen on some Scandinavian brooches from the Viking Age.

However, this type of paste has also been found in a heterogeneous group of objects with small narrow fields of cloisonné or single settings which includes work from Anglo-Saxon England and Hungary as well as the Orient. A composite brooch from *Gilton* (cf. fig. 56) produced a sample of paste which consisted of wax with very little quartz filler as well as traces of red lacquer paint. As I had not myself collected the sample I initially doubted that it represented original paste. However, it transpired that the red lacquer came from modern repairs where missing garnets had been replaced with red paint. Similar repair work has been established on objects in *Inventaria Sepulcrale* (Fausset 1856). Closer observation revealed that the paint had been placed directly on top of what appears to have been original paste. It seems likely, therefore, that a soft fused paste based on wax actually was used in the cloisonné work on the narrow panels of this brooch. The transverse cell walls were not secured to the base plate, but were held by the paste, while the circular cell walls were soldered to the base. Also the narrow panels on the buckle from *Milton* (BM 5) had a putty consisting of soft wax.

Further examples of soft wax paste are provided by some objects connected with the East Goths, cf. chapter 4:3. Mostly these items have small cloisonné fields and the inlays are set in a tray with thick walls which stabilize the work. Of special interest is that this soft putty was also recovered on a disc fibula formed as a tray from Hungary (Fe 2/D).

Finally, wax sparingly mixed with quartz was recorded from one of the single settings in the border at the edge of the so-called Chosroe disc (Paris 10).

### *3:3h Atypical organic pastes: Table XI, V:2–3*

The last group of the pastes analysed, consists of more or less atypical substances, often organic materials. Charcoal is the main constituent in a group of a pastes with a wide geographical distribution. Charcoal was commonly found in most goldsmith's workshops; in this context its sole purpose was to provide a supporting foundation for when the cell walls were bent over the edges of the inlays. This technique therefore belongs primarily to the clasped cloisonné technique (cf. 3:3a) or simple settings. It occasionally happened that such paste was used for an isolated piece of soldering in connection with repairs: this emphasizes the need for careful examination of the whole cloisonné work before collecting samples for analysis. The second most common organic paste consists of fine-

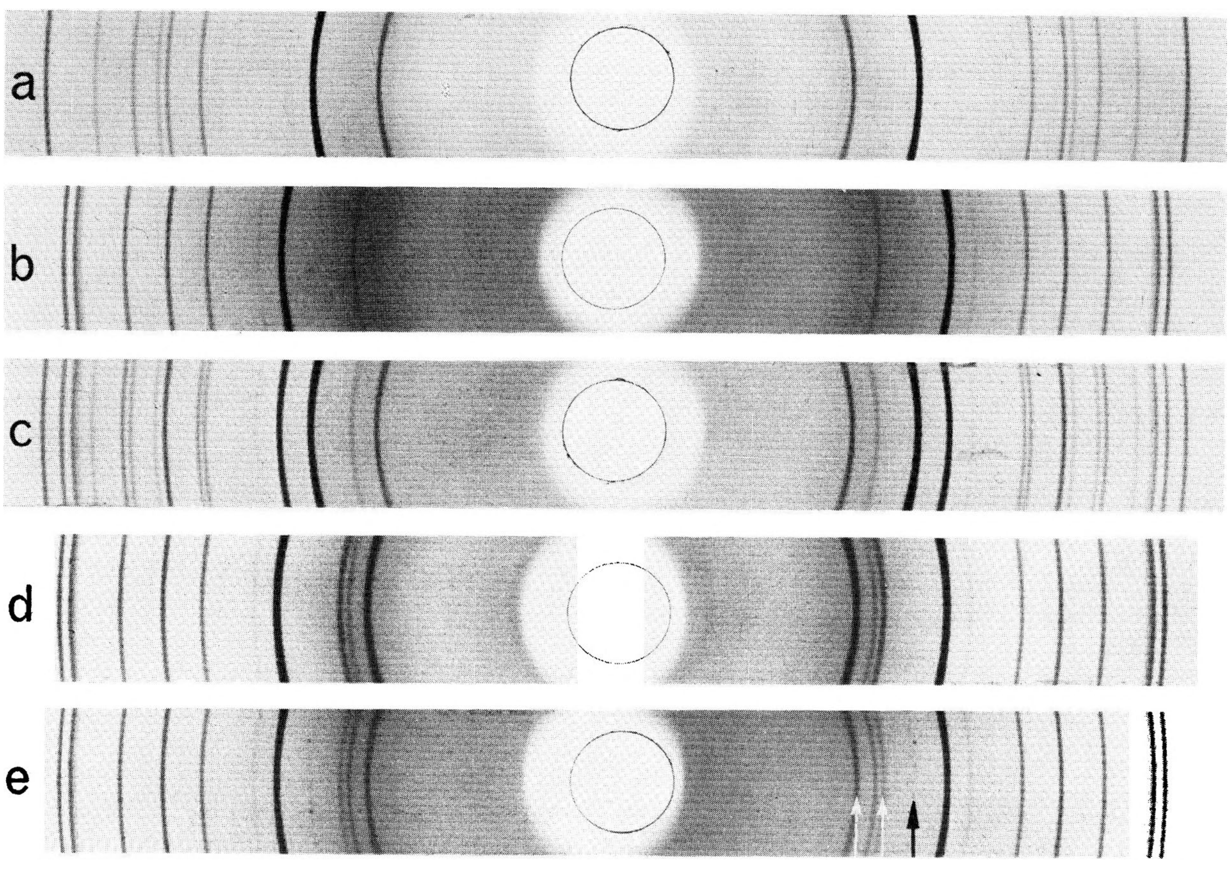



Fig. 100. The central parts of diffraction diagrammes. a) Quartz putty. b) Calcite putty. c) Quartz-calcite mixed, 1:1. d) Calcite and wax mixed, 1:1. e) Fused putty with appr. 80% calcite, 20% wax and traces of quartz (appr. 1%) (black arrow).

grained hardwood sawdust (Table XI, V:3). On three objects sawdust was the main constituent of a glutinous paste. On a fourth object, the brooch from (*Reinstrup, Cop 3*) the paste consisted of sulphur with a few added grains of sawdust (cf. Table XI, IV no. 58). However, there was no trace of sulphur in the first three samples mentioned. It must be pointed out that the wood traces in the pastes show no sign of decay, but were of the pale colour of fresh wood. On the disc brooch from grave 150, *Nocera Umbra* (Rom 1), the paste lay directly beneath the garnets without any underlay of gold foil. Although the stones now appeared to be loose in their settings, it must be presumed that the paste became detached with the passage of time. The glutinous texture and the state of the wood suggest a further ingredient apart from the sawdust, perhaps some plant juice with preservative properties. The sawdust paste on the brooch from *Wittislingen* (Münch 1) gave exactly the same glutinous impression. Even when sampling the paste from the *Wittislingen* object I associated it with that from *Nocera Umbra*. The close resemblance between the pastes of the two brooches may be important for determining their origins. Although I initially doubted that the sawdust represented an original paste, this seems to be confirmed by the presence of a related type of paste in the buckle from *Regöli* (Szek 3). *Regöli* is a recent find and the museum staff have stated that the filling was not added in the museum.

## 3:4 X-ray crystallographic analysis of paste samples from cloisonné work

((cf. Table X and XI, chapter 8)

by professor *Diego Carlström*, Department of Medical Biophysics, Karolinska Institutet

### *Introduction*

There were many reasons for the use of x-ray crystallographic analysis in this investigation. Preliminary examination revealed that the paste samples consisted mainly of fine-grained minerals. The small samples and the polycrystalline nature of the material, which often took the form of a mixture of several constituents, led to the selection of the simple powder diffraction method. This technique, like all x-ray diffraction methods, is based on the strengthening in specific directions of the coherently scattered x-rays in crystalline material, i.e. in material where the atoms are regularly spaced. These constructive interferences can be registered and their direction established, indicating the distance between the planes which define the three-dimensional lattice representing the regularly-spaced atoms. The relationship between the wavelength of the x-ray beam ($\lambda$), the distance between the atomic planes (d) and the angle between these planes and the interference beam ($\Theta$) is expressed simply in Bragg's law: $\lambda = 2d \sin \Theta$. For a full description of the theory and methodology of x-ray crystallography, see the current handbooks such as Bunn (1961) and Klug and Alexander (1954). With the powder technique x-ray interference appears as well-defined lines—diffraction lines—which form a characteristic diffraction pattern for each crystalline substance.

The non-destructive character of the powder technique was another important factor in the choice of this method of analysis. This technique usually results in an unambiguous identification of a crystalline substance as well as a rough idea of the quantitative composition of a mixture, which was required in this case.

The aim of the x-ray crystallographic analysis was primarily to identify the substances contained in the samples with a view to facilitating a classification which could be compared with the results reached by archaeological and stylistic means.

### *Material*

The material consisted of 183 paste samples. The samples were contained in small closed glass or plastic tubes in order to prevent contamination by foreign crystalline substances. The weight of the samples was usually between 0.05 and 0.5 mg. I was informed that the samples had been collected with great care and that only samples of real paste were chosen for analysis.

### *Method*

The samples were first carefully examined microscopically under moderate magnification (10–40X). The general appearance of the sample, its colour, homogeneity, consistency etc. was recorded. Sometimes this examination revealed that parts of the sample—e.g. metal fragments, verdigris and metal oxides—were not actually part of the paste. These substances, which came from the metal parts of the cloisonné work, were excluded from the paste samples by purely mechanical means. The microscopic examination included testing the samples to determine whether they absorbed or resisted water by placing a small quantity of paste on a drop of water. A small representative amount (0.05–0.15 mg) of the sample was then placed in a thin pyrex (glass) capillary tube with an internal diameter of 0.1–0.2 mm. Where the microscopic examination established that the sample consisted of two or more quite different elements, these were each placed in a different capillary tube. Samples which consisted of solid pieces—a common condition—were ground between two object-plates in order that they might be inserted in the tube.

The diffraction patterns (cf. fig. 100) were obtained in the usual way by the Debye-Scherrer technique using a 114 mm cylindrical camera. Ni-filtered CuKα-radiation ($\lambda = 1.54$Å) at 40 kV and 20 mA was used throughout. Exposure time was 1–4 hours depending on the choice of collimator. If the diffraction patterns revealed that the lines relating to wax, a common constituent, were so weak as to render an interpretation uncertain, or if the lines from other crystalline substances covered the positions of the two strongest lines relating to wax, a further test was undertaken. The sample was treated with chloroform after which the extract, with its wax content much concentrated, was again subjected to diffraction analysis to establish the wax content. In cases were the diffraction pattern was difficult to interpret, a mechanical separation of, for instance, different coloured grains in the sample could facilitate a full interpretation after renewed diffraction analysis. After the completion of the x-ray crystallographic tests, microscope slides were prepared of material from the samples to allow examination of, for instance, the grain sizes of quartz in an ordinary petrographic microscope. Sections for morphological tests were prepared in a few cases where the material consisted of plant fragments or where some other substance of biological origin was suspected (i.e. bone or shell).

### *Interpretation of the analyses*

The diffraction patterns were first compared with the patterns of pure organic substances, synthetic inorganic substances or natural minerals in the archives available at the Department. Most of the diffraction patterns could be positively identified by these means, especially where the substances were present in a pure form. Samples containing a mixture of several substances in the same diffraction pattern in some cases produced diffraction lines which could not be identified by comparison with reference patterns. In these cases the Θ-angles (Bragg angles) of these lines were measured and the d-values derived from them were used to find the substance or substances in the ASTM index. In many cases the samples could be identified in this way. In Table XI substances which have not been identified are indicated by the letters (UID) and where the identification is uncertain by (?). These substances are subordinate constituents in mixtures, represented by one or a few weak diffraction lines or a larger numer of diffuse lines, a common feature of mixed silicates. The powder method presents certain difficulties of interpretation where mixtures are concerned; a dual constituent system may cause considerable problems if the diffraction patterns of neither substance can be directly identified. The difficulties generally increase with the number of constituents involved. It is therefore only in exceptional cases and under favourable circumstances that more than four different crystalline phases can be idenfied in a mixture.

The main ingredient in a mixture can be determined if one constituent definitely predominates. In order to achieve reliable quantitative information it is necessary to produce reference series of diffraction patterns of mixtures of known composition for comparison with the diffraction patterns produced. But such comparisons may not produce a completely realiable result owing to the effect of the size of crystals in the sample. The heterogeneous nature of the samples made it not practically possible to carry out stringent quantitative analyses by this method. The components of mixtures have, however, been roughly sorted in such a manner that the main constituent is listed first, followed by the others in order of presumed decreasing quantity. This rough estimate may contain some fairly serious errors. Amorphous or slightly crystalline substances such as glass, resin and clay minerals could have been present in significant quantities without being detected in the diffraction patterns. In doubtful cases, or where the diffraction pattern had no lines, the nature of the sample was identified microscopically. The smallest amount of a constituent in a mixture capable of detection therefore varies considerably; in mixtures of well-crystallized material the lower level is usually 5–0.5%. With the methods used here the smallest quantity of α-quartz which can be detected mixed with calcite is approximately 0.3% and the smallest quantity of wax mixed with calcite is 2–3%.

In some cases it was possible to ascertain from the diffraction analyses whether or not a sample had previously been subjected to strong heat. The presence of calcium oxide (CaO) probably indicates that originally $CaCO_3$ was heated to a temperature of at least 550°C. The presence of wax or calcium oxalate dihydrate, on the other hand, suggests that the sample is probably in its original form. Signs of blistering or fusion in some samples, observed during the preliminary microscopic examination, indicated that these had been subjected to considerable heating.

*Conclusions and discussion*

The results of the tests are given in Table XI. Samples of similar composition have been brought together into groups and subgroups for clarity. The grouping is generally based on the main crystalline constituent in the paste. The Table X shows that 42 substances have been identified, 39 of which are crystalline. Of these 4 are simple elements, 5 oxides or hydroxides, 1 sulphide, 7 carbonates, 7 sulphates, 1 phosphate, 10 silicates and 4 organic substances. Relatively few samples contained these substances in a pure form, the majority consisting of mixtures of two or more constituents.

Of the 86 samples in the largest group, the carbonate group (I), $CaCO_3$ in the form of calcite was the main mineral constituent in 78 samples. In 14 of these, wax was mixed in with the calcite as an organic binding-medium. In four cases the wax was not evenly mixed with the calcite but formed an almost separate layer. The proportion of wax varied from barely 50% to the lowest level of detectability (approximately 3%), the most common proportion being about 20%. Wax-free samples in the calcite group (I:2) may hypothetically have different origins: a) originally wax-free paste; b) paste which originally consisted of a calcite and wax mixture, but which lost the wax through secondary heating (cremation). This occurs during experiments when calcite and wax mixtures are heated in an open crucible at 300°C. At temperatures exceeding 550–600°C, $CaCO_3$ passes into CaO, but this process can later be reversed through the action of water and air: $CaO + H_2O \rightarrow Ca(OH)_2$, $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2$. Where the sample was seen to be blistered during the preliminary microscopic examination it was assumed that larger amounts of wax were probably originally present in the sample. c) primary CaO (unslaked lime) mixed with water and perhaps with sand (mortar) and used as paste could have undergone a secondary change into $CaCO_3$ in the form of calcite according to the formula above. d) primary metastable $CaCO_3$ in the form of aragonite passes into the stable calcite modification by moderate heating. This change is not noticeable at room temperature, where a complete re-structuring would require the passage of many geological epochs, but at 400°C it can be accomplished in about an hour. It is difficult to decide which of the four alternatives is the most likely. Some indication can, however, be gained from the small groups I:5a and b. The temperature-sensitive aragonite modification of $CaCO_3$ occurs here both with and without the addition of wax. It is likely that in these six samples the paste is in its original state, as $Ca(OH)_2$ normally passes into calcite and not aragonite when it takes up $CO_2$. It is likely therefore that most of the wax-free calcite pastes are original. Calcite is a very common mineral, although found in Scandinavia mainly in the south-east and south and in Denmark, but aragonite is considerably rarer, and, moreover, is often mixed with calcite. Aragonite is also present in a very pure form in many biogenetic materials like sea shells, corals and otoliths from fish. Several samples contained dolomite, $CaMg(CO_3)_2$, mixed with calcite. This mixture occurs very frequently in many central and south European mountains.

In the second largest group, the silicate group (II), which contained 40 samples, quartz, $\alpha$-$SiO_2$, is the main mineral constituent in 36 samples. The table demonstrates that quartz is also a common subordinate constituent in pastes of the carbonate group. Pure quartz is not occuring in any of the samples as it always is accompanied by a compound of more or less well-defined silicates. These are listed in the table as 'mixed silicates' (MS) and consist of fine-grained feldspar, mica and clay minerals. The severe difficulties in identifying these minerals in mixtures arise from the numerous lines in the diffraction patterns of feldspar and the broad and diffuse lines of the clay minerals. Thus it was not possible to carry out a complete analysis of these mixed silicates. The main material in the silicate group is therefore not quartz sand, which is almost pure $\alpha$-$SiO_2$ with grain sizes of 2–0.6 mm, but very fine-grained silicates with quartz grains of $< 0.1$mm. The accompanying mixed silicates often have much smaller grain sizes, sometimes even similar to those of clay minerals ($< 0.004$ mm), with additional organic debris. Like the carbonate group, the silicate group includes samples with an admixture of wax, although in this group they amount to only 10% as compared to 23% for the carbonates. It is considerably more difficult to determine whether the wax-free sampled of the silicate group have been secondarily heated; these are generally much less homogeneous than the calcite samples and it is therefore more difficult to establish whether or not they contain vesicles. Low-temperature quartz, the common $\alpha$-$SiO_2$, is transformed in two stages at 1470°C into cristobalite, a modification of $SiO_2$ which when chilled can exist at room temperature. Cristobalite was the main constituent in two samples (12 and 21), but as the diffraction patterns were comparatively weak it is likely that these also contained amorphous $SiO_2$ glass. It is, however, very doubtful that cristobalite could have been formed secondarily; the common precious metals Cu, Ag and Au all have considerably lower melting-points than the temperature required for producing cristobalite and there would not have been much left of a cloisonné work if the cremation temperature reached 1500°C. In one sample (75), (Mainz 26) where the calcite and quartz were present in almost equal quantities, a problem arose as to which group it should be assigned to, and it was finally included in the calcite group. In some other samples (58 and 59) microscopically different parts of the same sample could be observed. Samples 58 and 59 (Cop 3) came from the same object, 58 from behind the garnet in the cloisonné jewel and 59 from beside the garnet. Even with the naked eye it was obvious that sample 58 was composed of three entirely different substances. The main bulk of the sample consisted of pale yellow pieces with irregular, shiny fractures and occasional blisters, and was found to be pure sulphur. Attached to one piece was a greyish-brown material which also occurred separately in the sample. This was an admixture of plant fragments with quartz grains and mixed silicates, mainly similar to feldspar. There were also some small, soft whitish pieces which turned out to consist of talc and kaolin. Sample 59 consisted of only the first and last of these substances, proving that the plant fragments lay at the bottom of the paste. Analyses have also been carried out on the remaining heterogeneous samples, but in these cases it was possible to determine which substances were the actual paste and which irrelevant impurities (oxides, carbonates etc.) from the metal parts of the objects. There is a small group of four samples in the silicate group (II:2c and d) where the main crystalline ingredients are substances other than $SiO_2$. This heterogeneous group has no common main ingredient and is unlike other samples in the silicate group. The low frequency of wax as a binding-medium in the silicate group by comparison with the calcite group can perhaps be explained by the addition of mixed silicates and clay minerals producing a binding effect sufficient to allow the paste to fulfill its purpose.

The smaller sulphate group (III) consists of a homogeneous gypsum group (III:1, III:2) and some odd samples (III:3 och III:4). Only four samples in the sulphate group contained wax (III:2 and III:4). Apart from gypsum, $CaSO_4 \times 2H_2O$, two of the gypsum samples contain a smaller amount of burnt gypsum or insoluble anhydrite, $CaSO_4 \times 1/2H_2O$. This product arises when $CaSO_4 \times 2H_2O$ is heated: already at a temperature of 70°C it easily absorbs water to form gypsum. At 200°C it becomes anhydrite, $CaSO_4$, which does not absorb water to an observable degree. This proves that none of the gypsum samples were subjected to considerable heat. Gypsum was also a subordinate ingredient in a calcite-wax sample (5). Of the samples in group III marked as other sulphates, two samples of the same item (Paris 3/M) actually contained jarosite, e.g. an iron-potassium sulphate which is rare. The other samples in this group have a complex composition, with barite, $BaSO_4$, dominating the diffraction pattern. One sample also contained wax (Paris 4/M) as a secondary constituent.

The equally limited sulphur group (IV) contains nine samples and is very homogeneous. All samples are pure elemental sulphur in which the presence of vesicles demonstrates that it has been melted. This material is therefore neither powdered natural sulphur crystals nor sublimated sulphur. As we have seen, two samples (58 and 59) also contain other constituents. Sulphur also occurs as a subordinate constituent in sample 13. The presence of sulphur in the pastes shows that they cannot have been heated secondarily above 445°C, the boiling point of sulphur. Elemental sulphur occurs primarily in volcanic areas, particularly in Italy. Sulphur was already well known and widely used in classical antiquity.

The group of organic materials consisted of pastes where wax predominated, where there were plant fragments or charcoal and finally of one sample where the main constituent was a crystalline substance, calcium oxalate dihydrate, $CaCO_2O_4 \times 2H_2O$, which at a temperature of about 270°C breaks up into $CaCO_3$. Calcium oxalate dihydrate, known as the mineral wedellite, has only been found at the bottom of the Wedell Sea in Antarctica, an impossible source for the samples discussed here. However, calcium oxalate dihydrate commonly occurs in biological contexts: it is found in certain plants and is frequently the main constituent of kidney stones. Calcium oxalate dihydrate also occurs as a subordinate constituent in samples 62, 63 and 177 (Worms 33/Sw, Wien 2/D). It is of course possible that plant remains rich in oxalic acid were mixed with the original paste and have disappeared, leaving only wedellite. This hypothesis is to some extent supported by samples 52, 53 and 111 (Rom 1/D, Münch 1/B), in which vegetal fragments were the main constituent of the paste. Analyses of the vegetale fragments showed that these fragments consisted of wood splinters from leafy wood (Dr. Adelaide Stork, Botanical Institute, University of Stockholm has kindly performed these analyses).

Finally several samples include crystalline substances which definitely derive from the metal parts of the objects. These do not therefore represent pastes. Verdigris occurs as a subordinate constituent in many samples, generally in the form of azurite, $Cu_3(CO_3)_2(OH)_2$, malachite, $Cu_2(CO_3)(OH)_2$, or brochantite, $Cu_4(SO_4)(OH)_6$. It is also common for gold and silver fragments to have been included in the sampling. In certain cases gold dust is found as a constituent of the paste; these cases occur without brackets in the table. Brackets are used when the presence of gold dust is likely to be due to contamination of the sample. Other derivatives from the metal parts of the object include zincite, $ZnO$, basic zinc carbonate, $Zn_4(CO_3)(OH)_8$, cuprite, $CuO_2$, and argentite, $Ag_2S$. Iron in the form of goethite, $Fe_2O_3H_2O$, and tin as cassiterite, $Sn_2O$, occur in one sample each. Both substances were in a pure form and are listed. Only one sample could not be fully identified. Apart from traces of silver and gold it had a completely amorphous diffraction pattern. It was therefore not possible to establish whether the very small amount of material in this sample was of organic or inorganic origin. If inorganic, it is most likely to consist of glass powder.

The results of the analyses show that the paste almost invariably consisted of easily available, fine-grained material. In some cases the substances seem to have been stored in the smithy itself, as indicated by the large amounts of gold dust and carbon particles (probably charcoal) in some samples. Deliberate grinding to produce a fine powder cannot be excluded, but samples including quartz always show naturally rounded grains and no crushed material. In less than a quarter of the samples wax was used as a binding-medium, but the majority of samples either containes no wax or quantities of wax so small ($< 3\%$) as to be without significance for the purposes of creating a plastic material. The desired consistency was presumably produced either by the extremely fine-grained nature of the paste itself or by considerable amounts of fine-grained material, such as sand and clay minerals.

The nature of the wax has not been closely defined. Wax was identified on the basis of two diffraction lines with d-values of 0. 14Å and 3.73Å, the water resistant nature of the sample and the fact that, on chloroform extraction a wax-like deposit remained when the chloroform evaporated. While it is most likely to be beeswax, other organic binding-media cannot be excluded as the diffraction pattern in this case is not altogether specific: paraffin or other long-chain hydrocarbons produce almost identical patterns.

It was not possible to ascertain whether other non-crystalline binding-media had been present in the samples. At the same time it is clear that any sizable amount of starch, resin or similar substance would have been detected under the microscope. It could not be established whether the wood splinter which occurred in four samples had originally contained gum or some other sticky liquid. Water-soluble binding-media, if they were used at all, could easily have been leached out during the period when the objects were buried in the ground.

# Chapter 4. Workshops for cement cloisonné

## 4:1 Features characterizing different goldsmith's workshops

A number of the attributes which characterize garnet jewellery have been identified in previous chapters. In the course of examining these attributes it was established that they were more or less closely associated with local workshops.

For this reason it may be prudent to examine more closely the concept of the workshop and what it implied in the Merovingian period. To the modern reader a workshop means a place where a master works with one or two apprentices, the workshop being registered in the name of the master.

It would seem, however, that the master and the workshop were not so closely associated in the early medieval period. We can, for instance, compare our concept with what is known about St Eligius, who worked in several different workshops (cf. *Vita Eligii, ed.* B. Krusch, 1902). It is known for certain that he worked in at least three places: *Limoges, Paris* and *Noyon.* He began as an apprentice to Arbon in *Limoges*, but also worked under his own name and established a workshop at the monastery in *Solignac* near *Limoges.* At Dagobert's request he moved to *Paris.* Among the works he produced for Dagobert were two saddles decorated with gold and precious stones (Vierck, 1974, 311, translates the two *sella* mentioned in *Vita Eligii* as saddles, in accordance with the chronicle from *St Denis*, published in 1741, and contrary to later interpretations where *sella* are taken to mean thrones. Vierck compares these saddles with the saddles set with precious stones which are known mainly from Merovingian graves, a suggestion which I find very plausible). Eligius also contributed to the decoration of the church at *St Denis.* He transferred his workshop to *Noyon* when he became bishop there in 641. Eligius has also been associated with the moneyer, *Eligius monetarius* (Lafaurie 1977) who struck coins in Paris. It is known that he contributed to the decoration of the saints' graves in *Beauvais* and *Tournai,* and it is therefore likely that he was in this area for a shorter period, even though he may not have worked here permanently.

The mobility which characterizes Eligius' activities is, I believe, typical not only of master goldsmiths of the highest rank but of goldsmiths generally in the Merovingian kingdom. They can be compared with moneyers who were also active in many different places. The reason for this mobility was, as Claude (1981) has pointed out, that the goldsmiths relied on commissions. In the late antique world there is already evidence suggesting that the products of goldsmiths were commissioned, the customer contributing the raw materials (cf. Claude 1981, 207). This was obviously due to the high cost of these materials. The less developed the monetary system was, the more difficult it must have been for the individual goldsmith to obtain the materials needed for his work. In Byzantine society, credit facilities were already limited because of a fairly high interest rate set at 12% (cf. Houmandis 1980, 488). A similar rate of interest was current in the Merovingian kingdom (Van Houtte 1980, 92 ff.). Goldsmiths were expected to make their profit on the difference between the estimated and the true amount of materials used in their work. The perpetual disputes and the suspicions centring on the opportunities for goldsmiths to make undue profits in this way (cf. Claude 1981, 255) ensured that they were not allowed wide margins in this respect. A rate of interest of 12% would probably have totally absorbed this profit margin. Most goldsmiths' work was therefore produced to order as a direct result of the limited credit available. The customer consequently had an interest in making sure that the goldsmith did not abscond with the materials provided, and a guaranteed place of work for the goldsmith became his primary concern. As a result, the goldsmith became attached to a powerful man who could guarantee a supply of work and materials, along with other facilities such as charcoal and cheap labour for working the bellows. In modern terms, this person would be the distributor. The customer and the distributor could of course be the same person, but it is important to note that this *need not* have been the case. The distributor and the goldsmith, however, appear to have been indispensable to each other in the society under consideration here. The fact that the workshops were associated with the distributors allowed goldsmiths greater mobility as they could expect to find a workshop in the neighbourhood where they were offered work. The workshops would supply the sources of power in the form of charcoal and human labour. Other equipment was

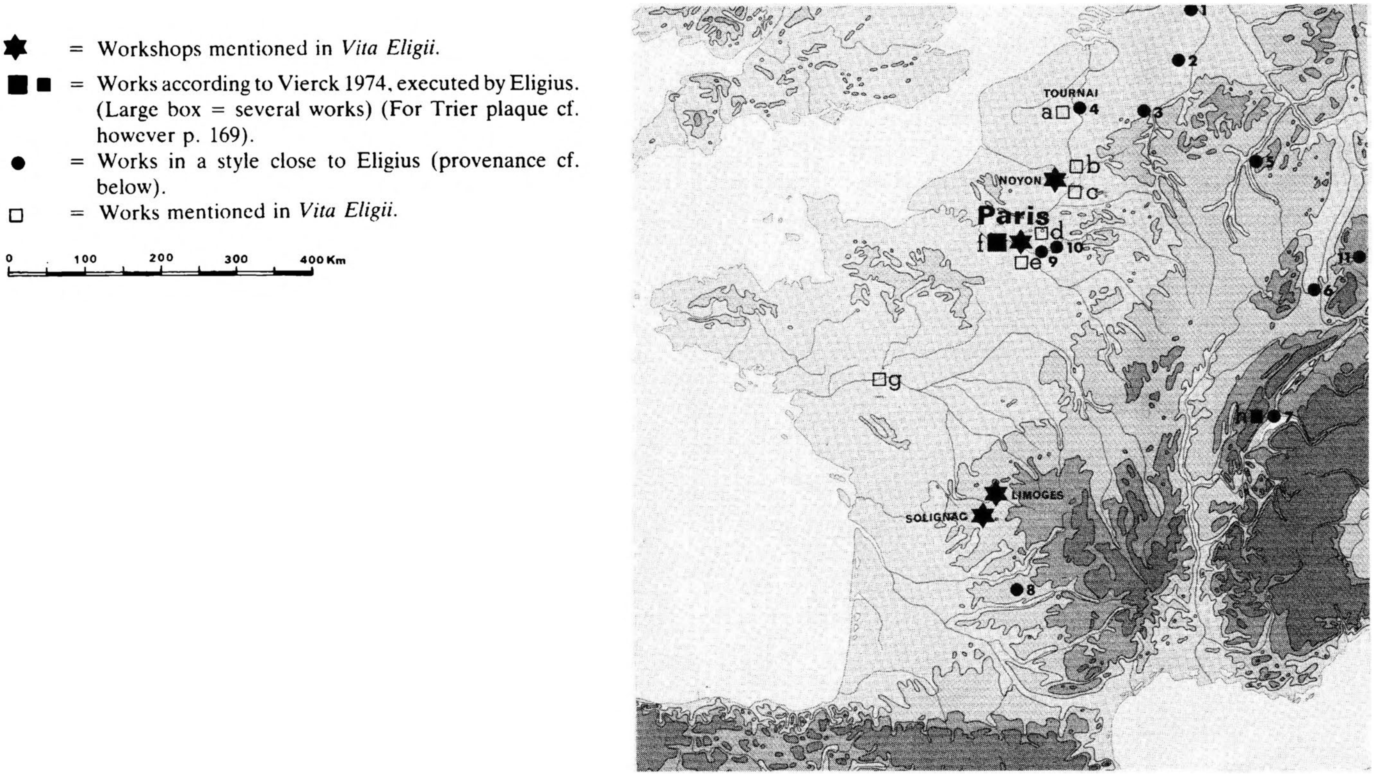



Fig. 101. Map showing the distribution of goldsmith's works associated with Eligius. After Vierck (1974), with minor alterations.
1) Mount from Broerkerk, Nijmegen, Gelderland, Netherlands. 2) Brooch from Houthalen, Netherlands. 3) Mount from Floriffoux, Namur, Belgium. 4) Ring from Tournai, Belgium. 5) Quatrefoil disc brooch from S:t Martin, Trier, Germany. 6) Rectangular disc brooch from Mengen, Germany. 7) Theoderigus' reliquary, St Maurice d'Agaune, Bas-Valais, Switzerland. 8) Reliquary from Conques, Aveyron, France. 9) Quatrefoil disc brooch from St Denis, France. 10) Ring from St Denis, France. 11) Quatrefoil disc brooch from München-Allach Germany.

probably fairly mobile, depending on how far it could be carried. I have already pointed out elsewhere (Arrhenius 1979) that goldsmiths' graves usually contain only fine tools and that heavier equipment like hammers, larger anvils and mounted draw-plates etc. was part of the fixtures of the workshop.

The location of workshops was probably primarily determined by the supply of raw materials available. It would seem that the most important consideration was proximity to sources of power, i.e. a good supply of charcoal and cheap labour. As for the gold and silver, these metals could easily be transported to the workshops once they had been extracted from the ore. Very rarely did gold- and silversmiths work in direct association with the mines. The opposite is true of work in bronze alloys and iron. These metals were often refined further in direct association with the places where the ore was extracted.

In the production of garnet jewellery, the inlay material was also very expensive. The production of shaped garnets is discussed above (2:6); I concluded that garnets cut to certain templets were probably produced at particular workshops and subsequently distributed to the goldsmiths by trade. This conclusion was based not only on the uniform shape of the garnets but also on the very wide geographical distribution of some of these shaped garnets. Those garnets which were probably sold as more or less irregular plates naturally received their final shaping in the goldsmith's workshop. However, these garnets were usually mounted as single stones, and a closer study of their edges demonstrates that they were not cut, but were shaped by grooving and breaking. It was apparently very rare for goldsmiths to know the art of cutting precious stones. Among Roman craftsmen there were many names for gem-cutters, and only the so-called *scalptor* (meaning carver) had any association with metalwork.

The term *scalptor* was often further defined to specify work in wood, stone or metal, and it is clear that a *scalptor-lapicida* could also be a *scalptor sacrae monetae,* that is *one who carves coin dies*. There was, however, a distinction between those who carved the dies and those who actually struck the coins, the *monetarius* (cf. Petrikowits 1981, 83 ff.). The same distinction was apparently also made in the Merovingian kingdom, as stated by Lafaurie in *Eligius Monetarius* (1977, 114): '*Le monétaire n'est donc pas le graveur des coins.*' Compared with the Byzantine coin dies, the Merovingian dies represent a marked decline in the art of carving. The quality of the dies improves slightly in the Carolingian period, but cannot compare with those of the Classical world. The art of engraving and cutting hard materials like metal and precious stones did not therefore survive the collapse of the Roman Empire to any great extent. Thus we cannot expect that gem-cutters were common in the Merovingian kingdom; on the contrary, this art was very rare. For this reason it is also unlikely that shaped garnets could be produced almost anywhere. As these garnets were apparently cut by a fast wheel, perhaps powered by water, the number of places in Western Europe where they could have been produced is reduced further (cf. 5:5). It is therefore most probable that the material for inlay in garnet jewellery was *purchased* and *not produced* in the local goldsmith's workshop. In his work on the cloisonné from *Sutton Hoo,* Bruce-Mitford (1978, 601 ff.) points out that the work must have been carried out by a gem-cutter who adapted the cut stones to the individual items of jewellery. This may be true of certain stones, but most of the material was probably obtained in ready-cut pieces. There will be a further discussion of the jewellery from *Sutton Hoo* below (5:4). To sum up, the inlay materials, like the metals, were apparently supplied to the individual workshops with the distributor as an intermediary.

The situation is different regarding the patterned gold foil which lies beneath the garnets. The rich variations displayed by this foil definitely suggest that it is the product of individual workshops. The use of foil to identify workshops is made difficult by the great variety of the foil patterns within each workshop (cf. chapter 1:5). The patterned gold foil and the stamps share the same characteristics, although on a different scale; the difficulties in using these as criteria for identifying workshops are chiefly statistical, in that the variety is difficult to manage.

In this respect the evidence of the paste used as filling in cloisonné is clearer. To some extent, at least, the pastes appear to have a local character: the distributor, or indeed perhaps the goldsmith himself, appears to have acquired the paste which was most easily available and most suitable for the technique used. The very fact that the constituents of the paste were often as readily available as sawdust leads us to suspect that the goldsmith might have provided them himself. One cannot disregard the fact that the paste filled hollow spaces in the jewel, and therefore *the size of these spaces* was important in determining the goldsmith's profit.

I have discussed here some aspects of the manufacture of garnet jewellery which I believe to be important in a consideration of the workshops where these objects were produced. The difference between jewellery with and without garnet inlay is that the former is *doubly* valuable in that it contains both precious metal and stones. The great value of cut garnets is demonstrated, for instance, by their frequent secondary use, whereby they were transferred to other jewels. This can be observed where stones fit less well than they would in an original setting. It can be presumed that in other cases garnet plates cut to fit a certain pattern would have been re-cut to make other patterns. Such re-cut stones would naturally be smaller than the originals, and there is reason to presume that some of the garnets from the g-templet (cf. 2:7) are re-cut from older material. It is difficult to establish where stones have been re-cut, and it is likely to have occurred to a much larger extent than we can prove, especially as there was clearly a great shortage of garnet plates in the period around 600.

The precious metals in older objects were typically re-used by the Merovingian goldsmith. This has been pointed out by Claude (1981, 255), who argues that the actual goldsmith's work was very little appreciated: there are many references in the written sources to the melting down of older objects to provide material for new work, and also the valuation of works in precious metals in wills and other similar documents was by their weight alone. This lack of respect for the work of the goldsmith is of importance in establishing the extent to which the archaeological material is representative. It can be maintained that where an object of precious metal was of little value as a source of material for new works, it was more likely to have been preserved in the archaeological record. The same principle can be said to apply not only to objects of precious metals but to all other material in the finds which could have had a secondary use. This thesis can be formulated thus: *the law of the accumulation of archaeological artefacts due to inadequate techniques for their re-use.*

This thesis is of great importance to the understanding of the distribution of the garnet jewellery in the archaeological record. Before discussing its relevance to garnet jewellery, however, I wish to illustrate how this thesis works with an example taken from a completely different field: the accumulation of glass fragments in occupation deposits in Iron Age sites and its connection with bead manufacture. In her study of the glass fragments from *Helgö,* A. Lundström discussed this problem (1976,7; 1982,1 ff.). She demonstrates that there is some evidence of glass-working here, possibly indicating bead manufacture. She points out, however, that the traces of bead manufacture on *Helgö* are far less extensive than those encountered in *Ribe* and *Paviken* (1982, 3). This statement is interesting if we consider the large number of glass sherds encountered on *Helgö*. The frequency with which glass sherds occur in the occupation deposits on *Helgö* appears to be the largest recorded in Northern Europe from this period (cf. Holmqvist 1964, Hunter and Sandersson 1982, 25 and Lundström 1982). There is no evidence of bead manufacture in Scandinavia before the Carolingian period, except for the production of the orange and red barrel-shaped beads for which a special glass flux or frit was used. It is not likely that glass from broken vessels could be used in this production. The great quantity of glass sherds on *Helgö* illustrates the accumulation of a material which had no value for secondary use.

If the glass sherds had any real second-hand value, they would not have been allowed to become scattered throughout the occupation deposits as we now find them, particularly in Building Group 2, where about 1200 glass fragments were recovered. This represents 96% of all the glass found in the buildings on *Helgö* (cf. Lundström 1982, 1). Most of the material appears to be Merovingian glass, with a fair amount of so-called Snartemo beakers from the Migration period and a few cut glass fragments of late Roman type. Carolingian cone-beakers are sparingly represented in the material from area 2 and are absent from area 3, where, according to Lundström (1976, 16), most of the evidence of bead manufacture was encountered. The rarity of Carolingian cone-beakers in the *Helgö* material is surprising when we consider that this is the commonest type of glass found elsewhere in Scandinavia, and particularly in the Mälar valley. Carolingian imports of other types, such as the Tatinger jugs, are well represented on *Helgö* (Lundström 1971), however, and the lack of sherds from Carolingian cone-beakers should therefore be interpreted as an indication that this was the period when glass debris became useful as raw material for bead-making. Evidence of settlement in area 3 in the Viking Age includes the dating of hearth 225 (by $C^{14}$ to 815± 121; cf. Kyhlberg 1981, 34) and the presence of wheel-thrown Viking Age pottery (Reisborg 1981, 161). The bead manufacture on *Helgö* is thus seen to be contemporary with that of other Viking Age trading posts. Lundström's hypothesis that the bead manufacture in area 3 was associated with the Migration period foundry, also situated in this area, is therefore most unlikely, especially as the bead blanks which were found here do not support the dating of the bead manufacture to this period. From a methodological point of view, this is an example which demonstrates the need to take account of negative rates of frequency in materials which could be used second-hand. The frequency rates on *Helgö* therefore illustrate the thesis presented above, in that there was an accumulation of glass sherds in the archaeological material due to lack of techniques for re-use. When, during the Carolingian period, it was found that glass sherds could be used as the raw material for bead manufacture this material no longer appears in as large quantities in the archaeological occupation deposits.

In the goldsmith's craft the materials were very extensively re-used: the evidence for this occurs not least in Merovingian written sources. More direct evidence can be gained from the rate of survival of those objects which are believed to have been produced by Eligius. Fifteen objects are mentioned in *Vita Eligii,* of which at most five are preserved in a more or less fragmentary condition (cf. Vierck 1974): thus the frequency of survival is about 30%. This may be unusually high, as it is likely that there was a certain reverence connected with objects made by Eligius (but it can also be said that jewels found in archaeological contexts were favoured when they were buried in pagan graves). The double value of cloisonné jewels naturally resulted in the preservation even of parts of jewels, because both the metal and the inlaid stones could be re-used. The rate of survival would also depend on the area in which the jewel was located. In areas where gem art was well developed, but where there was a shortage of material for gems, these would have been frequently re-used. By this process the gems were re-cut and their sizes became successivly smaller, a feature characteristic of antique gems re-used in medieval jewellery (cf. Wentzel 1962, 315). In areas where gem art was not practised, the tendency would more often have been to re-set old stones without altering their shape. The tendency for the rate of re-working to increase in technologically more advanced areas directly results from the same law which causes the accumulation of archaeological artefacts in technologically less developed areas. The objects which have survived from Eligius' workshops, and from workshops which operated in close association with these, provide a good illustration of this thesis. In the area immediately surrounding these workshops, that is less than two day's journey (or 60 km) from them, five objects have survived, three of which are mentioned in *Vita Eligii,* while in an area more than three days' journey (or 90 km) from the workshops, ten objects have survived, two of which are mentioned in *Vita Eligii* (cf. Vierck 1974) (cf. map fig. 101). A gem-cutting establishment was most probably associated with Eligius, although it suffered a shortage of garnets in his time. It seems likely that a large amount of older garnet jewellery was re-worked in this workshop, and there have indeed been few finds of such jewellery in this part of France.

The existence of a workshop may therefore have a negative influence on the rate of survival of objects. Thus it is possible that specialised workshops of this kind, such as gem-cutting shops, are not found in direct association with an area where the relevant objects are most frequently found, but in the centre of an outlying accumulation of finds with a radius of 90 km or more.

We have already established that gem-cutting shops were rare and that masters of this art were not usually present in most goldsmiths' workshops. In most workshops the goldsmith had to be content to assemble the precious stones provided by the distributor. Where cloisonné work was concerned, the goldsmith was dependent for his patterns on the more specialized gem-cutter. It must therefore be presumed that the distributor, who acquired the stones for inlay, must have had a fairly good knowledge of the goldsmith's craft. Another hypothetical suggestion is the presence around the more specialized workshop of a number of satellite workshops, whose main function was to assemble the jewellery. It would seem impossible to identify these separate workshops from the evidence of the finds, especially as they depended on the central workshop for their pattern development. Like the finds, it is likely that the satellite workshops tended to be located at some distance from the central workshops, in a situation where the distributor's ability to collect ready-cut stones from the central workshop would be particularly profitable.

The organisation outlined here relates to workshops which produced cloisonné inlay work. It would seem possible that these workshops, which to a large extent worked on the assembly of expensive parts like cloisonné panels, were organised into a central workshop with associated satellite workshops at some distance. The distributor would in this case play a key role as a link between the central and the satellite workshops. This model appears plausible from the point of view of modern business organization, but it seems that late Roman trade with mosaic *emblemata* was carried out along similar lines (cf. Schoppa 1956 and Parlasca 1959). Thus Parlasca has described ornamental panels with opposed pelta-motifs which were produced in *Trier* and are found throughout the Rhineland (1959, 132 ff.). Mosaic *emblemata* could, however, also be transported long distances – across the Mediterranean for instance – and North African mosaics provide many examples of this long-distance trade in *emblemata* (cf. R.J.A. Wilson 1982).

In the case of mosaics it was the builder or his representative who acted as distributor, while in the case of jewellery it was, as we have seen, the customer or his intermediary who was the distributor. We have stressed the importance of the distributor being knowledgeable in the goldsmith's craft, particularly in the case of more complex work. It must have been the distributor who determined the patterns on cloisonné work, as this depended on the stones he supplied. If the cloisonné panel was purchased as a complete *emblema* it must have been suited to fit the shape of the jewel.

We have discussed the theoretical conditions for the cloisonné workshops' business. The distance between the central and satellite workshops has been estimated as at least seventy-five kilmetres or three days' travel. The reasoning behind this estimate is that a workshop situated more than three days away from the central workshop could not have had contact with it more often than about once a month. The further away the satellite workshop was, the rarer were its contacts with the central workshop and the more important the role of the distributor.

The economic links between central and satellite workshops would also have varied with the distance between them. They were close if the distance was short, but if the satellite workshop was some 1000 to 1500 kilometres away, the central workshop could have been virtually unaware of the existence of the satellite workshop, while this in turn would have been directly dependent on the central workshop for its very existence. The conditions of work in these businesses thus varied greatly, and different types of workshop will be described below. In this section the fundamental conditions for the existence of the workshops have been put forward, while the local variations will be discussed in more detail below.

## 4:2. Cement cloisonné: central and satellite workshops

### *4:2a The central workshop (cf. diagrams fig. 102, 120, 121)*

Objects with cement cloisonné provide an interesting example of central workshops with satellites. In chapters 2 and 3 it was shown that garnets on objects produced by this method were cut from b-templets. B-templets were typically cut with a concave or convex wheel which produced curved indentations or projections; both b-stepped garnets and other b-templets demonstrate a very advanced wheel-cutting technique. With this technique the cement was applied in a soft state and would later set and become hard. The garnets were therefore mounted from the back of the cell work, which often appeared to consist of a pierced plate, after which the cement was poured into the cells. Patterned gold foil was placed behind the garnets, its pattern visible through the stone.

Objects produced by the cement cloisonné method show a wide geographical distribution. Furthest east are the hoard from *Olbia* in South Russia and a buckle from *Reastan* in Syria (cf. fig. 105); it is also probable that the swords from *Pokrovsk-Voschod* and *Dimitrewka* were produced by this method (cf. 3:3c). The technique is represented in finds from *Apahida I and II* in Rumania and in Childeric's grave at *Tournai.* The technique is well represented in the Rhineland by the gold-hilted spathae of Böhner's type II (Böhner 1948, 234 ff.). The objects from *Olbia, Apahida* and Childeric's grave are of the finest quality; another common feature of these objects is that gypsum was used as cement. Gypsum occurs naturally in the northern deserts of Egypt and was used there and in Syria since the earliest times (cf. chapter 3). Much later, in the seventh century AD, gypsum deposits near *Paris* began to be exploited for purposes which included the making of sarcophagi. Fossard (1961, 62 ff.) has pointed out that some ornaments on these are clearly related to the jeweller's art; it is therefore very likely that the gypsum was first used in making bossed disc brooches (Rademacher 1940,10) and that it was the goldsmiths who introduced the use of this material to France. It is important to note, however, that there is no evidence to suggest that this took place before the end of the sixth century, while cloisonné work made with the cement technique was produced in the fifth and early sixth centuries.

The gypsum used in closisonné was therefore probably imported from Egypt and Syria. In chapter 3:3b I have described the many attempts to produce hard cement without gypsum, which demonstrate that gypsum was an expensive material and not easily obtained, at least not in the Rhineland. It was apparently a little different in the Mediterranean world. The buckle and the mount from *Reastan* in Syria, which were made with typical cement cloisonné containing gypsum, were nonetheless of bronze, and hardly valuable objects. *Reastan* is not far from the sources of gypsum and it is therefore natural to assume that these objects are Syrian and were produced in *Beirut,* for instance. The fact that the cement can be used as a good indication of the location of workshops makes this a reasonable conclusion. But we also know that there was a very lively trade in this part of the Mediterranean, and it is possible therefore that gypsum was part of this trade. *Constantinople,* for instance, had strong trading connections with Syria, and it is more likely that these objects were produced in *Byzantium,* where it is known that the manufacture of jewellery with precious stones was most important (Lafontaine-Dosogne 1979,103 f.).

Another reason to suggest that cement cloisonné with gypsum was produced in *Constantinople* is the presence of such jewellery in South Russia, as indicated by the find from *Olbia.* It appears that *Constantinople* acted as an intermediary in trade with goods from the southern Mediterranean and the areas to the north (cf. Houmanidis 1980,487).

A further reason to relate the production of this jewel-

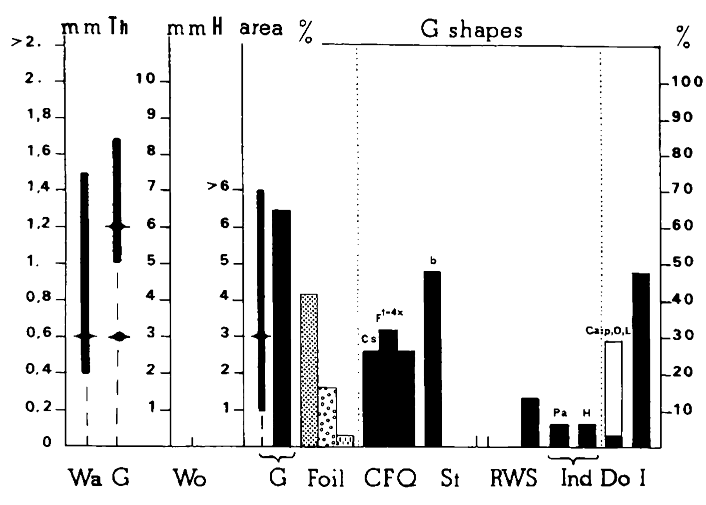



Fig. 102. Diagram showing the common technical features of the cement technique, based on 31 samples: BM 1, 3, 7; Brno 1–4; Cluj 24–26; Eri 10; Karl 1; Köln 1–3, 33, 34, 39–42; Mainz 1; Paris 9, 12, 16, 17; Stut 1, 2, 8, 9, 11, 14; Szeg 1, 2; Wash 1, 2; Worms 33; Wien 2, where however Brno 1–4 and Wash 1–2 are each counted as one sample. The domed garnets consist only of cabochon-cut stones of different shapes. In the bar for "Do" black indicates cabochons of pin-head size and white the oval and lentoid cabochons.

For the Apahida and Childeric finds, which are not included in the diagram, see diagrams fig. 120 and 121. Note that the thin garnets are from one find only (Planig).

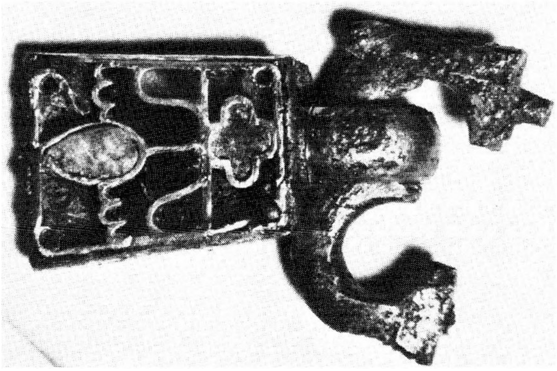


Fig. 103. Bit mount from Hungary (Bud 12) with cloisonné in the late cement technique; garnets and green glass. 1:1.

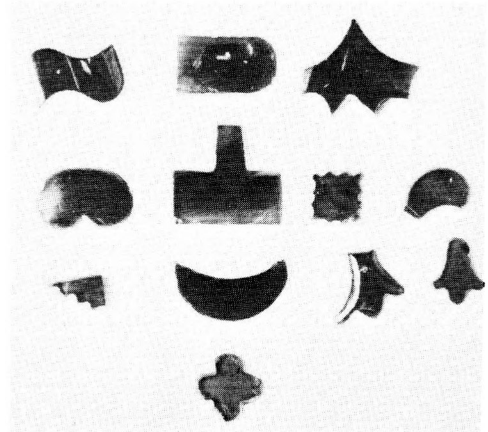


Fig. 104. Garnets from Tunis showing shapes typical of cement cloisonné. After Haevernick (1973a). 1:1.

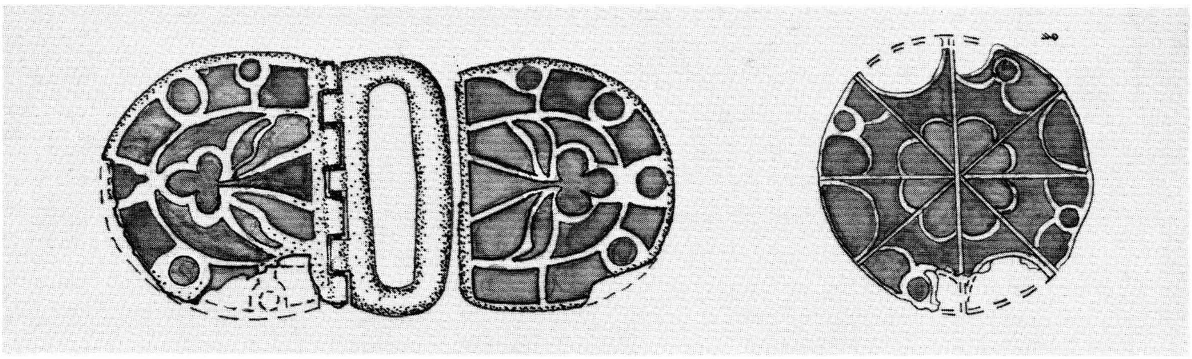


Fig. 105. Buckle and mounts from Reastan, Syria (BM 1) with gypsum-cement. The inlays are not preserved. 1:1.

lery to *Constantinople* is the clearly Christian character of the capsule from *Olbia* (fig. 64). This is a feature which is particularly associated with Byzantine jewellery (cf. Lafontaine-Dosogne 1979,103). Is it possible that Germanic kings like Childeric, or the chieftain who was buried in Apahida, could have ordered their equipment from *Constantinople?*

Direct contact between these Germanic chieftains and *Constantinople* is indicated by the presence of gold brooches with onion terminals in Childeric's grave and grave I at *Apahida.* According to Werner (1971) and others, these brooches were part of the costume which the Emperor gave to his subjects when they undertook to protect his interests in certain areas. The large silver jug in grave I at *Apahida,* which probably came from a workshop in *Constantinople* (Werner 1956, 87), is another indication that gifts were exchanged in the course of such arrangements. The gold coins which were found in Childeric's grave were apparently for the most part struck in *Constantinople* (Böhner 1981, Allemand 1965), and also reflect the nature of the relationship between the East Roman Emperor and the Germanic chieftains. In this context it is interesting to note that the upper and lower guards on Childeric's sword contain a cement which probably consists of hardened calcite, which is not the case for the other parts of the sword e.g. the pommel and mouthpiece of the scabbard (cf. fig. 106). The elongated thin guards of the grip are a typical feature of Germanic swords, which may therefore have been added by Childeric's own goldsmith (cf. Böhner 1948, 236 ff.). If this was the case, it can be seen that he obtained for this purpose stones cut from b-templets forming a pattern with its own ingenuity but closely related to the patterns on the other objects. This illustrates the relationship between the central workshop, which I believe in this case was in *Constantinople,* and its satellite workshops,

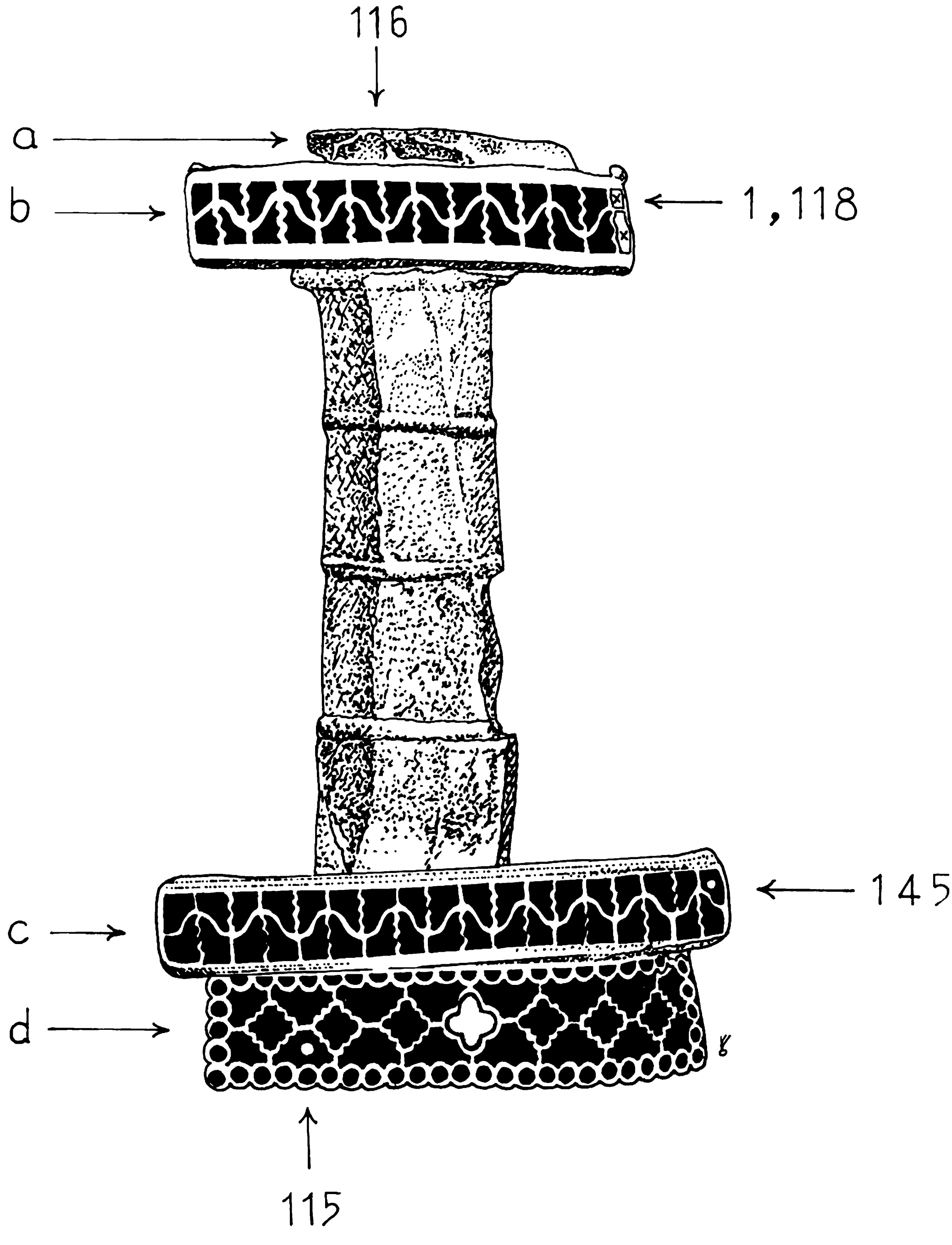



Fig. 106. Childeric's sword showing the places from which the cement samples were taken. Slightly less than 1:1.

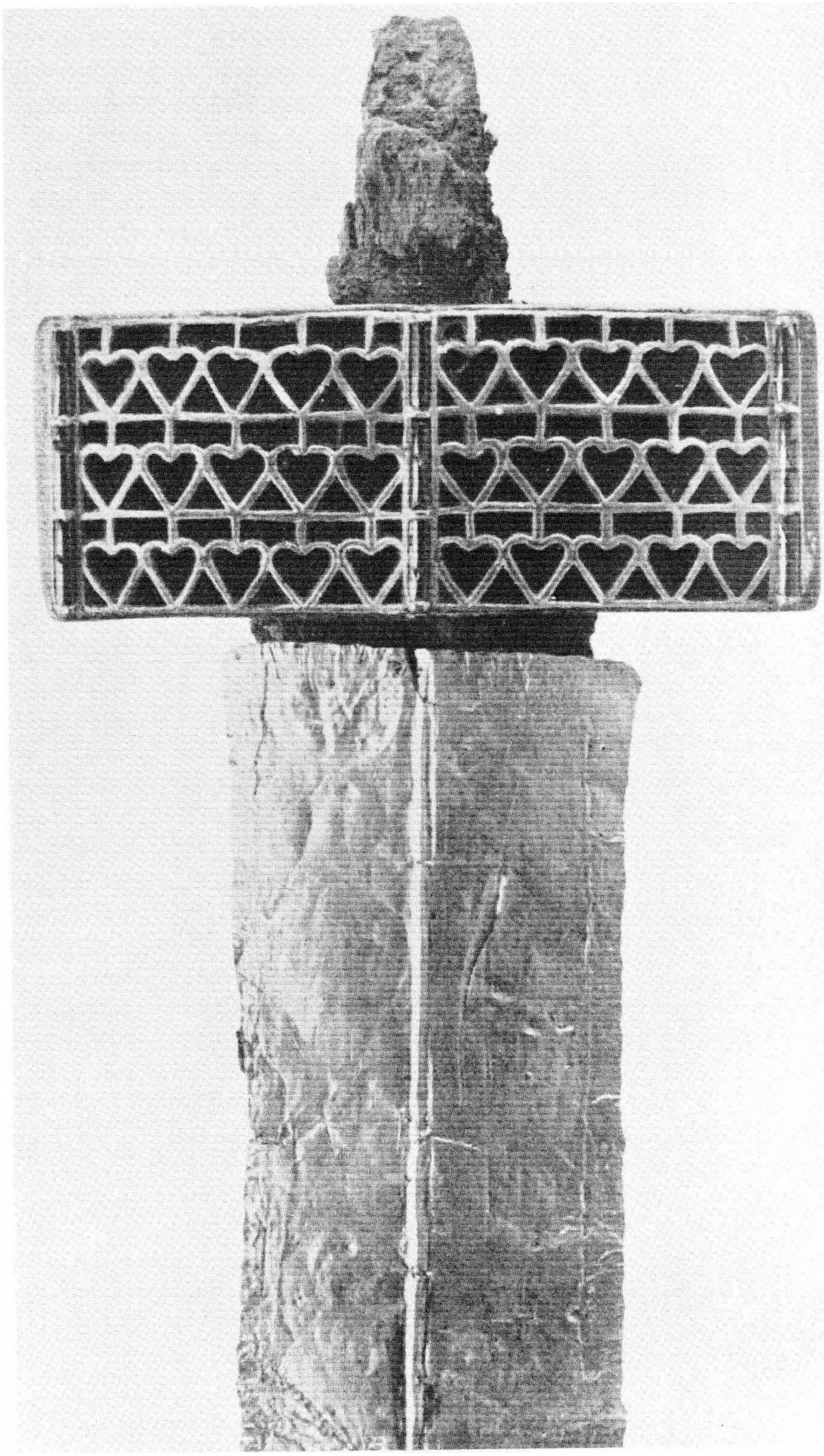


Fig. 107. Sword from Altlussheim (Karl 1). After Werner 1956. 1:1.

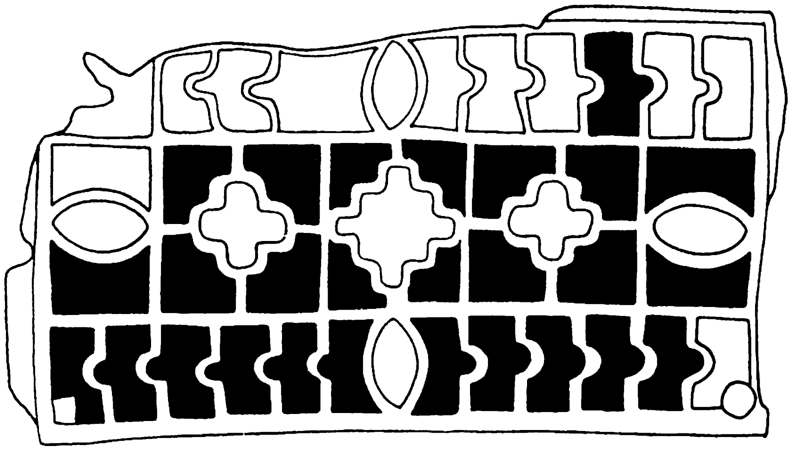


Fig. 108. Buckle plate from Cologne Severinstrasse (Köln 42). 2:1.

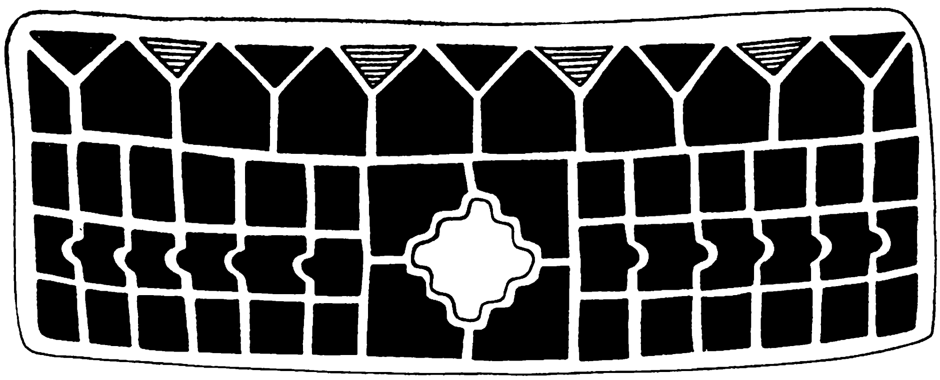


Fig. 109. Scabbard mount from a sword from Eich (Worms 33). 2:1.

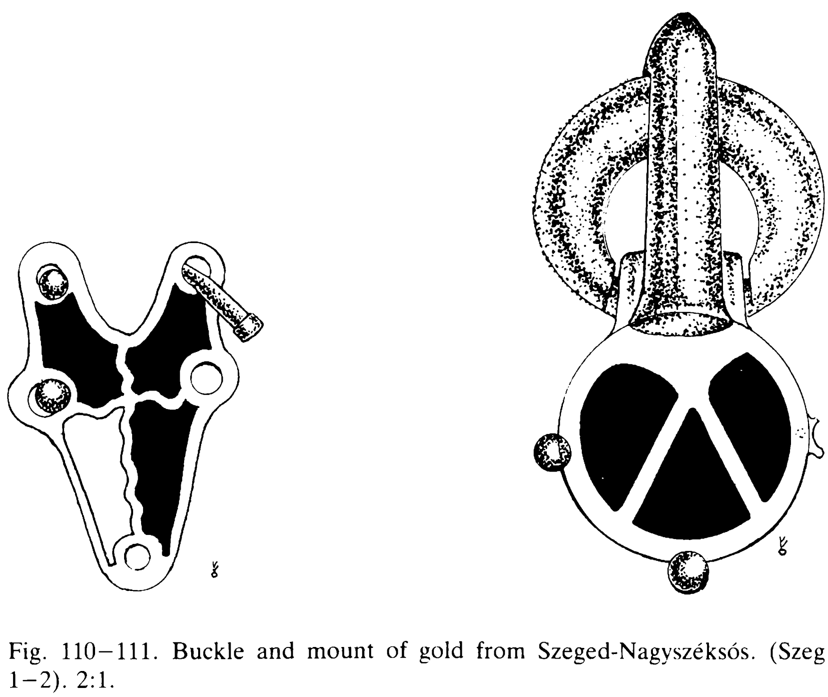


Fig. 110–111. Buckle and mount of gold from Szeged-Nagyszéksós. (Szeg 1–2). 2:1.

which included those in the Rhineland. There are numerous examples from the Rhineland of cement cloisonné work with inlays of garnets cut from b-templets and with cement which, although not of gypsum, has similar properties. These include the gold-hilted spathae of type II described by Böhner (1948), but significantly also one spatha referred by Böhner to his type I, the sword from *Altlussheim* (cf. fig. 107). This spatha has a high lower guard decorated with a cloisonné design consisting of three rows of heart-shaped garnets in a repeat pattern and finished at the edges and in the centre with rounded garnet rods. The sword now has no pommel, but it has a chape of carved lapis lazuli. Garscha (1936,193) points out that the chape was originally a guard and that it was secondarily adapted for its present use. The sword has a suspension loop of bronze, terminating in a biting animal head with eyes of cabochon-cut garnets. Werner suggests (1956,42) that there may have been a cloisonné inlay at the top of the loop which is now missing; rivet-holes which pierce the loop suggest some kind of decorative plate on its upper surface.

The paste analysis showed that the cement behind the cloisonné was aragonite with calcite. Carlström (3:4) points out that the admixture of calcite demonstrates that the mixture is a mineral and not crushed seashells, for instance, which consist of aragonite only. The cement is very hard; analysis of a very similar cement from the scabbard mount on a sword from *Eich* (fig. 109) shows traces of calcium oxalate. It is likely that oxalic acid was added to the aragonite cement, rendering it as hard as gypsum (cf. 3:3c). It is very probable that aragonite cement was developed as *a substitute for* gypsum cement.

Aragonite cement of this kind is found on three swords, from *Altlussheim, Planig* and *Eich.* The swords from *Planig* and *Eich* (fig. 109) are very similar, both in their shape, where they are typical examples of Böhner's type II (1948,234), and in the cell patterns with their omega-shaped cell ladders and b-stepped garnets surrounding a central rhomboid of a different material. There are further green glass inlays in the lower border on the scabbard mount from *Eich.* The sword from *Altlussheim,* fig. 107, is different both in shape and decoration: this consists of heart-shaped garnets with no omega-shaped or b-stepped cells. These variations could well be encompassed by the same workshop. There is no reason to believe that a gem-cutting shop which produced b-stepped shapes would not also produce other patterns, which may be more difficult to identify and which have therefore not been identified here. Heart-shaped garnets, both relief-cut and flat, are known from the Black Sea area, for instance, and continued to be produced well into the Migration period (cf. 2:3). It is therefore not *the design* on the sword from *Altlussheim* which makes it impossible to imagine that all these swords came from the same workshop. The puzzling feature of the *Altlussheim* sword is the shape of the guard, which is much wider and higher than those typical of Böhner's type II. This feature associates the *Altlussheim* sword directly with Byzantine swords, as they are illustrated, for instance, on the Probus diptych (fig. 112), or with Sassanian swords of the type seen on the silver bowls and elsewhere. These swords are, however, much longer than the one from *Altlussheim.* It seems likely, therefore, that separate parts were imported into the Rhineland and assembled there, and that the chape was made out of the original lapis lazuli guard, as an angular chape was apparently required. The *Altlussheim* find suggests that swords were assembled from *imported complete parts.* The cloisonné work probably came mounted as panels, not yet attached to objects. A layer of wax immediately behind the gold-foil backing of the garnets, and between this and the cement, was observed in several cases (cf. 3:3c). It is likely that when the assembled cloisonné panels were sold, they were only backed by this wax layer, which would have given the panels some stability, and that the cement was added when the panel was finally mounted.

In this case it would appear that aragonite cement is typical of satellite workshops which acquired the inlay material from far away, because they had to produce their own cement, and which sometimes acquired cloisonné panels which did not quite fit local sword designs.

The *Altlussheim* sword was previously generally believed to be South Russian (cf. Böhner 1948,226; Garsha 1936,198). It is most closely paralleled among finds from South Russia by the swords from *Pokrovsk-Voschod* and *Dimitrevka.* It is, however, overwhelmingly likely that these swords were also assembled from imported parts. One can, for instance, observe that a scabbard mount on the sword from *Pokrovsk-Voschod* is made up of two joined pieces with both b-stepped and a-stepped garnets, while the guard is completely missing.

It is often said that jewelled suspension loops are typical of South Russian swords. It would seem that the suspension loop arrived in Europe with the Sarmatians, but that it quickly spread both to Sassanian Iran and to India and China (cf. Maenchen-Helfen 1958). The suspension loop was adopted in *Byzantium,* where it can be seen as a typical feature of the tetrarchs' swords on the *Venice* monument (cf. Arbman 1948 fig. 28) and on the diptych from *Monza* (cf. Menghin 1973, fig. 1). The suspension loop is also a typical feature of the sword from

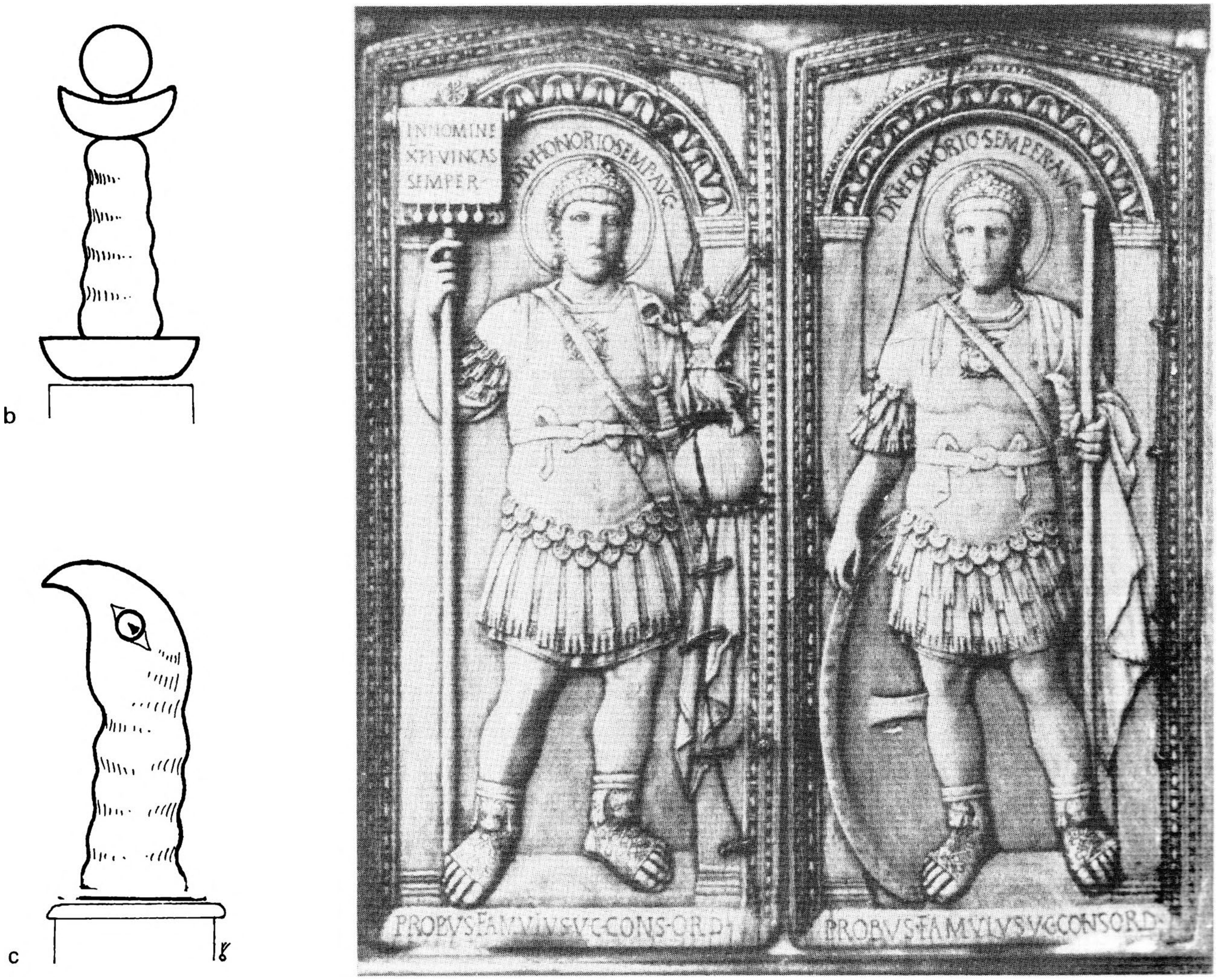
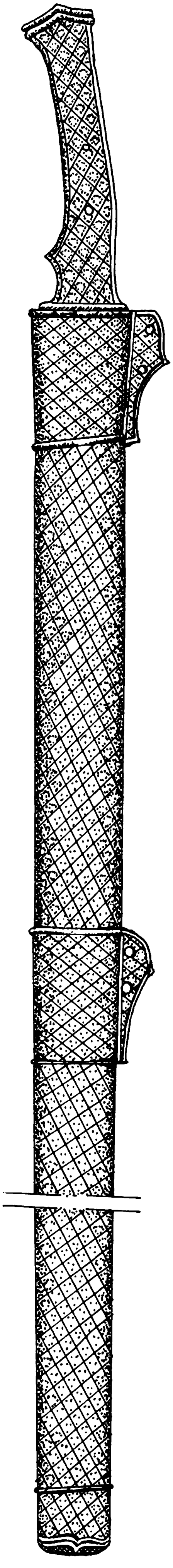
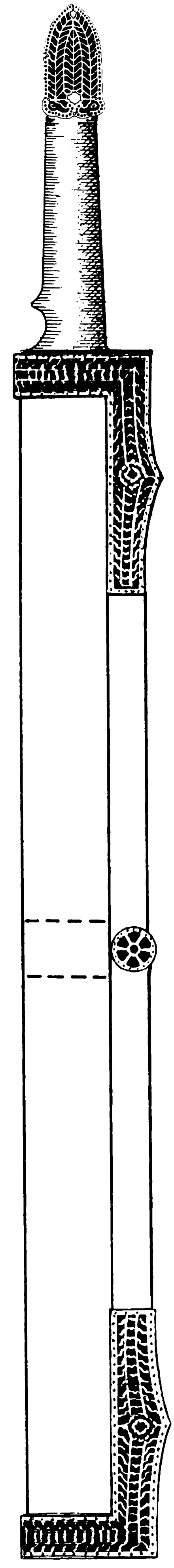



Fig. 112. The Probus diptych. After Riegl 1927. b–c) Enlarged details showing the different sword grips.

*Apahida II* (cf. fig. 122). We have already noted that the cloisonné work in objects from *Apahida* was made with gypsum cement and was therefore a Byzantine import. In *Byzantium,* it appears that suspension loops often occur on swords with angular chapes, that is chapes of the type on the *Altlussheim* sword. Werner (1966a) points out that this type of chape also occurs in late Roman finds. It must be emphasized that this type occurs not only on double-edged swords like the one from *Altlussheim,* but is also typical of long single-edged swords or seaxes.

The seax in Childeric's grave (fig. 114) has an L-shaped chape of this type; however, it was not carried from a loop, but was suspended from one or two projections on the scabbard. It appears that this was not typical of all older long seaxes; the seax from *Pouan* (fig. 147), for instance, does not have these projections and was therefore suspended in some other way, although it is a close copy of the Childeric seax and has an angular chape. The cloisonné on Pouan (cf. 5:1) was, however, made using the sand putty technique and was therefore a Frankish work. The swords of the Venice tetrarchs have asymetrical grips, which suggests that they were long seaxes of a new type, perhaps most similar to Childeric's, but with a suspension loop. The Probus diptych (fig. 112) suggests that in late fourth- and fifth-century *Byzantium* there were not only double-edged spathae but also long single-edged seaxes, since the consul is depicted not only with a typical spatha, but also with an asymmetrial pommel of the same type as those carried by the tetrarchs. It is clear, therefore, that in this period strong and diverse influences affected the forms of both the spatha and the seax; it is only towards the end of the period that it is possible to





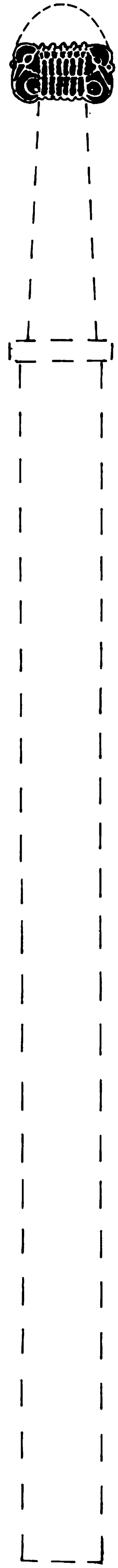


Fig. 113. Sassanian seax from the sixth century A. D. After Kent and Painter 1977, the sword however turned right. 1:3.

Fig. 114. A reconstruction of Childeric's seax with the pommel, fig. 119. 1:3.

Fig. 115. Mount, fig. 125, from Apahida II, reconstructed as a seax pommel. 1:3.

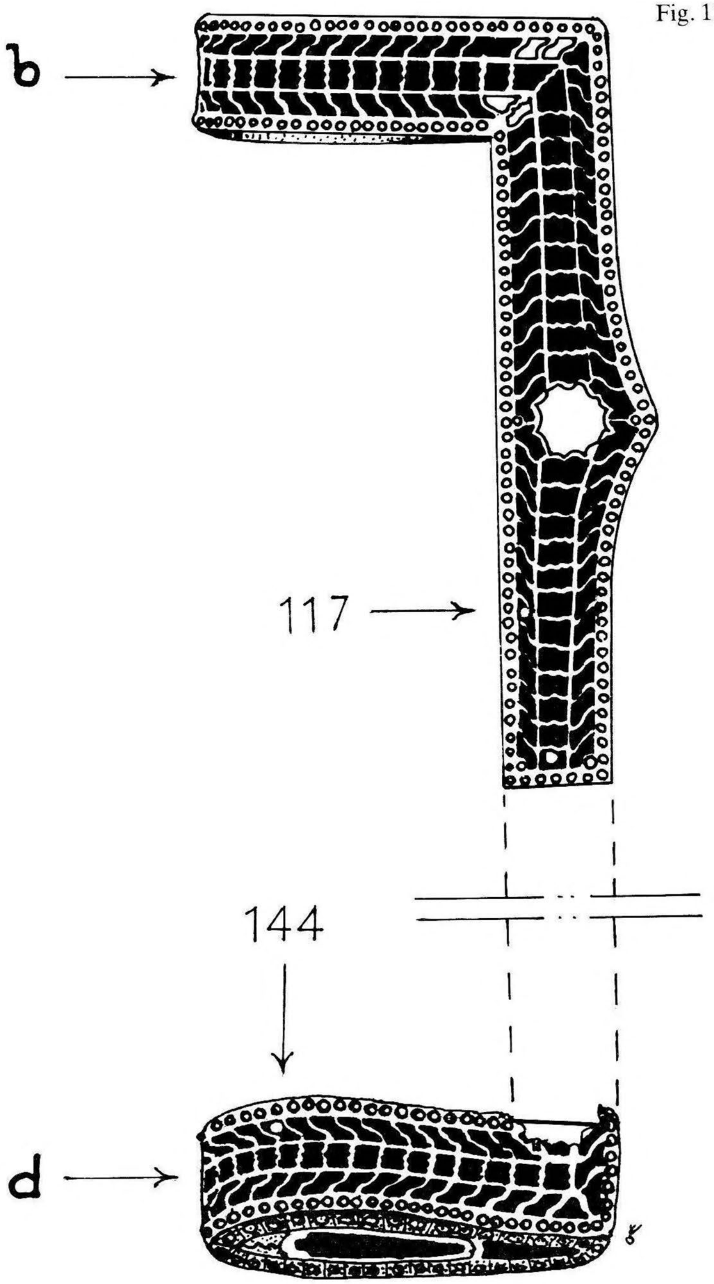
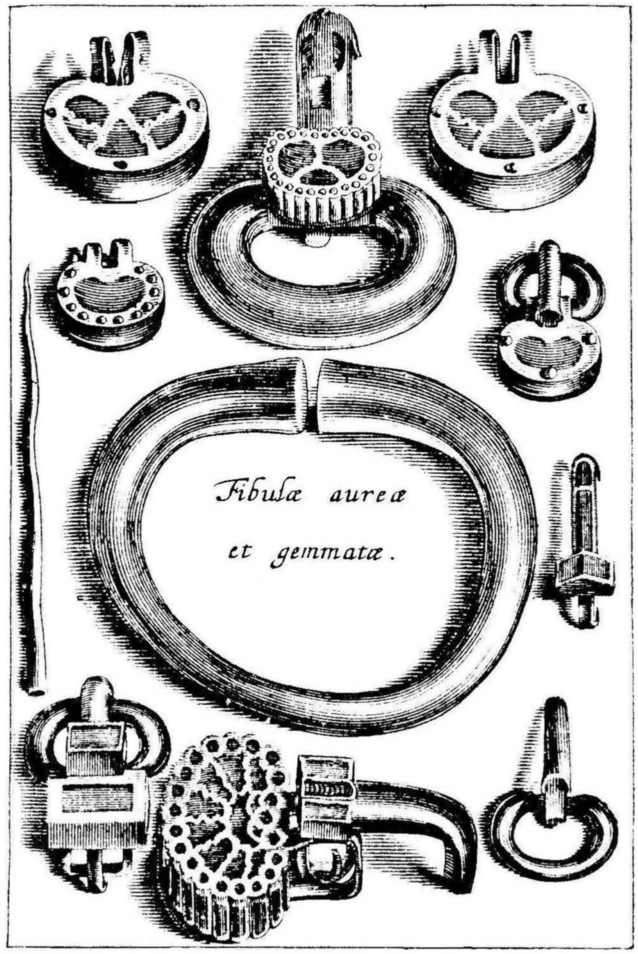



Fig. 116. Mounts from Childeric's seax showing the places from which cement samples were taken. Slightly less than 1:1.

Fig. 117



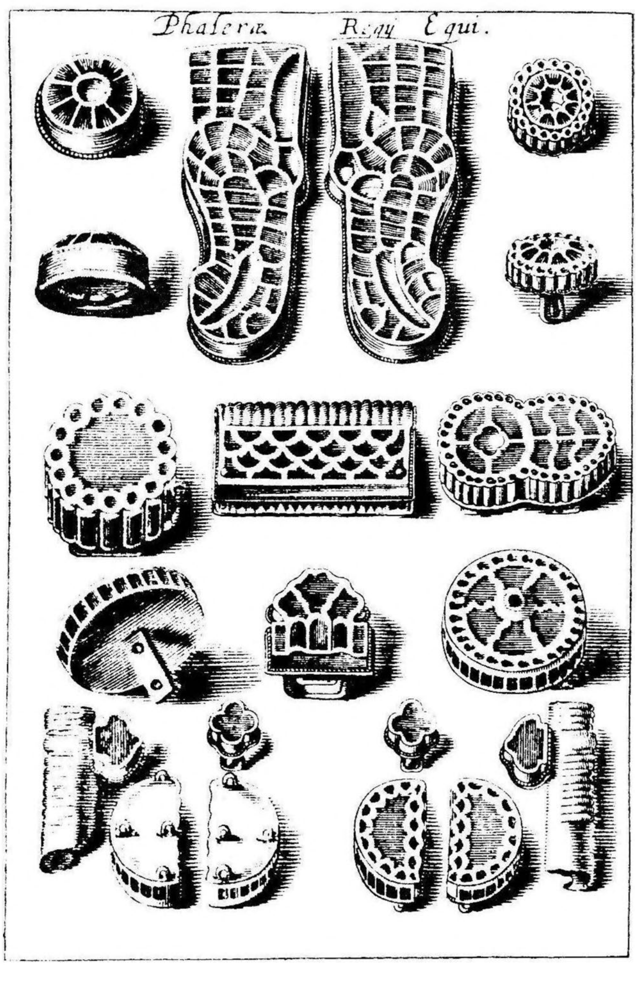




Fig. 118

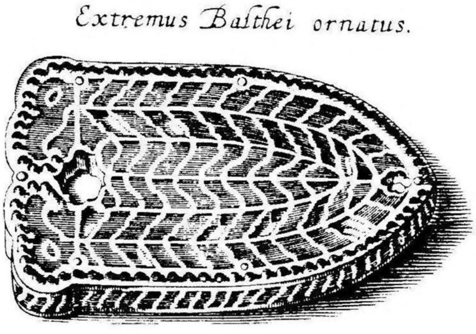



Fig. 119

Fig. 117–119. Chiflets' drawings of the finds from Childeric's grave. Note the mount, fig. 119.

identify types which are characteristic of local manufacture.

The seax from Childeric's grave is a good example of this. To this seax belongs not only the above mentioned angular chape as well as a L-shaped scabbard-mount but also a mount which probably formed a bullet-shaped pommel. This bullet-shaped mount has traditionally been seen as part of a strap mount, while Böhner (Böhner 1981, 444) believes it to be a mount from the chape of the spatha. Both these interpretations appear unlikely in the light of this object's elaborate finish: even the narrow edges are inlaid with garnets. The mount must therefore have been very thick and it is suggested by Chiflet's drawing (cf. fig. 119) that there are pin-head-sized cabochon-garnets along the edges. In this respect the mount is very similar to the other mounts on the seax, which also have garnets of this kind and a similar cloisonné pattern, while the cloisonné patterns of the spatha are different. The round button which both Arbman (Arbman 1948) and Böhner see as the pommel of the seax, and which also has rivet-like garnets and inlaid edges, probably also belonged to the seax, but as a scabbard mount, similar to the round rivets on other seax scabbards. The two animal heads on the bullet-shaped mount, when seen as part of the pommel as suggested here, fulfill a similar function to the animal heads which terminate the pommel of the spatha. A pommel like this would give a natural finish to the grip and to the seax, which is characterized by its magnificent decoration throughout. It is also tempting to suggest that one of the mounts from *Apahida II*, now generally believed to belong to a spatha, was originally the pommel of a seax of this kind (cf. fig. 115, 125). The *Apahida* grave was robbed and the grave goods only fragmentary (cf. Horedt 1972, 175) which may explain why no other parts of the seax were found. Otherwise there is a striking similarity between the cloisonné on the weapons and buckles (harness) from Childeric's grave and *Apahida II* (cf. table XII and the diagrams fig. nos 120–121). The only dissimilar parts are the two guards on Childeric's spatha which however through the cement analyses proved to be secondary additions, probably made by Childeric's own goldsmith.

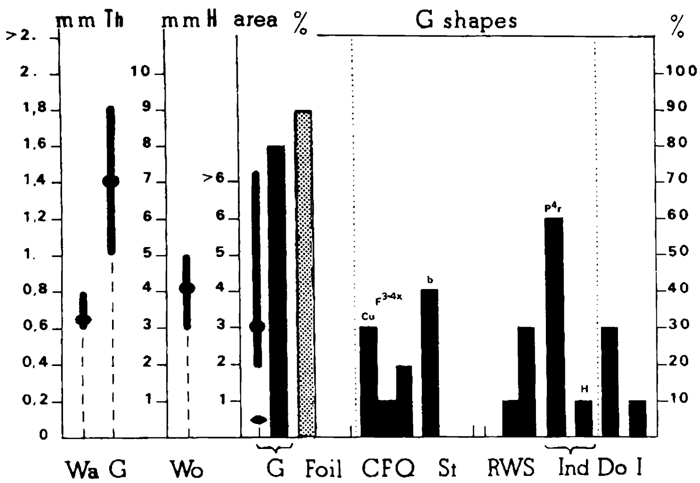



Fig. 120. Diagram showing the main technical features of the cloisonné from Childeric's grave.

The diagram is based only on the objects which exist today.

The small area marked with a dot represents cabochon garnets of pin-head size and the small rectangular garnets used at the edges.

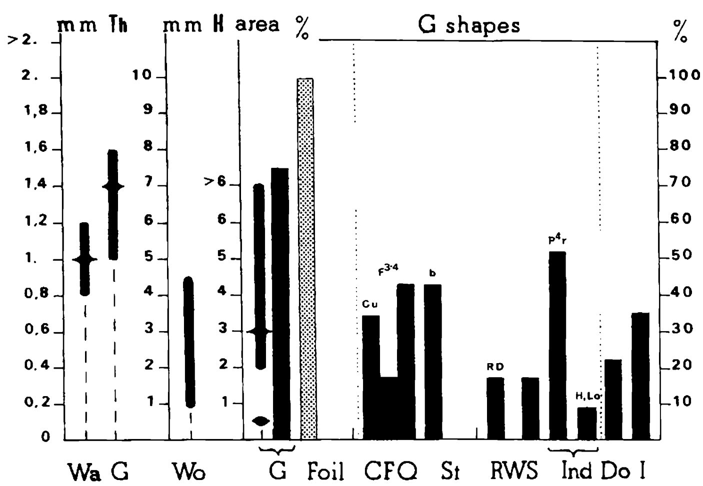



Fig. 121. Diagram showing the main technical features of the cloisonné from Apahida II. Each type of object is counted as one unit. The small area marked with a dot represents cabochon garnets of pin-head size. The RD shape is one half of the 2 RD-shape, illustrated in fig. 4.

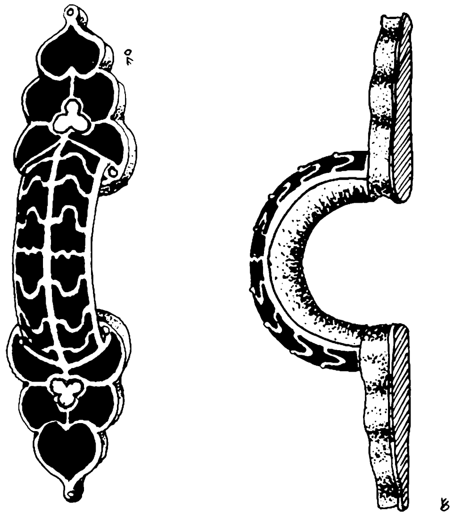


Fig. 122

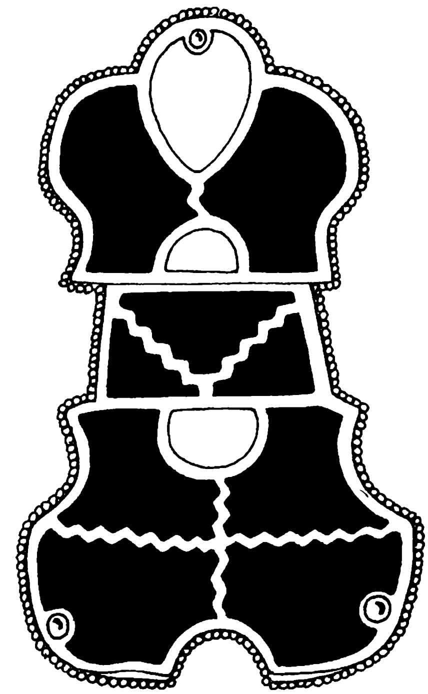


Fig. 123

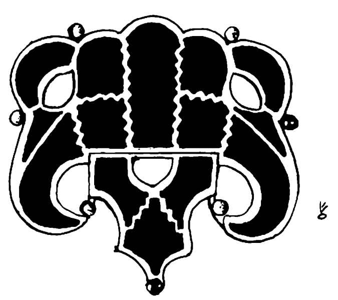


Fig. 124

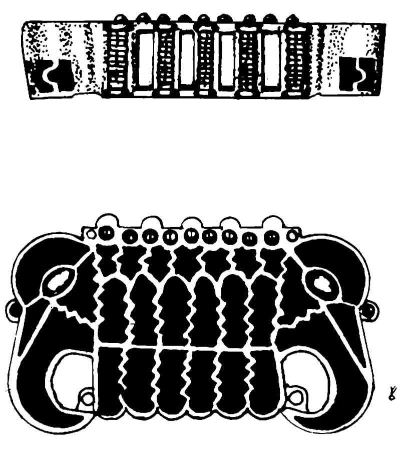


Fig. 125

Fig. 122–125. Objects from Apahida II showing typical cloisonné patterns.
122) Suspension loop with heart-shaped garnets. 1:1.
123) Bridle mount with a pattern which probably represents a lotus. 2:1.
124) Bridle mount with a pattern of hanging birds' heads. 1:1.
125) Mount (from the seax pommel ? ), with hanging birds'-heads pattern. 1:1.

Fig. 126

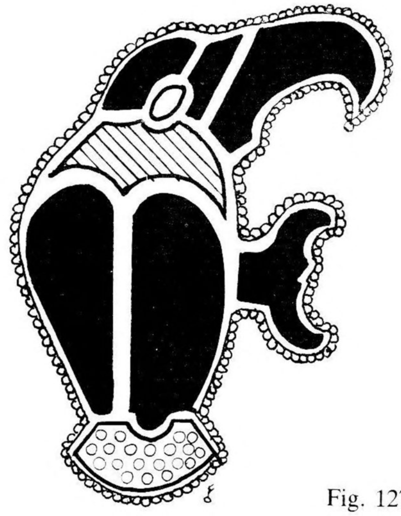


Fig. 127

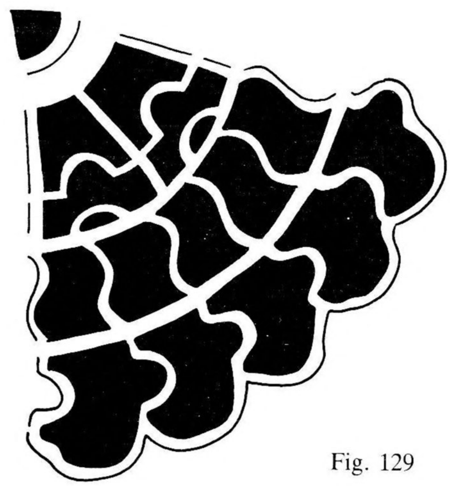


Fig. 129

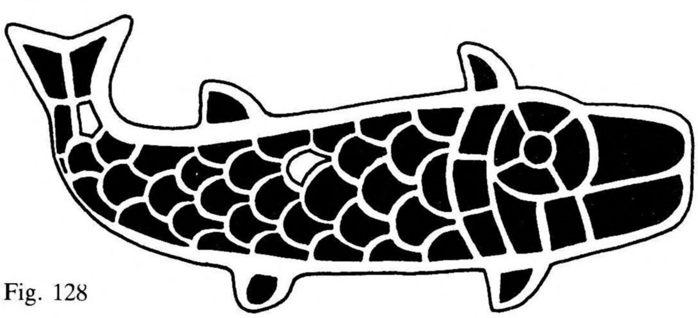


Fig. 128

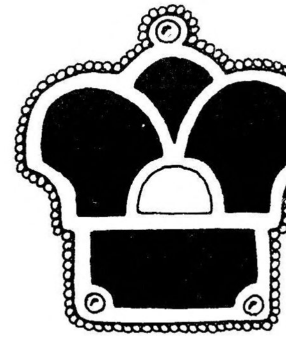


Fig. 130

Fig. 126. The centre of a diptych from Milan. Gold cloisonné with domed garnets. After Volbach 1958. 2:1.
Fig. 127. Eagle-brooch from Beregszász. Garnets, green and white inlays. 2:1.
Fig. 128. Brooch in the shape of a fish with garnet cloisonné from Bülach, Switzerland. 2:1.
Fig. 129–130. Ornaments in garnet cloisonné on horse trappings from Apahida II (Cluj 4 and 5). 2:1.

Table XII. Cell shapes of the cloisonné on the swords and buckles (harness) from Childeric and Apahida II.

| | Childeric | Apahida II |
|---|---|---|
| 4 C | X | |
| 2 C | X | |
| Cao | X | |
| Cap | X | X |
| Cp | | X |
| Cc | | X |
| Cu | X | X |
| $CubSt^{3-4}$ | X | X |
| $CD^{2-3}$ | X | X |
| CDX | X | X |
| $P^4r$ | X | X |
| $P^4rbSt^{4-6}$ | X | |
| $TbSt^{4-6}DX$ | | X |
| TDX | X | |
| $FbSt^{4-6}$ | X | X |
| $CbSt^{4-8}$ | | X |
| $CbSt^{4-8}DX$ | | X |
| PhDX | X | |
| $WbSt^3$ | X | |
| H | X | X |
| Q | X | X |
| $F^3$ | | X |
| $F^4$ | X | |
| O | | X |
| S | X | X |
| N = 25 | N = 18 of which 10 also occur in Apahida | N = 17 of which 10 also occur in Childeric's grave |

Böhner has shown that the one-edged sword is not in itself something new in the Germanic world: the innovation which characterizes the Merovingian scramaseax is the two-point suspension by projections on the scabbard which appears first on Childeric's seax. Parallels have been sought among the equestrian peoples, the Persians, the Sarmatians, the Sassanians and the Huns (Ginters 1928, 6 ff.; Gjessing 1934, 95 ff.; Olsén 1945, 66). The Huns have been considered as having brought the seax directly to the Germanic peoples (Olsén 1945, 66). It is my contention that this type of seaxes with cloisonné ornaments was originally produced in *Constantinople* and that it is Byzantine. It could be argued against this attribution that this type of seax most often is reproduced in Sassanian art. This is, however, due to the fact that the Sassanian rulers were depicted as warrior heroes, with the result that weapons and horse trappings played an important role. As this kind of heroic art did not exist in Byzantium, such equipment was therefore not illustrated. It seems however, that largely similar equipment was used in Byzantium and Sassanian Persia and that the main difference was that in Byzantium the swords had cloisonné ornaments.

That the two-point suspension by projections was known in Byzantium is proved by the scabbard found in *Castell Trosino,* grave F (Olsén 1945, 55).

The production of weapons decorated with cloisonné has been assigned to Byzantium and not to the Sassanians because several Christian cult objects decorated with this type of cloisonné are known from Byzantium and there is no evidence that this type of cloisonné was *ever produced* in the Sassanian lands. It has been pointed out above (cf. 2:5) that in Sassanian cloisonné art clasped mounting techniques and relief cut garnets were frequently used whereas cement cloisonné seems not to have been known.

### *4:2b Satellite workshops*

Apart from the satellite workshop in the Rhineland where aragonite cement was used—identified above—other workshops can be identified from the evidence of the material analysed. In two finds from Hungary, a paste of the rare mineral heulandite (a silicate of aluminium and calcium) was used instead of aragonite as a replacement for gypsum. Oxalic acid was not found, but the texture of the paste shows that a hardening agent must have been used. One of these is a small bird from *Beregszász* (fig. 127), one of three brooches from a probably Gepidic grave find dated to the middle or second half of the fifth century (cf. Csallány 1961, 220 and 6:1 below). The brooch is of exquisite workmanship with an omega-shaped cell ladder pattern marking the foot. The other object, a small gold buckle with a round plate, comes from the hoard at *Szeged-Nagyszéksós* (cf. Fettich 1953). These two objects are presumably examples of the work of an early Hungarian satellite workshop.

The richly decorated sword, seax and buckles from the chieftain's grave in *Blûcina,* Moravia may derive from another workshop using imported garnet cloisonné-panels (cf. fig. 131 and list Brno 1–4).

The evidence suggests that there were probably other satellite workshops in the Rhineland. Analysis of the paste from a buckle from *Stammheim* showed that ordinary calcite was hardened with oxalic acid. The change to calcium oxalate dihydrate, which occurs during hardening, only affects part of the cement and it has a tendency to crumble away. It is therefore likely that calcium oxalate can only be identified in some cases. In many objects the analysis of the paste only registers calcite, as for instance in the grip of Childeric's sword. In such cases it is the other characteristics of the cement technique, like the thin cell work where the walls are flattened at the top and not attached to the bottom plate, the shape of the garnets

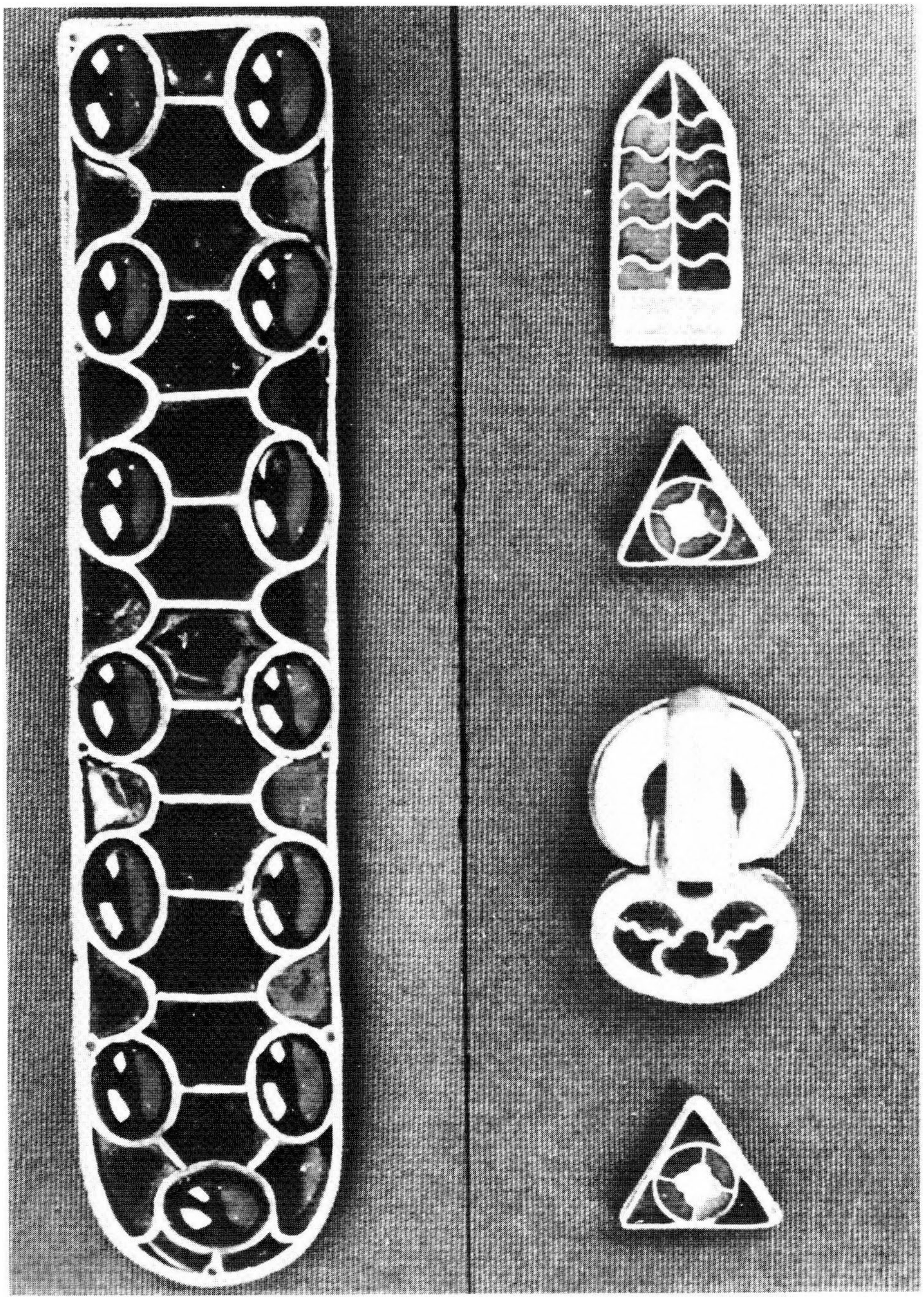


Fig. 131. Mounts from a seax, buckles and harness from Blûcina, Moravia (Brno 1–4). 1:1.

and the *hardness* of the paste, which identify such objects as using the cement technique.

Apart from the typical b-stepped shapes there are a number of other less typical forms which characterize the cement technique. The concave wheel favours gentle, more or less S-shaped outlines, and animal ornament in cloisonné interestingly first appears in association with b-stepped patterns. The bird from *Beregszász* (fig. 127) is a typical example of this tendency, in that most of the bird is made up of the usual geometrical shapes, while the beak and the claw must have been cut specifically for this purpose. Some of the inlays on the distinctive Frankish purse mounts (i.e. mounts from bags containing strike-a-lights) must also have been ordered specifically for their purpose. These pursuse mounts belong to the same groups of finds as the gold-hilted spathae of Böhner's type II, and it is therefore likely that the inlays came from the same central workshop. The technique of the inlays was the same, except that no cement was added in the case of the purse mounts, presumably because the mounts were stitched directly on to the leather without a metal base plate. The only remnants of paste appear to be traces of wax, but I have been unable to obtain satisfactory analyses because the corrosion of the iron strike-a-light has usually completely destroyed the backing material. Another difference between the inlays on the purse mounts and on the swords is that the former are considerably more polychromatic. This is presumably because the more expensive garnets were replaced by pieces of coloured glass. The cell walls are also usually of silver or other cheaper materials like bronze or perhaps lead. Some of the sword mounts, however, also tend to be polychromatic, as when, for instance, the central feature is inlaid with a white substance, often mother-of-pearl (cf. 1:4).

The specially-cut shapes provide many problems in that they suggest a fairly well-established contact between the central and the satellite workshops. The standardization of objects such as the purse mounts is, however, remarkable: compare, for instance, the mounts from *Planig,* and other Frankish graves (Kessler 1940, pl.12) where the designs are composed of almost identical shapes. Similarly there are a number of bird beaks on objects from *Apahida II* which are cut like the one from *Beregszász*.

The presence of more or less individually cut garnets in the shape of bird beaks and parts of animal heads could be seen as evidence against the thesis put forward above, that all the garnets came from *one* central workshop. The most important criterion for a central workshop was the widespread occurrence of b-stepped garnets and related forms in both Germanic and Byzantine cultural areas. The evidence suggests that the garnets which were individually cut for animal ornament are centred in the Germanic material. This could indicate that there was a Germanic workshop which produced different shapes from those in Byzantine finds. One find, however, suggests that such shapes also occur in Byzantine art: a diptych from *Milan* (cf. fig. 126). includes an Agnus Dei in cloisonné which on visual inspection can be identified as made with cement technique (technical analysis could not be carried out on this object). The lamb is composed of three-sided cells with s-shaped outlines, which give a very good impression of the lamb's wool. The muzzle is made from a large garnet plate of similar shape to those used for the birds' heads at *Apahida,* for instance (fig. 129). With the addition of the pointed ears, however, this produces a good likeness of a lamb's head. The central workshop which produced the birds' heads could therefore also produce other animal figures. It is noteworthy that the Agnus Dei was mounted on the diptych as a complete design, because it overlaps the surrounding ivory frame in some places. This is not to say that this design is secondary to the diptych, as it occupies an empty central field which must have been reserved for some significant ornament.

Volbach dates the diptych to the second half of the fifth century and compares the garnet inlays with those on the so-called Theodoric mounts. Vierck (1972, 213 ff.) has established that these mounts are part of a saddle of the same type as that from *Krefeld-Gellep* (Kre 4), which is dated to the second quarter of the sixth century. The Theodoric mounts are made using quite a different technique from the Agnus Dei, and the small size of the garnets on these mounts demonstrates that they are of a considerably later date. The halo of the Agnus Dei contains small garnets, but most stones are almost twice as large as the garnets on the Theodoric mounts.

The only reason for associating the *Milan* diptych and the Theodoric mounts is that they were found in the same part of the country. Considering the large number of objects with cloisonné which have been found in Italy, this argument can have no relevance.

The Agnus Dei is, however, closely associated with other examples of cement cloisonné, and is probably a Byzantine product from the central workshop which has been described here. Another feature of the Agnus Dei supports this attribution: the characteristic combination of domed garnets (on the body) and flat garnets (on the head), which is typical of more expensive work using

Fig. 132

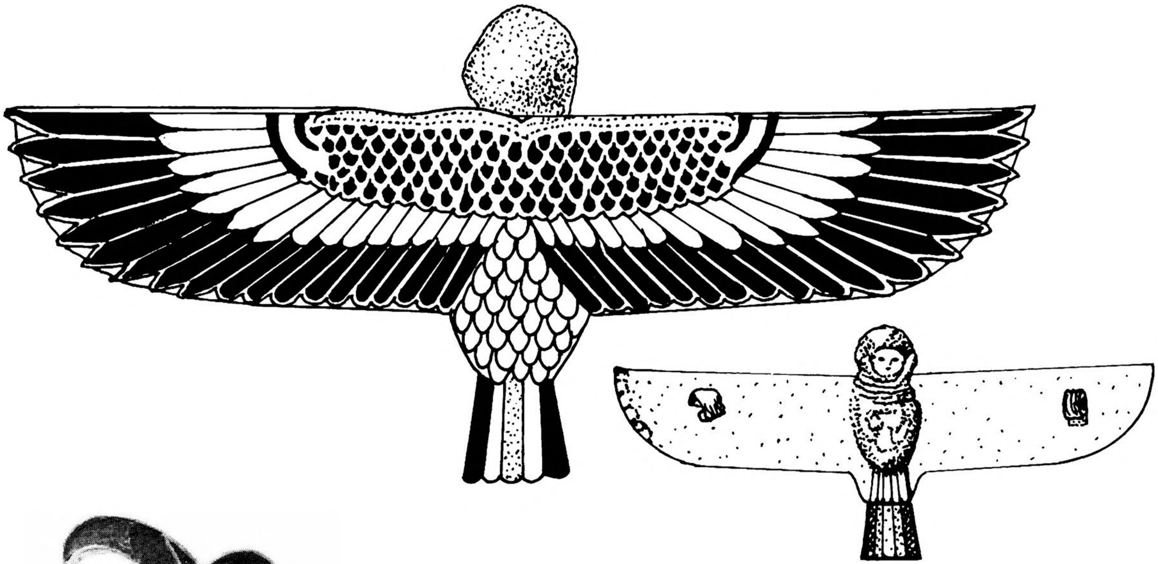


Fig. 133

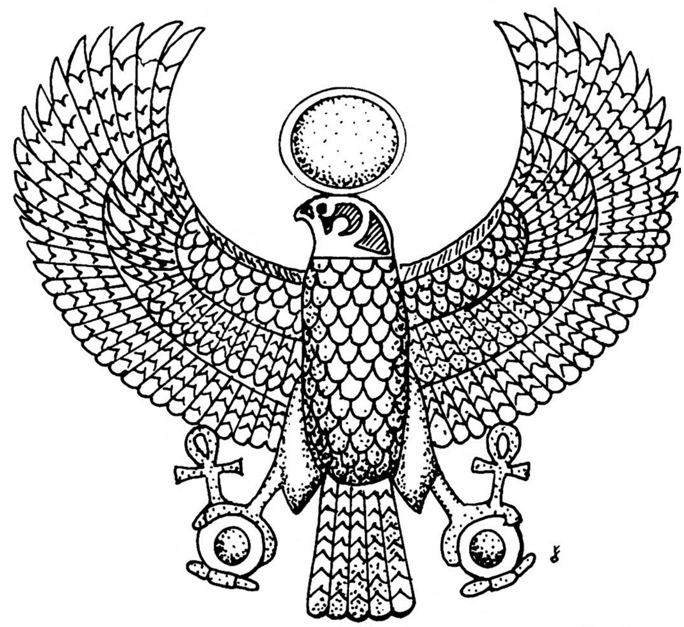


Fig. 134

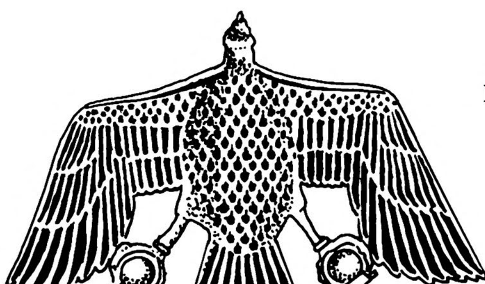


Fig. 135

Fig. 132–135. Bird motifs.
132, 134, 135) Egyptian bird motifs in cloisonné. After Edwards (1972); not to scale. 133) Saddle-mount in the shape of a bird from Apahida II, not to scale.

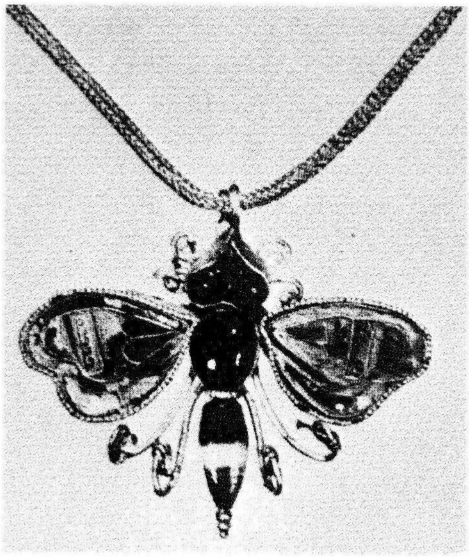


Fig. 136. Flying insect from Chersones. 1:1.

Fig. 137. Flying insect in garnet intaglio; no provenance. 1:1.

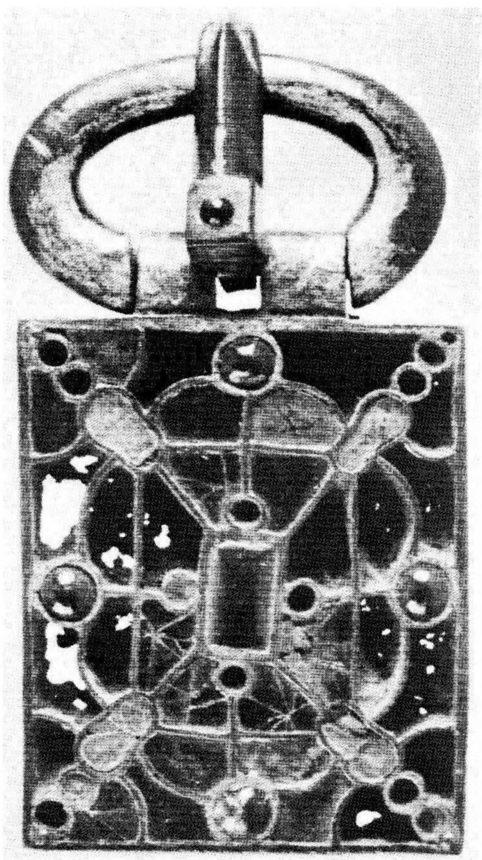


Fig. 138. Flying insect in cloisonné on a buckle from Dep. Herault, France. 1:1.

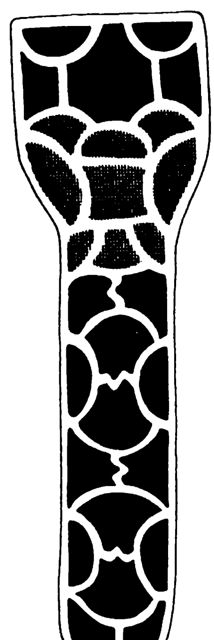


Fig. 139. Flying insect pattern on a strap-end from the Cologne Cathedral grave (Köln 5). 2:1.

cement cloisonné, as for instance in the finds from *Tournai* and *Apahida.*

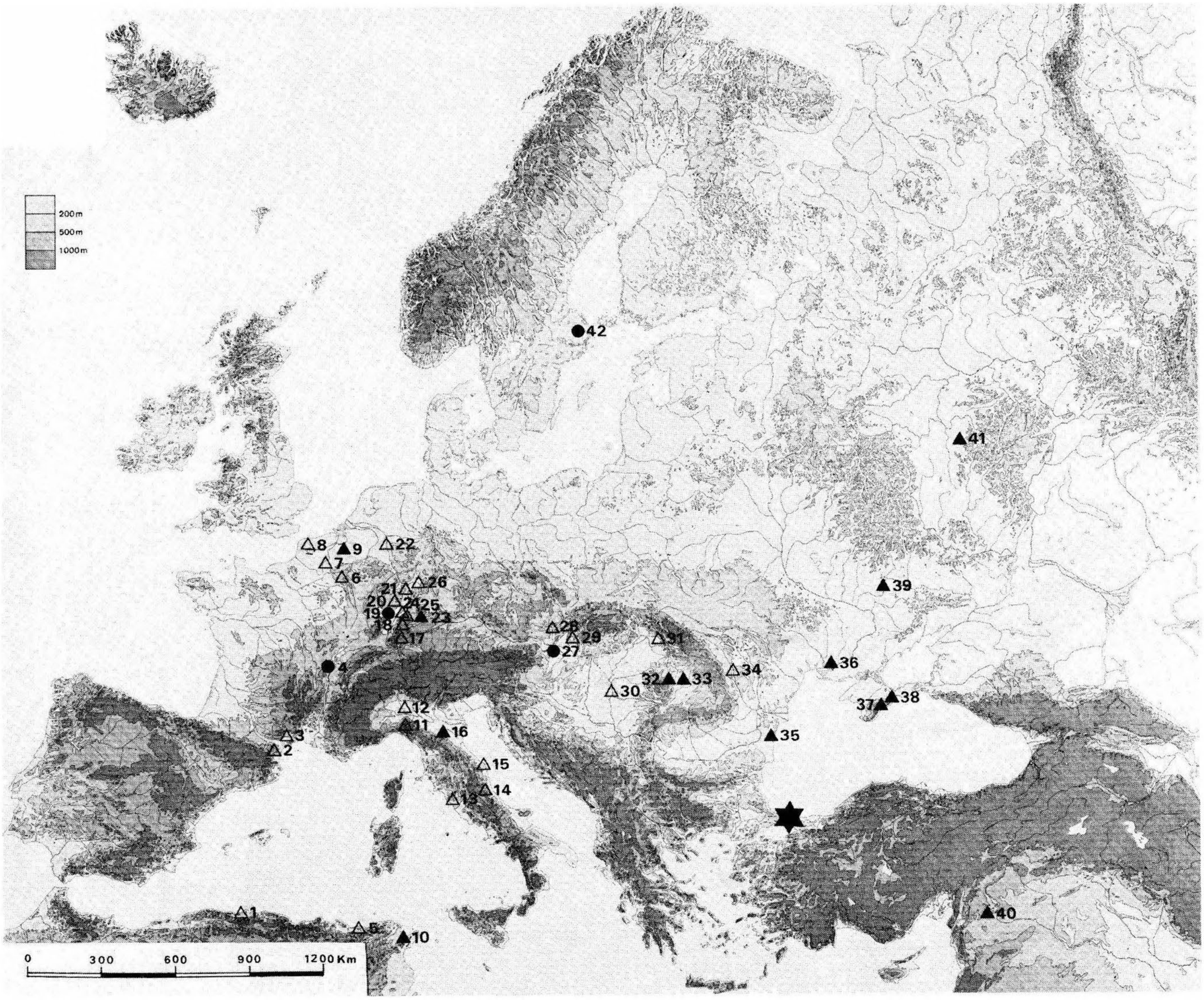
I would suggest that it is generally likely that the Byzantine animal representations in garnet cloisonné had some relevance to the development of Germanic animal ornament. In particular, the bird designs which often occur in Germanic animal ornament could be influenced by similar designs in the considerably older Mediterranean cloisonné art. Haseloff (1981) has most recently convincingly established that the late Roman chip-carved bronzes were an important source of inspiration in the development of Germanic animal ornament in Salin's style I. While chip-carved bronzes display numerous examples of four-legged animals, masks and dolphins, which could have served as prototypes for equivalent motifs in Germanic animal ornament, there are no examples of the bird motifs which occur so frequently. Like earlier scholars, Haseloff looked for the bird motifs in material from the Danube area (1981, 334 ff.). Werner (1963, 356 ff.) maintains that the motif with two bird-of-prey heads flanking an animal head was introduced by the Goths, and the large so-called eagle brooches are usually associated with the West and East Goths. In my opinion these bird motifs are not particularly associated with the Goths but are among *the oriental motifs which are disseminated from the Black Sea to Western Europe, perhaps principally through cloisonné art.* Bird designs of this type are found in oriental cloisonné art, particularly from Egypt. Among the Egyptian cloisonné work there are, for instance, necklaces with terminate in paired falcons' heads. Closer parallels still are the representations of birds on Egyptian pectorals and the large Gothic eagle brooches, (fig. 133–135). The great difference in age between these objects is considerably diminished if we realize that the same bird designs which were produced in Tutankhamon's time continued in use well into the Hellenistic period. The falcon, swallow, peacock and eagle were believed to carry the souls of the dead (cf. Edwards 1972, no. 10), and the so-called ba-bird pendant—a falcon with a human head—was very common in the Hellenistic period (cf. fig. 132). Vultures were also important in Egyptian mythology and were represented on many cloisonné pectorals. These representations could serve as prototypes for the so-called ibis brooches from *Petroassa* (cf. fig. 34), with their jointed necks and rounded bellies. Such motifs were introduced into Christian art in the Hellenistic period, and similar birds occur, for instance, as handles on the chalice from *Gourdon* (fig. 67). It is likely that early Christian representations of angels also were based on concepts of this kind (cf. ba-bird pendant fig. 132). In the Hellenistic world which confronted the Germanic peoples in the Black Sea area there were therefore a number of designs focussed on birds which were adopted by Germanic art, probably particularly through cloisonné art. The earliest of these birds' heads are probably those in Sarmatian art where, for instance, they occur at the ends of diadems with garnet inlays (cf. Werner 1956, 61 ff.). The scabbard mount on the sword from *Pokrovsk-Voschod* has a bird's head at each end (fig. 55).

If is clear, therefore, that bird motifs are not exclusively associated with cement technique, and that they existed much earlier. The design composed of a-stepped garnets found in a cremation burial from *Husby Långhundra* was probably a bird design (to be published by B. Almgren *et al.*) and there are, as previously mentioned, bird-brooches in clasped cloisonné from *Petroassa.* Bird designs are, however, very common in cement technique and further emphasize the strong eastern element in this technique.

The so called cikadas, which are better named flying insects as they represent bees or other insects, are also common in objects using cement tecnique. Like the birds they have a long history in Oriental art as a symbol (cf. Deonna 1956). In Hellenic art we find the insects engraved on a garnet gem, for instance (fig. 137). It is also the motif of a pendant in enamel cloisonné from a grave in *Chersones* in the *Crimea* (fig. 136). The body of the insect on this pendant is made up of two circular agates which together almost form the shape of an hour-glass. This shape, in garnet and glass flux, occurs on a buckle from *Tressan*, Hérault, France, as part of a design in cloisonné which probably represents insects with their wings inlaid in garnet (cf. fig. 138). More or less similar patterns occur on the rectangular buckles described by Götze (cf. 1907, nos. 40–45). In some cases the pear-shaped body alone is an element in the design, in others the wings (Götze 1907, nos. 42 and 45). Werner (1958) lists a number of objects where the insect designs form part of the cloisonné inlay, including the strap-ends from the *Cologne* Cathedral grave, (fig. 139) a buckle from *Le Sart* etc. Finally insects mounts were found in Childeric's grave and considered by Böhner to belong to the horse trappings (cf. Böhner 1981).

The bird and insect designs are typical examples of originally oriental motifs which were often cut on intaglio and gems. They were adopted in cloisonné art; using a- and b-stepped garnets and the cement technique, these designs were transferred from south-east Europe to the Germanic peoples in Central and Western Europe.

Floral motifs occur in cement cloisonné in the shape of quatrefoil, acanthus, lotus and palmette. These designs are often inlaid in coloured glass flux, mother-of-pearl or




✶ ▲ = Central workshop in Constantinople and works in cement cloisonné deriving from this workshop.

△ = works in cement cloisonné from satellite workshops.

● = works with a-stepped garnets mounted in clasped cloisonné.

*Distribution map I.*

The map shows distribution of cloisonné jewellery in cement technique and clasped technique from the central workshop in Constantinople and its satellite workshops. The distribution is however not complete as there is, for example, most probably a West Gothic satellite workshop (cf. Köln 1, 2, 3) with a distribution in Spain, which has not been exemplified. The distribution only includes cloisonné work dated to the 5th century and the first decades of the 6th century.

The following finds have been listed: 1) Alger (Paris 9/B), 2) Aude (Köln 3), 3) Tressan (Paris 12/Bu), 4) Gourdon (Paris 11/Bo), 5) Bone (Bm 3), 6) Lavoye, Gr 319 (Paris 16), 7) Monceau-le-Neuf, Aisne (Köln 40), 8) Maroeuil (Br 3), 9) Tournai (Paris 1–8), 10) Carthage (only G) (fig. 104), 11) Pavia (Bierbrauer 1975, nr 21), 12) Tortona (Bierbrauer 1975, nr. 35), 13) Via Flaminia, Rome (Rom 4), 14) Nocera Umbra, Gr 1 (Rom 5), 15) Acquasanta (Bierbrauer 1975, no. 3), 16) Reggio Emilia (Bierbrauer 1975, no. 25), 17) Schwenningen (Stutt 1–2), 18) Gültingen (Stut 8), 19) Wolfsheim (Wiesb 2–5), 20) Altlussheim (Karl 1), 21) Eich (Worms 3), 22) Cologne, Severinsstrasse (Köln 41), 23) Rüdern (Stut 9), 24) Möglingen-Heilbronn (Stutt 14), 25) Stammheim-Stuttgart (Stut 21), 26) Planig (Mainz 2), 27) Vienna (Wien 1), 28) Blûcina (Brno 1–4), 29) Baumgarten (Wien 2), 30) Szeged-Nagyszéksós (Szeg 1), 31) Beregzasz (Bud 34), 32) Apahida I (Cluj 24), 33) Apahida II (Cluj 1–23), 34) Concesti (Eri 10), 35) Olbia (Wash 1–2), 36) Varna (Roth 1979, plate 25 a), 37) Kerch 1904 (Eri 8–9), 38) Kerch (Werner 1956, fig. 2:3), 39) Paternus-bowl (Werner 1984, pl. 1), 40) Reastan (BM 1), 41) Pokrovsk Voschod (fig. 55), 42) Husby-Långhundra (cf. p. 118).

white substances such as ivory (cf. 1:4), lapis lazuli, green malachite or turquoise. Böhner (1948, 238) maintains that objects from the Rhineland are less polychromatic than those from South Russia. This holds true if the objects compared include work using the older clasped cloisonné technique as well as the cement technique (as was the case in Böhner's study). This is because the clasped cloisonné is generally more polychromatic than cloisonné using cement technique. A comparison between objects using cement technique only reveals no signficant difference in this respect between objects from the Rhineland and South-East Europe. The coloured or white inlays are not used here to create a polychromatic effect, but serve to enhance the red colour of the garnets. The reason why the floral motifs were chosen for inlay in coloured blue, green or yellowish-white glass flux was the higher degree of definition of shapes thus achieved. The choice between glass flux and semi-precious stones appears to have depended on the customer's resources. Sardonyx was particularly expensive.

We have already seen that behind all garnets mounted by cement technique is gold foil, usually impressed with a fine waffle pattern (1:5). On a few objects the foil is decorated with a stamped ring pattern. It is clear that this foil developed from the circles which were commonly engraved on garnets and filled with gold or enamel in clasped cloisonné work. Garnets decorated in this way continue to be used in cement cloisonné work, but become much less common. The ring-patterned foil would have been seen as a substitute for the engraved rings, and could give a superficially similar impression. It appears that the ring-patterned foil originated in the central workshop, as it occurs on two objects mounted with real gypsum: the cloisonné-decorated objects from *Olbia* (fig. 63–64) and a large rectangular buckle of Götze's type A, possibly found in Italy (fig. 61) (BM7). The ring-patterned foil also occurs on objects with simpler cement, such as the disc brooches from *Baumgarten* (Wien 2) or Algeria (BM3). This type of foil also occurs on objects made using the sand putty technique (cf. chapter 5).

## 4:3 The central workshop for cement technique: chorology and chronology

The object's discussed in this section were produced, in whole or in part, in what I have termed a central workshop. This has been hypothetically located in *Constantinople,* because the distribution of the products reaches from South Russia in the east to Syria and North Africa in the south and Spain and the Rhineland in the west (cf. distribution map I). No place other than *Constantinople* traded over such a wide area during this period.

Most scholars working in this field have presumed that there were a large number of different workshops, each cutting the almandines they needed for cloisonné work. It has been shown that the production of stones for inlay is complicated, demanding considerable knowledge of gem-cutting techniques and probably also access to mechanical devices, probably powered by water and with transmission, to achieve the necessary speed for the cutting wheels. *Constantinople* was one of the few cities accessible to the Germanic peoples where this technique, developed in the late Classical period, was still practised. Access to almandines of the particular quality described in chapter 1 was also necessary. *Constantinople* was also favourably situated in this respect, as the type of garnet described in chapter 1 as type 3 probably came from the Black Sea area. These garnets are the equivalent of those described by Pliny as *albandicus,* that is the type of garnet which was cut in *Alabanda,* but which came from *Orthosia* in Asia Minor. It is possible that work with garnets was transferred to *Constantinople* as a direct result of the Sassanian conquest of *Iberia* and *Armenia* around 370. Finds from *Armazis-Khevi* (Apakidze 1958) (cf. also Lang 1966, 91 ff.) demonstrate that there was a flourishing garnet art in south-east *Georgia* in the third and fourth centuries, closely associated with that of the *Crimea.* In both areas, clasped cloisonné and relief-cut garnets predominate. With the transfer to *Constantinopel* it is the flat garnets which predominate, and garnet cloisonné becomes a part of Byzantine mosaic art.

Unfortunately, no material for mineralogical analysis of b-stepped garnets has been obtained. Some analyses of e-stepped garnets, however, show that they belong to the same group as the garnet jewels from the *Crimea* (cf. 1:3). These garnets have only one or two of the slightly curved steps typical of b-stepped garnets, and I have interpreted them as late products of the same Byzantine workshop. Other than on Scandinavian button-on-bow brooches, e-stepped garnets occur on a cloisonné-decorated object from *St Denis,* which Vierck (1974) believes was part of a cross made by Eligius. This fragment has a design of roundels made up from e-stepped garnets (cf. fig. 74); alternating with the garnets are borders of blue and green glass flux, in a sequence of plant motifs and arcading. Vierck's suggestion that this fragment is a work by Eligius is very likely, as a date in the first half of the seventh century accords well with the date of the button-on-bow brooches from Gotland which have the same type of e-stepped garnets (cf. chapter 5).

The likelihood that e- and b-stepped garnets came from the same workshop is strengthened not only by the cutting technique needed for both types, that is a convex cutting wheel which produced round indentations, but also by the gypsum cement which is associated with such garnets. This is the case with a retangular mount from *Gilton* in Kent, (fig. 75), which has garnets of this type set with cement technique as a border round a rectangular panel decorated with loosely-coiled ribbons of filigree. Several aspects of this mount are peculiar: rectangular mounts of this type which occur in association with Salin's style II are not common in Anglo-Saxon England. Its closest parallels are the cloisonné-decorated mounts from *Sutton Hoo*. Cement cloisonné is generally not common in England; the *Gilton* mount is to my knowledge the only example using this technique. There are a few examples of garnet shapes commonly associated with this technique, such as the omega-shaped garnets on a brooch from grave 44 at *Lymminge* (Maid 1), but such shapes are usually set with the sand putty technique or as clasped cloisonné. The omega-shaped cells in the panel on the Lymminge brooch are backed by plain foil, unlike other inlays on this brooch; thus the panel may have been taken from another object which was perhaps mounted in cement cloisonné. The stepped garnets on the *Gilton* mount belong to a period when gypsum was available in the Merovingian kingdom (cf. 101) and it is therefore not necessary to postulate that it came from the central workshop. But the use of this technique together with these particular garnets suggests that close contacts still existed between central and satellite workshops in this period. In this respect, the filigree ornament of the mount is also relevant in that arhythmic filigree coils of this type are unusual in Anglo-Saxon jewellery, but typical of the bossed disc brooches found in the Merovingian kingdom (cf. Rademacher 1940).

E-stepped garnets of the seventh century must therefore be considered as among the latest products of the central workshop; the date when production ceased will be discussed below. The earliest examples of the cement technique apparently arrived in Central Europe at about the same time as the Huns. This seems at least to be indicated by the presence of cement cloisonné in the find from *Szeged-Nagyszéksós* which included a possible strap-end with b-stepped garnets, but without any preserved paste (fig. 110) and a round buckle (fig. 111) with heulandite paste, indicating that it was mounted in a satellite workshop. The same find contained numerous mounts using clasped cloisonné (cf. Fettich 1953, pl. 1–2). An interesting feature of these mounts is that several garnets were cut. Analysis of the stones revealed that these simple triangular or irregularly shaped garnets belonged to type 2, which we presumed came from Central Europe, perhaps from lower Austria (1:3). In this area, therefore, b-stepped garnets were imported while, at the same time, there was a local production of simpler cut garnets. Analysis of the garnets in the hoard from *Szilágy Somlyó* indicates that this simpler production may have begun at about the same time as the production of cut garnets from *Constantinople.* Six analyses carried out on material from *Szilágy Somlyó*—two of which came from the same brooch—established that the garnets on the bow brooches were of type 2. These were all cut to simple shapes, but some were engraved and had central perforations; they were thick, varying in thickness between 1.5 and 2 mm, often domed and sometimes with traces of keels.

One of the analysed garnets was of type 3, that is from the Black Sea area (cf. 1:3). This type of garnet occurs on the round brooches with lion figures (cf. fig. 6). The garnets are all rectangular or triangular in shape but were not produced by cutting but by grooving and breaking. There is also one kidney-shaped rock crystal fitted into the cloisonné. The garnets were quite flat, their thickness varying between 0.9 and 1.1 mm. Under the microscope they are seen to have the so-called feather polish (cf. 2:10). The garnets are mounted with a typically early technique with charcoal backing (cf. chapter 3). The attribution of the garnets on the round brooches from *Szilágy Somlyó* to the Black Sea area supports the opinion of previous scholars as to their provenance: Fettich (1932,65), for instance, maintains that the animal motifs are taken from the art of the Black Sea area.

The fact that these garnets were shaped by grooving and breaking—as was the case with the garnets from the *Crimea,* for instance (cf. 2:7)—and not by cutting may be an indication that the use of garnets in the area to the north of the Black Sea never became more technologically developed. However, most type 2 garnets are cut. We have seen that cut garnets first appear in settings of an early type, as in the *Petroassa* find, for instance, where the palmettes and the acanthus leaves on the collar must have been cut (cf. fig. 91). The motifs are Classical and are seen, for instance, in enamel on bracelets from *Armazis-Khevi* (cf. 2:8). There is, however, no evidence of shaped garnets of this type in the flourishing garnet art which is reflected in the finds from *Armazis-Khevi* and other localities in Georgia (cf. Apakidze 1958, Lekvinadze 1975), nor is there any evidence of cut garnet-plates in the Sassanian gem art.

One can envisage a hypothetical sequence of events where the conquest of south-east Georgia by the Sassa-

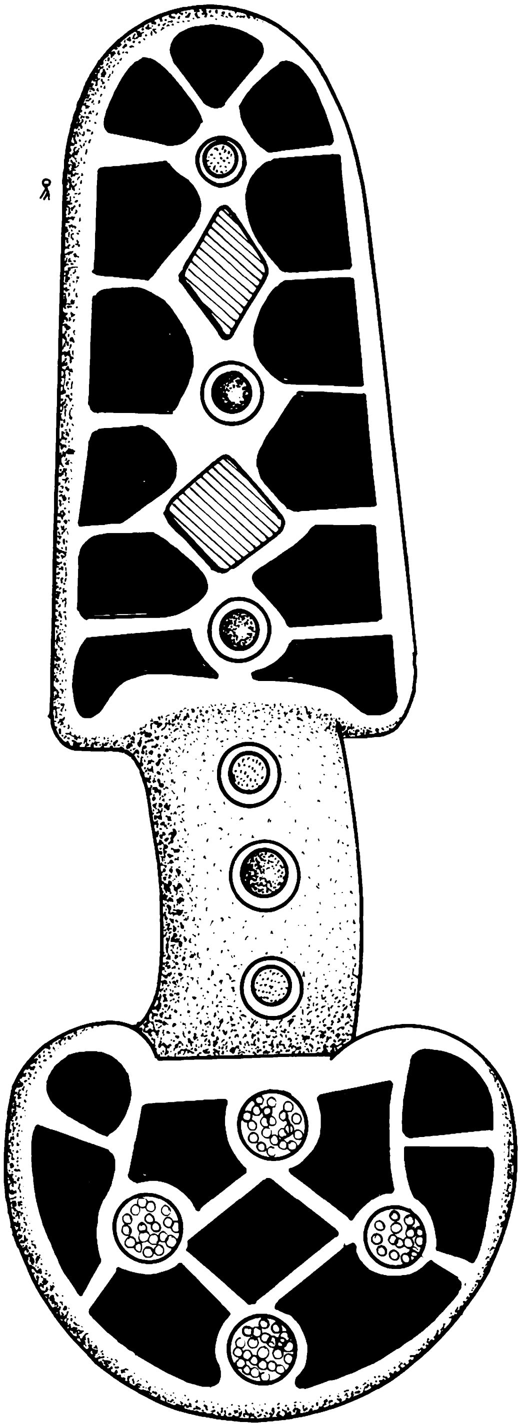


Fig. 140. Bronze brooch with garnet cloisonné and white and green inlays from Maroeuil, Belgium. (Br 3). 2:1.

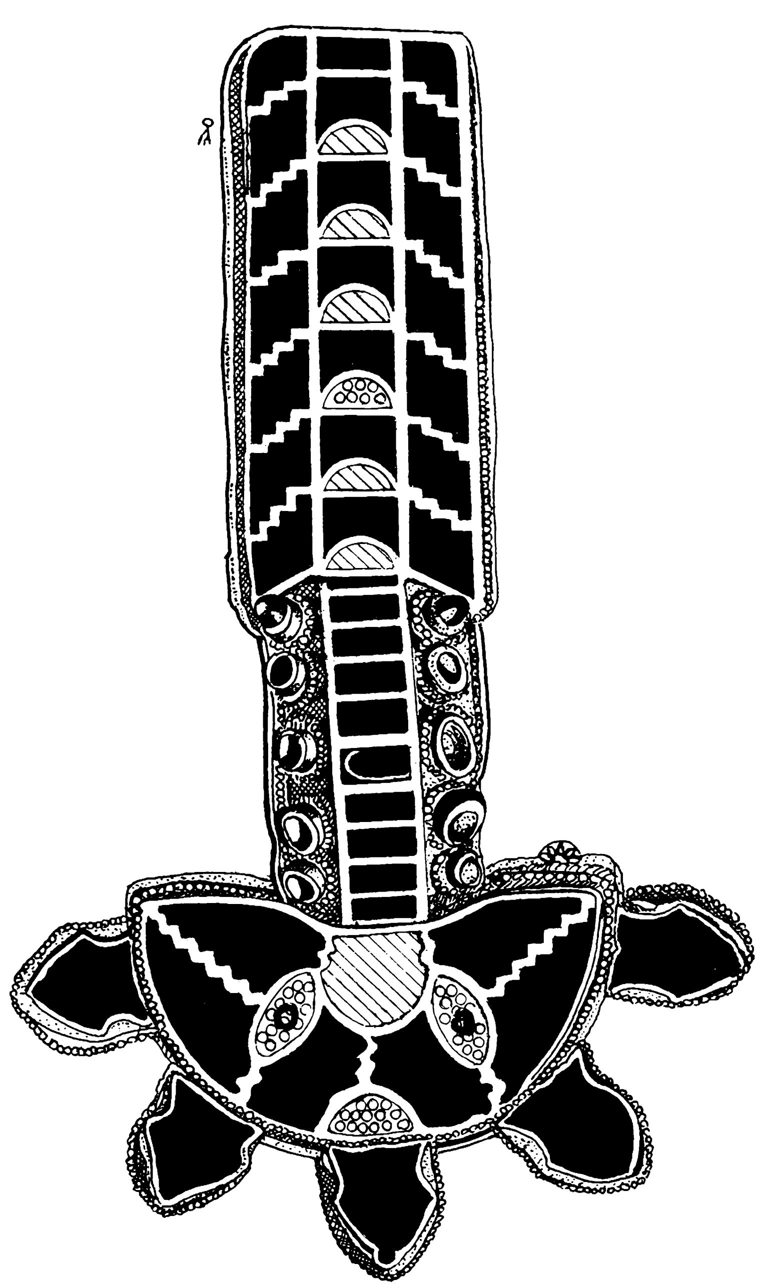


Fig. 141. Brooch of silver with gold cloisonné set with garnets and green and white inlays; no provenance. After von Hessen (1981) 2:1.

nians and the invasion of South Russia, including the *Crimea,* by the Huns in the last quarter of the fourth century resulted in the unemployed gem-cutters from these areas moving to the large cities, not only to *Constantinople* but to cities like *Tomi* and *Aquincum* in the Danube area, and creating new centres in these places. Their customers were the new rulers, the Huns and the Germanic peoples. The greater distances to the sources of raw material in Asia Minor would necessitate a more economical use of the material, resulting in the development of machine-cutting techniques, also used for cutting mosaic stones (cf. fig. 45 and 2:8). While the machine-cutting technique spread to other centres, the development of stepped shapes was apparently limited to the central workshop in *Constantinople.* It is possible that the stepped patterns reflect a stronger influence from mosaic art, particularly in the use of composite templets such as the a. St- and b. St templets. As these templets occur on the same objects they must be at least fairly contemporaneous (cf. 70). With the increased influence from mosaics, cement was introduced and the type of cloisonné which covers the surface entirely was created. The development of this sort of cloisonné took place, for instance, in *Constantinople* at the same time as local garnet deposits of type 2 quality began to be exploited in the Danube area. Type 2 garnets were, however, at first mainly used in single settings or in simple early clasped cloisonné. Composite templets were never used with garnets of type 2 quality and shapes for use with the cement technique were acquired from the central workshop. As the cement technique spread to satellite workshops a number of local mixtures developed. This sequence of events would have been completed in the period from the end of the fourth to before the middle of the fifth century, by which time satellite workshops were probably fully developed. The effort expended in the early satellite workshops in an attempt to find a substitute for gypsum is demonstrated by the rather rare minerals used, such as heulandite (calcium aluminium silicate) and aragonite. Calcite gradually became the most popular material for cement, at first hardened with oxalic acid; it is possible that linseed oil was later used as a hardener (cf. 3:3c). The satellite workshops seem to have operated already by the middle of the fifth century.

The sword from *Altlussheim* (fig. 107) is probably an early product of a satellite workshop. I believe this sword to be one of the first products of a Rhenish workshop which later produced the gold-hilted spathae of Böhner's type II. This workshop (which used aragonite as cement) seems to have been contemporary with Childeric and it continued for a further generation, producing the sword from *Planig* as one of its latest products.

During this period certain changes can also be traced in the central workshop. In the earliest finds, step patterns occur mainly on complete motifs like rhomboids or half-rhomboids, while they were later added to a number of geometrical shapes. This can be observed in the find from Childeric's grave. The omega shape is introduced at about the same time (cf. diagram fig. 120) and in time this shape became more common than the step-patterns. The find from *Apahida II* is a good early example of this development, which reached its apogee with the buckle fig. 61 (BM7) and the grave find from *Schwenningen* (Stutt 1–2). These finds date to the early Merovingian period, and it is at this time that the gold-hilted spathae of Böhner's type II were produced. Other types of cloisonné are also represented in these finds, such as the purse mount. Repeat patterns are generally typical of the cement technique during this period, and shapes developed gradually from those already employed in clasped cloisonné. These include the heart and fish-scale shapes seen, for instance, on the *Altlussheim* sword, the Agnus Dei from the *Milan* diptych and the fish-brooches from *Bülach* (fig. 128, cf. Werner 1953a). The S-curves, the chevron and Ph-shapes are all found on the purse mounts as well as on some of the large eagle-brooches and bow brooches (fig. 140–141).

The bird motif which is a characteristic element in cement technique has been discussed above. We have also established the presence of other animal motifs: lamb, fish etc. The cross is another very important motif which recurs throughout the whole period and was presumably responsible for the development of the stepped rhomboid motifs and the composite rosette motifs. As the stepped patterns went out of fashion, cross designs became more clearly-defined. This is most obvious on Christian objects from the central workshop, like the pendant from *Olbia* and the hoard from *Varna* (Arrhenius in Roth 1979, 124). This hoard, with its pendant cross and buckle mounts, provides typical examples of the objects which were produced by the central workshop in the early Merovingian period in about 500 (cf. Roth 1979, fig. 256). The objects decorated with cloisonné were here found along with several Byzantine jewels (cf. Venedikov 1966).

After this period contact between the Frankish goldsmiths' workshops and the central workshop is lost; and the contacts between Western Europe and Byzantine *Ravenna* now become more clearly marked (cf. chapter 6:1).

It is likely that the central workshop continued with a production which can be traced in Eastern material, particularly in Pannonia and Italy, in jewellery which Bierbrauer (1975, 85ff.) has assigned typologically to the East Goths. It appears that the East Goths mainly acquired their garnets from the central workshop in *Constantinople.* In some cases, such as the buckle mentioned above (fig. 61), the whole cloisonné design, which is mounted with gypsum cement and has ring-patterned foil, was produced in the central workshop and subsequently riveted to its foundation. In other cases, and apparently more commonly, a *thick layer* of wax was used instead of cement. Cloisonné panels would perhaps be bought unmounted, and covered on the underside with a thin layer of wax; this was the form in which they were usually provided when they were to be mounted using the cement technique, and a hard layer of gypsum was applied to the back. If this cement was replaced by wax, which is soft and susceptible to heat, it was necessary to place the panel in a tray with thick walls, often made of bronze or silver. The cell walls thus form a lattice-work which is attached to the tray only by its outside edges. Examples of this technique are the buckle from *Nagydorog* (Szek 1), the bit mount without provenance in *Budapest* (Bud 12) (fig. 103) and the eagle-brooches from *Rome,* fig. 60 (Rom 4). This technique was probably more common than I have been able to demonstrate by analysis, because the enclosing tray did not allow me to sample the cement, except where the objects were damaged. The technique is most useful for heavier objects and also tends to make the cloisonné look a little clumsy. It was succcessfully used on small, detached panels, however, as on the buckle without provenance (Budapest 11) which is closely paralleled in the East Gothic find from *Torre del Mangano* (Bierbrauer 1975, 137ff.).

This type of cloisonné was not only associated with the East Goths, but was more generally distributed in southeastern Europe, as is demonstrated, for instance, by the buckle from the Black Sea area (fig. 87–88). It is possible that the wax technique represents a simpler method which was distributed at the same time as the more durable cement technique. The connection between the two methods is apparent not only because the garnet shapes are the same but also because they both disappear towards the middle of the sixth century, when the Frankish sand putty technique, the Byzantine fused paste technique and the new garnet shapes become current among the Germanic peoples.

There seems, however, to have been a continuous export of garnets, for instance to the Anglo-Saxons. Although insufficient analyses are as yet available, there are some indications that this was the case (cf. 1:3). The T-shaped garnets on Kentish disc brooches of classes 5 and 6 (Avent 1975, 34–5) are closely paralleled in a find from *Carthage* (Haevernich 1975), where this shape occurs along with several other garnets of shapes very typical of those used in cement technique (cf. fig. 104). The large size and the rounded cutting of the stones are further reasons why I consider them to have been imported from the central workshop. While most Anglo-Saxon cloisonné took its material and patterns from Frankish garnet art, there are occasional large garnet plates which are probably oriental imports. This feature will be discussed further below (chapter 6).

## 4:4. Summary

The following statements can be made about the central workshops and the satellite workshops which produced cloisonné work using the cement technique. There was an earlier phase when objects of this type occurred along with objects using the older clasped cloisonné technique. The repeat patterns of the cloisonné were similar to those in mosaic. At first, stepped shapes were particularly popular, but heart and fish-scale shapes or S-curves were also used.

There was some animal ornament, mainly in the form of birds' heads, but four-legged animals were also portrayed. Plant ornaments like palmette and acanthus occurred, often inlaid in coloured glass flux. Domed garnets took the form of rivet-heads or larger cabochon stones. Relief-cut stones were occasionally fitted into the patterns. In the central workshop, probably situated in *Constantinople,* gypsum was used as cement, while in the satellite workshops gypsum was replaced by other minerals which were hardened to a firm, strong texture. There were satellite workshops in Central Europe, in the Balkans, South Russia, the Rhineland, South Germany and North Africa. Closely-patterned gold and silver foil predominated, but plain foil was also used. The material consists of Christian cult objects (the paten from *Gourdon,* the *Milan* diptych), parts of swords and seaxes, mounts from men's belts, and purse and bit mounts. There is no women's jewellery.

This phase can apparently be situated between the beginning of the fifth century and Childeric's generation, and it can be said that the Childeric and *Apahida* finds represent the end of this phase and the beginning of the next. This next phase begins around 475 and is characterised by the stepped rhomboid shapes becoming rarer and being confined to the centre of the designs. The new filling patterns, the omega-shaped cell ladders together with S-curves and triangular forms, almost take over

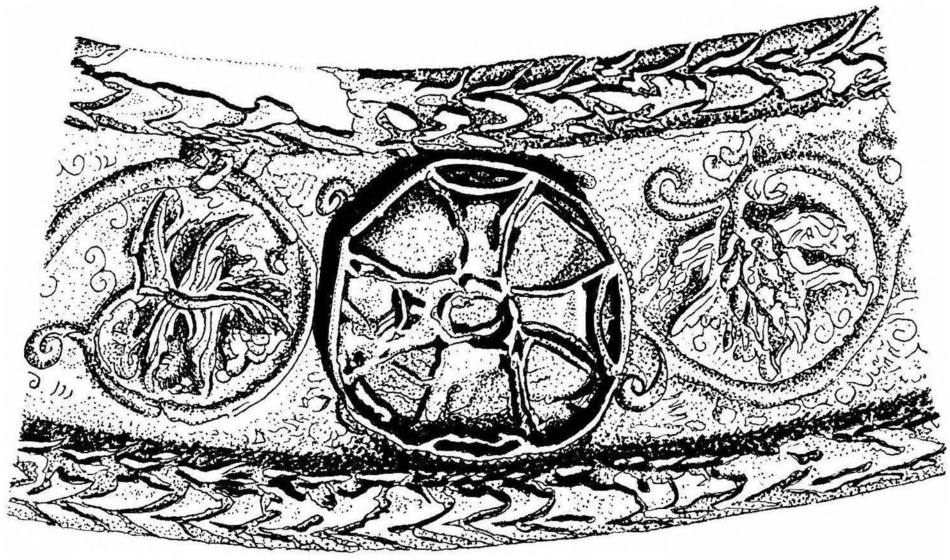


Fig. 142. Drawing of the cloisonné ornament on the Paternus bowl. 1:1.

from the stepped shapes. Apart from the closely-patterned foil, there is now also foil with ring-patterns. As before, the material consists of mounts from weapons, belts and bits, but *women's jewellery now provides new types* like disc brooches, large bow-brooches and eagle brooches. Finds from Syria, Algeria and Spain extend the area from which the material comes.

In the Frankish area this phase finishes in the early Merovingian period (AM1, cf. Ament 1977), that is 520, but the East Goths continue to use the cement technique a little longer. With the East Goths, and also in south-east Europe, a simpler version of this technique occurs: instead of cement, the cloisonné panel is filled with wax and set in a tray of bronze or silver. From the middle of the sixth century, this type of cloisonné also disappears, and only rarely is contact with the central workshop apparent in the Germanic area.

The central workshop for the production of cement cloisonné appears to have reached its apogee in the period between 400 and 525, when the garnet-cutting workshop in *Constantinople* excelled in a rich repertoire of garnet shapes which were distributed to satellite workshops up to 2500 kilometres away in South Russia, Central Europe, Western Europe and North Africa. After this period production continued, but served only a smaller, mainly Byzantine sphere, exemplified by the strap mounts from *Kerch* in the *Crimea* (fig. 217), which are remarkable not least because they are decorated with a cable twist design in cloisonné. There are parallels to this design on mounts from *Sutton Hoo* and on the brooch from *Desana* (fig. 194).

The Byzantine mounts from *Kerch* have been given various dates: Fettich (1951) believs that they are late Hunnish, while Ambroz (1971,373), for instance, assigns them to the seventh century. Considering the omega-shaped cell ladder patterns and the S-curves in the design, both of which are somewhat degenerate, I suggest that a date at the end of the sixth century is more likely. They certainly represent the last high-quality objects from the central workshop so far encountered.

The continued activities of this workshop cannot be traced directly through Byzantine finds, but they are reflected in the outlying Byzantine area represented by the Christian church of late Merovingian France. Vierck (1974) has correctly emphasised the importance of the connections between *Byzantium* and the late Merovingian kingdom, particularly well exemplified by Eligius' activities. It is in the late Merovingian period that the gypsum deposits in the Paris basin begin to be exploited, which may also have resulted from the more frequent contacts with *Byzantium.*

The cloisonné designs on late Merovingian Christian objects were mainly made up of e-stepped garnet shapes, set in a fused paste technique which will be discussed in more detail below (chapter 6).

In conclusion it may be of interest to establish whether there is any direct evidence in the sources that cloisonné was in fact produced in *Constantinople.* It is well known that ivory was worked there on a large scale (Vollbach 1916, Delbrüeck 1929). There are finds of enamel, including pendants which, because of their inlays (as for instance a medallion of the Empress Faustina) can be located to *Constantinople.* But the material from this period is very sparse, perhaps because there was a continual production which, in accordance with the thesis formulated above, that there is an accumulation of archaeological artefacts where there are insufficient techniques to allow secondary use, produced the opposite effect; that is, in *Constantinople* older material was continually re-used in new production.

It is particularly difficult to establish with absolute certainty the production of goldsmith's work in fourth- and fifth-century *Constantinople* (Lafontaine-Dosogne 1979,103). From the written sources we know that production was considerable. The sources reveal that Constantine the Great favoured the goldsmiths in many ways—with exemption from taxes, for instance—and that their work consisted largely of direct Imperial commissions. From the end of the fifth century it becomes easier to identify finds from *Constantinople,* particularly because the Emperor imposed controls on the silver content, and vessels had to be stamped. Of the stamped vessels recorded by Matzulewitsch (1929), most were stamped in *Constantinople.*

From the point of view of this study, one stamped vessel with cloisonné is of special interest. This is the so-called Paternus-bowl which is dated by its stamps to the reign of Anastasius I (491–518) (Matzulewitsch 1929,102). The bowl has two inscriptions, one on the bottom in Latin: 'Of old this vessel is made new by Paternus, our revered bishop. Amen'; and on the inside of the foot-ring a Greek inscription listing the amount of materials used, divided into pure silver, pure gold and mixed gold. The last item is interpreted by Matzulewitsch (1929,105) as gold mixed with mercury for gilding, while the pure gold refers to the medallions (with garnet cloisonné) which were attached to the rim of the vessel.

The fact that information about material for gilding is inscribed on the bowl, and that the amount is such as a goldsmith considers adequate for the bowl in its present form, is interpreted by Matzulewitsh as evidence that the inscription was added in the workshop where it was assembled in the form seen today.

The decoration of the rim is closely associated with late antique art in silver in the Black Sea area, as seen, for instance, on finds from *Kerch,* dated to the middle of the fourth century (Matzulewitsch 1929,107). I cannot, however, agree with Matzulewitsch that the two medallions with garnet inlay (fig. 142) were also produced in *Kerch.* The Latin inscription clearly states that the bowl was made from old parts which had been supplied by bishop Paternus. It is likely that Paternus is the bishop who served in *Tomi* (*Constance*) at the beginning of the sixth century. He brought an older bowl to *Constantinople,* where its silver was tested and the bowl stamped. The alterations carried out by Paternus included the addition of a Latin cross in the centre of the bottom, and the inscription. It is even possible that the whole bottom section was remade during this process, because it is plain and undecorated on the inside, and differs in this respect from comparable Crimean objects. The rim is original, however, and there had obviously been eight oval inlays attached to it by rivets. Paternus had these inlays re-made into two larger roundels with patterns of inscribed equal-armed crosses in cloisonné. The inlays overlap part of the relief decoration, which has been a little damaged, and is therefore clearly seen to be seondary. All the inlays are now missing, but must be presumed to have been of garnet. The cells are very low and the inlays were therefore probably mounted using the cement technique. This suggestion is further indicated by the fact that the cell work was soldered to the edge, while the oval inlays had been attached by rivets which still remain. The cloisonné cells had no bottom and were soldered to the rim along the outside edges.

The Paternus bowl therefore clearly demonstrates that cloisonné was produced in *Constantinople* in the first decades of the sixth century. It further reveals the strong tendency to re-work older objects which apparently characterised the products of the goldsmiths at this time.

The bowl was discovered in a hoard from *Poltava* in the village of *Malaja Pereščepina* together with a number of silver bowls, several with stamps showing an origin in Constantinople. Together with these bowls were also a number of Byzantine gold coins, which however were of later date, mostly belonging to the early seventh century. From this period are also weapons of Avarian types.

After this was written Werner has brought out his important paper on the treasure from *Malaja Pereščepina* (Werner 1984). He very convincingly demonstrates that this find is a grave find perhaps for KUVRAT, kargan of the Bulgars.

I cannot however agree with his opinon that the cross medaillions (cf. fig. 142) on the Paternus bowl are additions made in Avarian time e.g. in the seventh century. I know of no find with flat garnet settings of this size from the seventh century. In the Avarian finds especially, the garnet settings in cloisonné are of a very small size. It is only in earlier times e.g. the fourth and fifth centuries, that flat garnet of this size occur. I am thus convinced that the cross medallions are additions made for bishop Paternus when he renovates an Antique bowl. The gold used for the settings as well as the gilding corresponds well to the gold mentioned in the Greek inscriptions. The bowl is one of several antiquities which belong to this find.

# Chapter 5. Satellite workshops for sand putty cloisonné

## 5:1 Sand putty technique: workshops

The paste used for the sand putty technique is soft and of a sandy texture. It consists of pure silica sand, finely crushed calcite or a mixture of calcite and silicate (cf. 3:2). It is likely that an organic binding agent, perhaps egg white, was originally added to make the putty firmer when heated (cf. 3:3d), but it never became as hard as the substances used in the cement technique. The main purpose of the sand was therefore as a filling, and the actual cell work of the cloisonné had therefore to be of a firm box-like construction. The inlays were not set in from the back, as in the cement technique, but were mounted from the top in the same way as in the old clasped cloisonné. In order that the cell walls could be flattened over the edges of the garnets, they had to be securely attached by soldering at the bottom and round the edges: however, this was usually simplified by attaching transverse walls to each other and only soldering certain supporting walls to the bottom plate. The more general caracteristics of sand putty works are shown in diagram fig. 143.

In most of the analysed objects made with the sand putty technique, type 1 garnets were used (cf. 1:3a). Among these garnets were shapes with very fine step-patterns (f-stepped shapes) and complicated forms (cf. 2:8). However, the sand putty technique was not at first associated with f-stepped shapes and it is important to note that this method was also used with garnets of different kinds. Early examples of f-shaped garnets have been found mounted with fused paste, but are never used in the cement technique.

One of the earliest examples of the sand putty technique appears to be a heart-shaped mount from *Németkér* in Hungary (fig. 146). It has a central design of omega-shaped cell ladders and was as Kovrig early observed (Kovrig 1959) probably the pommel of a seax of the same type as the one from *Pouan* (Salin and France-Lanord 1956) (cf. fig. 147).

The origin of the heart-shaped pommel on the seaxes has not been definitely established. Heart shapes as such are associated with the cement technique, and when they are first encountered on the seaxes of the Franks, in Childeric's grave, it is in association with cloisonné using the cement technique. It will be demonstrated below that the heart-shaped pommel made using the sand putty technique is probably a copy of the pommel of Childeric's seax.

I have not been able to analyse the cloisonné from the *Pouan* find, but my observations indicate that most of the inlays were mounted by the sand putty method. The depth of the cells and the comparatively thin cell walls, together with the fact that no hard cement remains were found, where stones have fallen out, indicated that both the older clasped cloisonné and the cement technique can be discounted when considering the *Pouan* objects. It is typical of the hardened cement paste that it adheres to the metal, while the sand putty paste falls out as soon as a cell

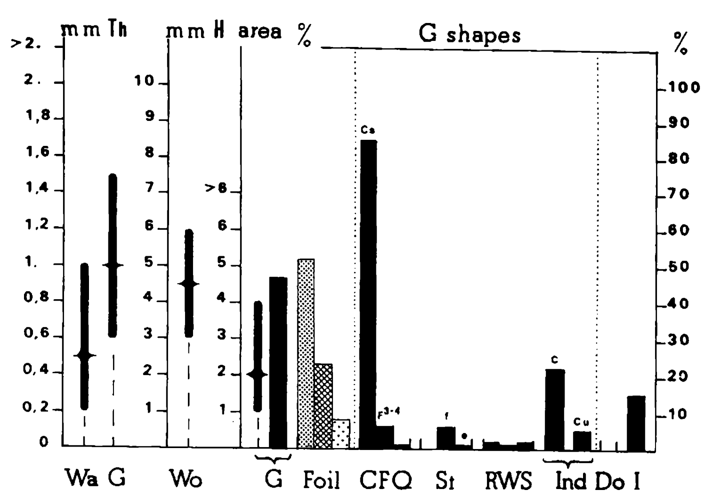



Fig. 143. Diagram showing the common technical features of cloisonné with sand putty.
The diagram includes those objects, mainly brooches, not designated to specific workshops. The stepped garnets are less common than in the specific workshops, since stepped garnets are more common on mounts for weapons and horse trappings. The following objects were used: Bonn 1–29, 32, 34–39, 41–50; Bud 31; Karl 2; Köln 12–27; Krefeld 6–9; Worms 1–10, 21–27.

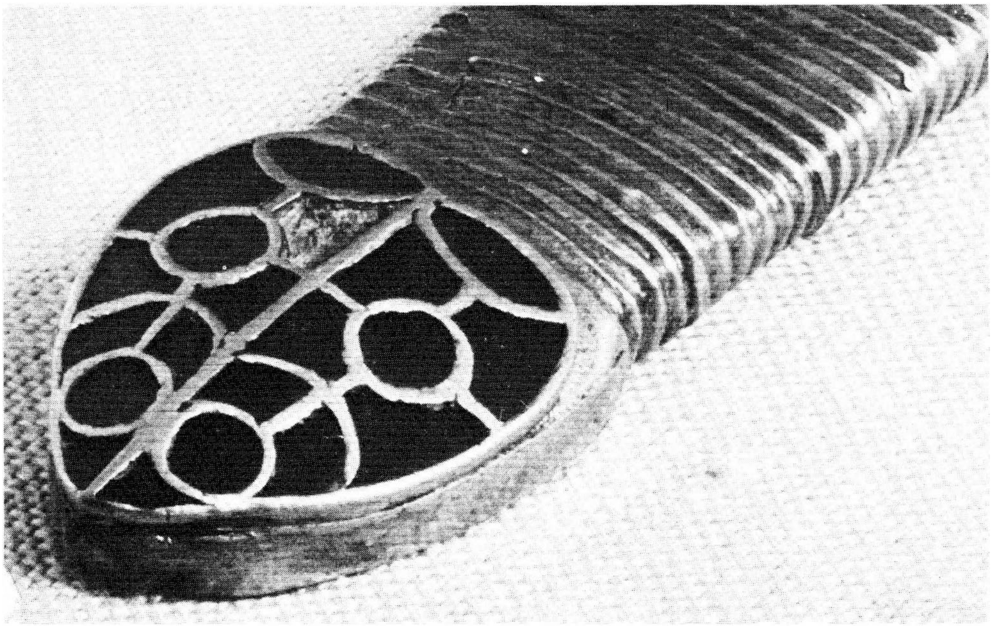


Fig. 144

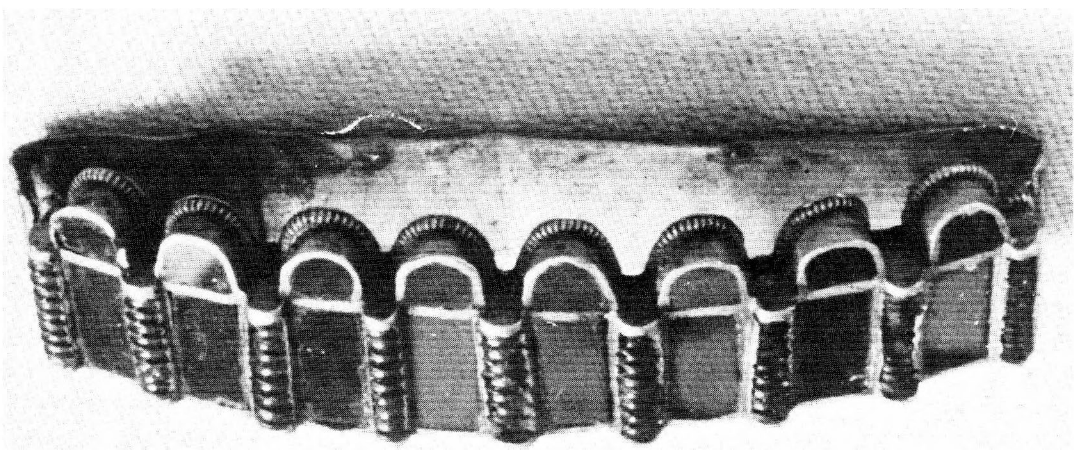
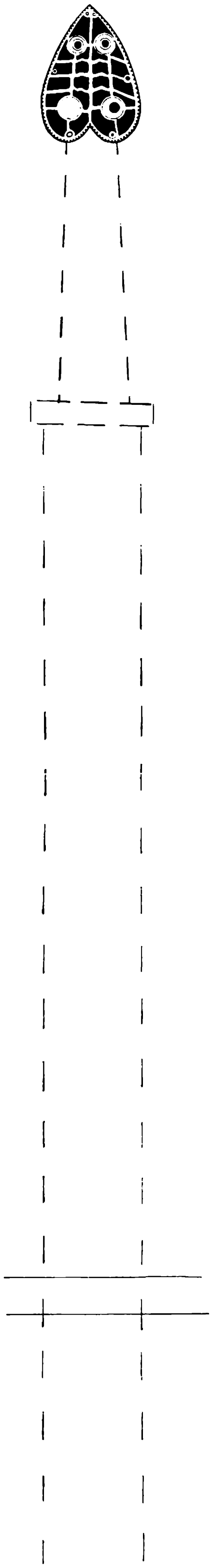


Fig. 145

Fig. 144–145. Enlarged details of the seax and sword from Pouan. Note the beaded garnets on the scabbard mount of the sword, 145, and the empty cells on the heart-shaped pommel from the seax, 144.
Not to scale.

is opened. The seax pommel from *Pouan* has several such empty cells (cf. fig. 144).

The *Pouan* find includes two gold buckles with round plates and cloisonné decoration (fig. 150). According to the description (Salin and France-Lanord 1956, 72), the garnets are backed by foil with a fine waffle-pattern and a thick layer of paste. The pattern is typical of those made using the sand putty technique, with garnet segments surrounding a hexagonal stone. The cell work is attached to a plain outer strip instead of being soldered directly to the edge of the panel as would have been the case in clasped cloisonné or cement cloisonné. We have already seen that buckles of this type were produced using clasped cloisonné or cement technique. But some of these buckles from Hungary, which I have been able to analyse, were made using the sand putty technique: these were two buckles without provenance in the National Museum in *Budapest* (Bud 1 and 30, fig. 148–149). The buckles are of gold with a massive frame and the round plates are inlaid with cloisonné. In one case, segment-shaped garnets surround a central roundel inlaid with a flat garnet, while in the other the segments surround a



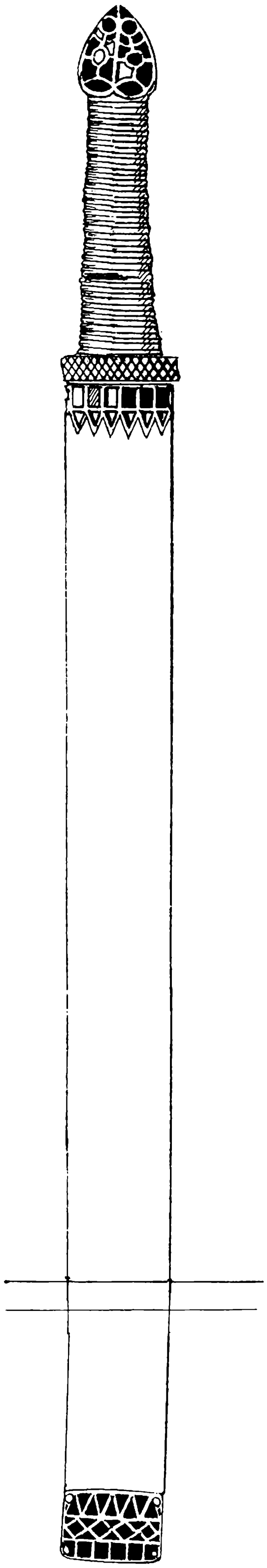


Fig. 146. Pommel from Németkér, Hungary (Bud 38) reconstructed on a seax. 1:3.
Fig. 147. Reconstruction of the seax from Pouan with a heart-shaped pommel and rectangular chape. 1:3.

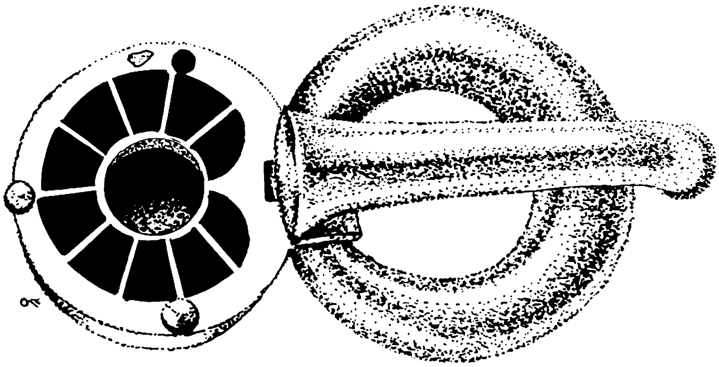


Fig. 148. Buckle of gold with garnet cloisonné from Hungary (Bud 30). 2:1.

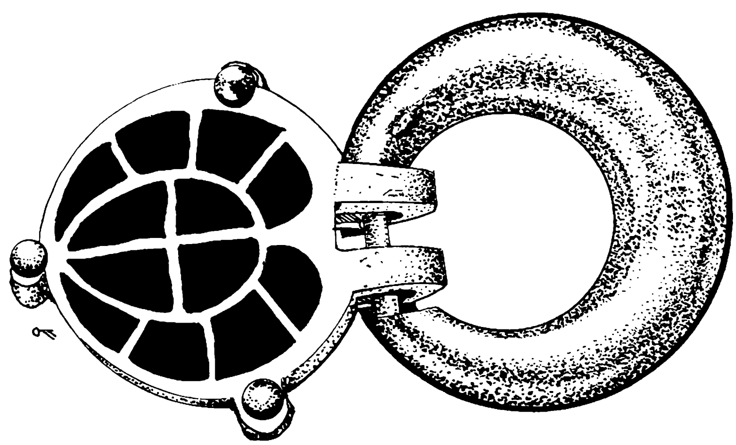


Fig. 149. Buckle of gold with garnet cloisonné from Hungary (Bud 1). 2:1.

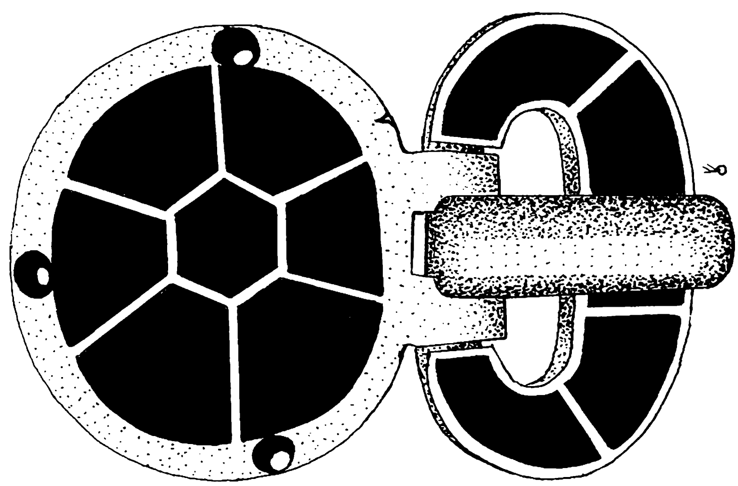


Fig. 150. One of two buckles of the same type from the Pouan grave with garnet cloisonné on the plate and frame. 2:1.

lentoid central panel made up of four sectors. It is typical of these buckles, like those from *Pouan*, that the cloisonné pattern is arranged in circular designs. This division into circular zones is also typical of the many round disc brooches which were made using the sand putty method. It was pointed out in 3:2 that designs of concentric zones had a structural significance, as the transverse walls were soldered to the walls of the central zone. Analysis of the paste from the Hungarian buckles showed that it was made from a mixture of calcite and quartz. It is not in itself surprising to find sand putty cloisonné in the lower Danube area at this early date, as is suggested by these finds. Coarse sand was apparently used as a filling in gold jewellery as early as the *Szilágy Somlyó* find, where the onion-shaped terminals of the large cross-bow brooch are made from thin gold foil over a core of coarse crystalline quartz sand (cf. Table XI, II:2, no. 207). The filling in this brooch differs from that used in sand putty technique in that the sand is much coarser, but the principle is the same. Fettich maintains that the large onyx brooch from *Szilágy Somlyó* was not made in *Constantinople*, despite its Imperial brooch form, but instead represents a Pannonian/Hungarian imitation of this type of brooch. The use of sand filling in this brooch can therefore perhaps be interpreted as a primitive feature, typical of a barbaric imitation.

The question is whether all objects with one type of sand putty can be assumed to have come from one workshop, or whether several workshops used a similar putty. The problem is the same as that encountered when determining the provenance of pottery through the study of cut thin sections; it is assumed that there is a certain *probability* that a common origin can be determined on the basis of the presence of more or less characteristic elements in the clay. It is of course possible to choose for comparison either trace elements or the main constituents. In the case of the putties, the material was not burnt and outside elements could therefore be introduced; for this reason I have considered that relevant comparisons could only be achieved on the basis of the main constituents of the putties and the structure of the putty, e.g. the grain size. The metal carbonates which occur are probably of no significance in this context as they may have been produced by the corrosion of the metal in the objects.

The groupings based on certain elements in the sand putty are used in the diagrams summarizing other elements of the cloisonné, (cf. fig. 151–154, 156, 164–165). These diagrams show clear differences in the use of garnets' shapes, sizes and foil backing in the different paste groups. This indicates that the grouping corresponds to different workshops. The location of the single workshops will be discussed below.

A calcite and quartz putty with dolomite occurs in the samples from a group of disc brooches (cf. diagram fig. 153) from *Schretzheim,* Germany and from *Szentendre* and *Tatabanya* in north-west Hungary and *Varpalota* in south-west Hungary. Bona (Bona 1971a, 49) has pointed out that the Hungarian cemeteries are located by the Danube. Another brooch of this type, from *Schwarzrheindorf* and an S-shaped brooch without provenance in *Mainz,* probably also belong to this group. It seems probable that the group is centered on the valley of the upper Danube.

Another workshop group (cf. diagram fig. 152) consists of objects, which have a calcite and quartz putty with an admixture which has proved difficult to identify, but which in some cases was shown to be a clay mineral. There are five samples from this group, four of which do not have the mixed silicates which are typical of other calcite and quartz putties, a clear indication that they constitute a closed group. The fifth sample was taken from the large eagle brooch from *Domagnano* which during conservation in Mainz have had all the garnets and their foil backings removed; it is therefore possible that this sample was contaminated. However, it is likely that the paste, contaminated or not, is original, since I observed paste of a similar colour and texture on that part of the treasure which is in the British Museum.

The objects in this group are a sword pommel from *Sturkö*, Blekinge, Sweden (Swed 16), two rosette brooches from the *Mainz* area (Mainz 6 and 8), the large brooch from *Desana* (Torino 1) and finally the treasure from *Domagnano*. There is therefore a common connection with *Mainz*: even though the East Gothic element is also conspiciuous, the typically Frankish form of the small simple disc brooches suggests that the workshop was situated in *Mainz*. The Frankish elements in the Domagnano-treasure is discussed below 5:3, 150f.

The third and largest group (cf. diagram fig. 151) is of objects with a putty consisting of only calcite, quartz and mixed silicates. Objects in this group include the finds from Hungary (Bud 1, 30, 38) mentioned above; rosette brooches from graves 54, 29, and 14, *Szentendre* (Bud 2, 4 and 6); disc brooches from grave 2, *Szentendre* (Bud 5), grave 87, *Nocera Umbra* (Rom 6) and grave 42, *Bifrons, Kent* (Maid 1); a rosette brooch and an S-shaped brooch from *Dalsheim* near *Mainz* (Mainz 7 and 9); rosette brooches from *Hahnheim* (Mainz 5) and without provenance, perhaps France (BM 8) and a bossed brooch (BM 10) also without provenance but certainly continental. Finally the bird-shaped mount of a spatha from *Rommersheim* although only visually analysed, probably belong to this group. The finds from *Mainz* are an im-

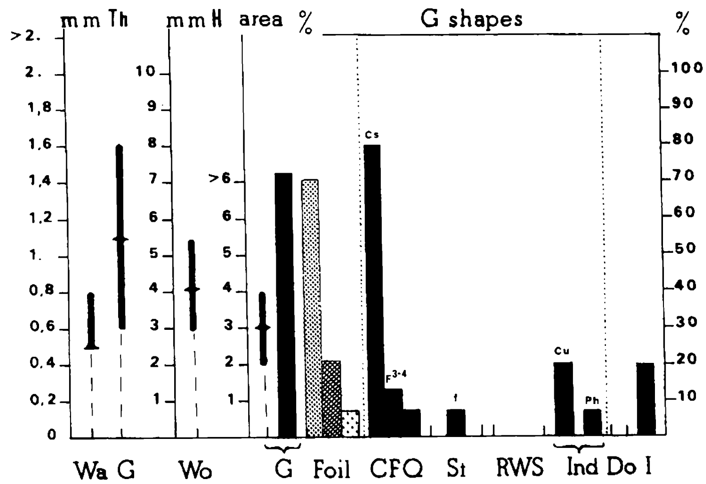



Fig. 151. Diagram showing the technical features of cloisonné with sand putty I:4a, from a workshop located to Mainz. The diagram is based on 15 objects including disc brooches, sword mounts and buckles. A bossed disc brooch (BM 10), where this putty constitutes the filling, also belongs to this workshop, though it is not recorded in the diagram.

The objects are: BM 8; Bud 1–4, 6, 30, 38; Maid 1; Mainz 4, 5, 7, 9; Rom 6; Worms 32. An important feature is the wide range of the thickness of the garnets. The occurrence of the early shapes Q, Cu, and Ph, considering the fairly late activity at this workshop indicated by the bossed brooch, is important.

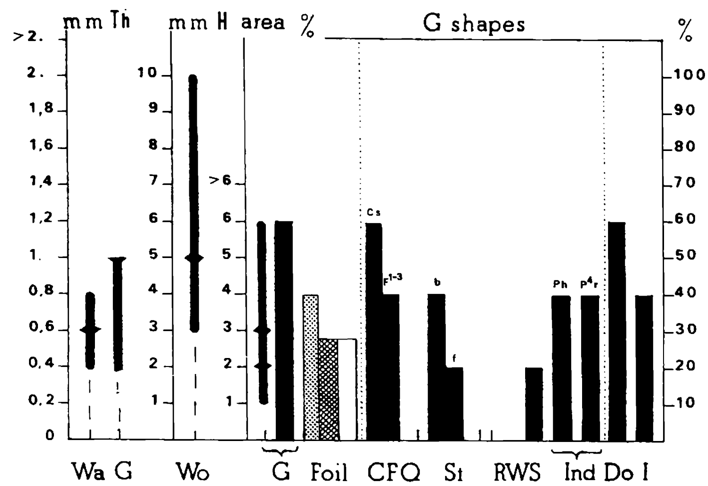



Fig. 152. Diagram showing the technical features of cloisonné with sand putty I:4d, from a workshop tentatively located to Mainz.

The diagram is based on a small group of objects dominated by the Domagnano treasure. This treasure is counted in the diagram as one sample.

The objects are: BM 14–15; Nürn 1–4 (e.g. Domagnano); Mainz 6, 8; Swed 16; Turin 1.

Like the Mainz workshop in the diagram, fig. 151, this workshop is also distinguished by early garnet shapes, like the b-steps and the small Ph shape.

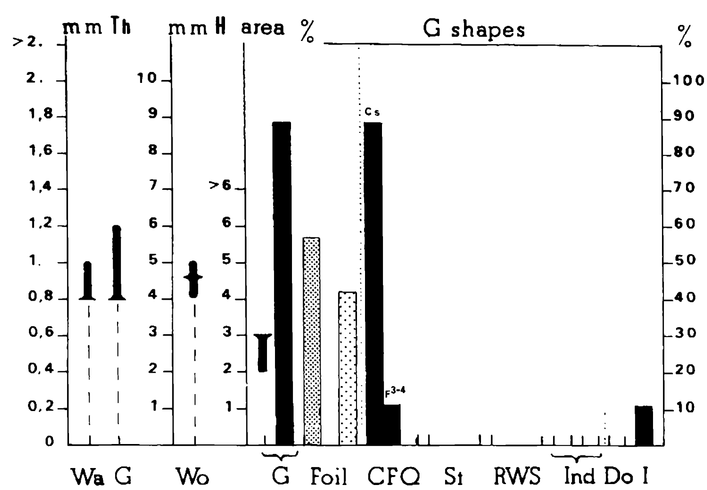



Fig. 153. Diagram showing the technical features of cloisonné with sand putty I:4 c, from a workshop located to southern Germany. The group consists of 9 brooches, seven of which are from gravefields located along the upper Danubian valley.

The objects are: Bud 5, 7; Dill 2, 6, 7, 9; Mainz 13, 14; Westp 1.

The diagram represents a very close group with small variations.

portant element, 25%, enabling this group, like the previous one, to be assigned with some confidence to a workshop in *Mainz*.

Thus the character of the pastes and other technical elements allows three different workshops to be identified. In the third and largest, where a relatively pure quartz and calcite putty was used, garnets of two different qualitites were used, types 1 and 2. Garnets of type 2 were only found in the analyses of objects from Hungary, in the two round buckle plates (Bud 1 and 30). The analyses are probably unrepresentative in this respect, as it is my impression that type 2 garnets are more common than the results indicate. I would expect to find this type of garnet particularly in the earliest Frankish material. There is also a find from *Skrävsta* (Swed 26 b) in Sweden, with a garnet of this type, perhaps from a buckle like fig. 148. It is, however, interesting to note that type 1 garnets, which are represented in all three workshop groups, also occur in Hungary on the rosette brooch from the Langobardic cemetery at *Tatabanya* (Bud 7).

Finally a workshop with a putty closely related to the other three, Table XI, I:4 b, but only used as filling with no garnets in the cloisions and so far only located to *Castel Trosino* (Rom 2–3) should be mentioned. As described in 3:3 e, this secondary use of sand putty also occurs on other items.

If we consider the geographical distribution of the three types of putty, I:4 a, I:4 c and I:4 d used for garnet cloisonné, it can be seen that Frankish finds are represented in all three groups. In the first group, apart from Frankish finds, there are finds from Langobardic graves in Pannonia and Allemannic finds from *Schretzheim* in south Germany. In the second group there is one find from Sweden, two from Italy and two from the *Mainz* area. In the third and largest group there are finds from Hungary and Italy as well as Frankish finds from the *Mainz* area. The third group represents the workshop with the widest chronological range, the Hungarian buckles and the pommel from *Németkér*, being the earliest objects and the brooch from grave 87, *Nocera Umbra* the latest. There is a marked bias towards objects from the *Mainz* area in the Frankish material, represented in two of the three workshop groups. The workshop from the Danube region was probably located along the so-called *Frankenstrasse*, which connects south Germany with the *Mainz-Tauber* area (cf. Koch 1977, 10).

But before discussing the implications of this attribution the workshops which can be identified by their use of pure quartz and calcite putty respectively will be considered.

The calcite and quartz group of putties was easy to identify because this mixture does not occur in nature and must be deliberately made by man. This is not necessarily the case with a substance consisting of quartz and mixed silicates; a few grains of quartz and mixed silicates can easily have been accidentally introduced into an object from its environment. Great care was therefore exercised in the sampling to ensure that there were no accidental intrusions of this kind and that the samples were taken from bodies of genuine paste. This is discussed in chapter 3:1, where cases of secondary quartz paste are also considered. We have already encountered coarse quartz-filling in the large onyx brooch from *Szilágy Somlyó* where it was used as a core in the onion-shaped terminals. It should also be remembered that in the charcoal-filling occasional quartz grains are commonly found in clasped cloisonné. In these cases the coarse character of the quartz differ clearly from the putty found in the cloisonné using the sand putty technique. The extremely fine grain size is particularly typical of the quartz-sand putty where,

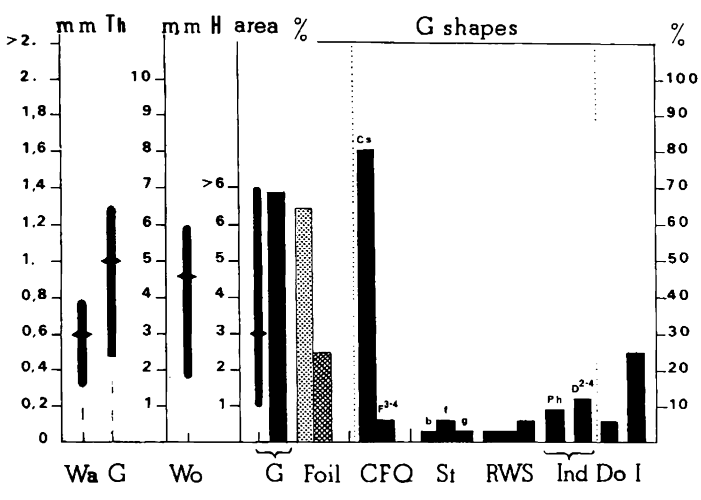


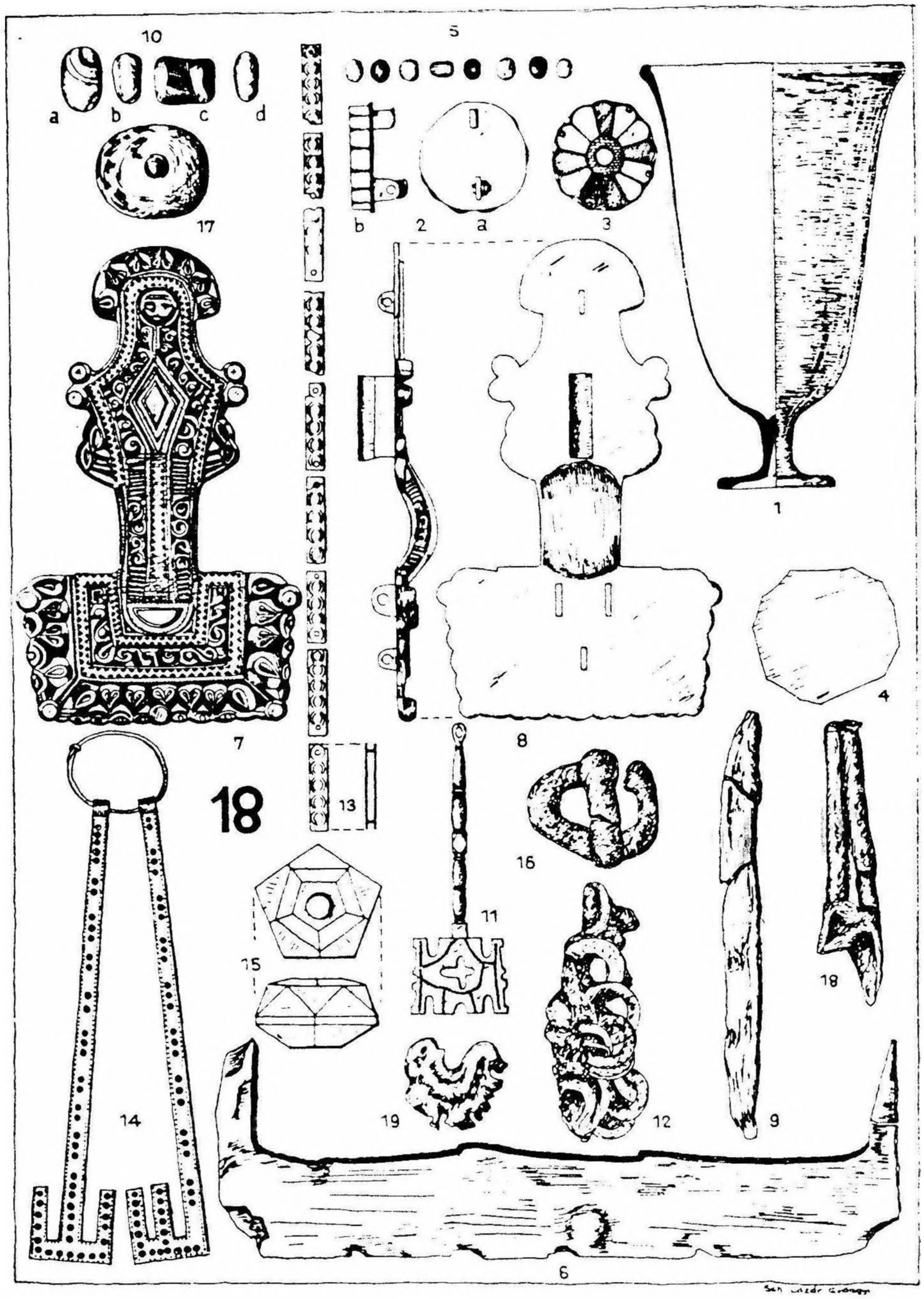

Fig. 154. Diagram showing the technical features of cloisonné with quartz putty II:2a, from a workshop located to the Cologne-Trier area.

The diagram is based on 32 objects, mostly brooches but also 3 sword pommels and one bow brooch.

The objects are: Bonn 23, 31, 40, 45–48; Br 1; Bud 8; Dill 1–4, 11; Krefeld 1; Köln 17–22; Maid 7; Mainz 15, 16; Swed 2, 13, 21; Szek 2; Trier 2, 3, 11.

The workshop is distinguished by stepped garnets from b-, f- and g-templets, and the occurrence of RWS shapes.

Fig. 155. Grave-find from Hegykö, grave 18. After Bona 1971 a.



as Carlström demonstrated, the quartz and the mixed silicates occur in grain sizes rarely exceeding 0.1 mm. There are also sometimes particles of organic material of a type which may be found in river deposits. In some cases, traces of gold were encountered in a fine, granular form, similar to the rest of the putty, indicating that the gold could not have come from the objects, but must have been gold dust from the workshop environment or native gold, which occurs in the river deposits of the Rhine, for instance. The pure quartz putty (cf. diagram, fig. 154) has a marked predominance in the Cologne-Trier area. In the museum collections from the Cologne-Krefeld-Trier-Bonn area this putty dominates the cloisonné found on disc brooches in the form of S-shape, rosette or simple circular brooches. The clearly distinguishable brownish colour makes it easy to recognize the putty and the samples taken could be seen as a confirmation of a visual inspection. In this area more expensive cloisonné jewellery with this putty is rarely found. This limitation is of a special interest, as the more expensive jewellery with this putty is met further afield as in the two gold pommels with cloisonné found in Sweden (Swed 13 and Swed 21) and in an Anglo-Saxon gold pendant from *Milton* (Maid 7).

There are only two analyses from Hungary with fine grained quartz putty (cf. Table XI, II:2, nos. 155, 169), one of which is from a rosette-brooch (Szek 2) found in grave 2 at *Kajdacs*, a Lombardian grave-field. As will be discussed below, it seems highly probable that most of the rosette-brooches with sand putty are of Frankish origin. The other analysis is taken below a single setting from one of two relief brooches from *Hegykö,* grave 18 (cf. fig 158). In the same grave were two rosette-brooches which were not analysed but gave visually the impression of containing the same sand putty. The relief brooches belong to the so-called Cividale-types (cf. Werner 1962, Tafel 34). This type is found from the Rhineland to Italy. The existence of fine grained sand putty on this particular type of relief brooches should be of certain significance as on more typical Pannonian, brooches from this period with a semi-round headplate the cement below the settings was of charcoal sparingly mixed with coarse grained quartz (cf. Table XI:V 2, nos 164, 179).

The origin of the Cividale brooches has most recently been discussed by Roth (Roth 1973, 107 ff.). He distinguishes three main groups of this type of brooch. The groups are:

1) Bügelfibeln mit Strichverzierung an den Kopfplattenfeldern und unvollständigen hängenden Tierköpfen am oberen Ansatz der Fussplatte. 2) Bügelfibeln mit Spiralverzierung auf den Kopfplatte, vollständige Tierköpfen an der Fussplatte und Strichverzierung im innersten Fussplattenfeld. 3) Bügelfibeln mit reiner Spiralrankenverzierung und intakten Tierköpfen an der Fussplatte.

Roth considers that the two first groups are of Merovingian origin, e.g. from the Rhineland, whereas the third group, which is only found in Pannonia and Italy, is of Pannonian origin. Roth obviously includes the Hegykö-brooches in his third group although these brooches differ from all the others in having almandine settings on the head- and foot-plates. I consider the Hegykö-brooches to constitute a fourth group consisting of brooches with settings and spiral ornaments of high quality. So far the only examples of group 4 are the Hegykö-brooches and I agree with Bona that these are of unusually high quality (Bona 1976, 58). The settings are cast and are inlaid with flat cut garnets with goldfoils of a fine waffle pattern. The putty sample was taken beneath the foil where the putty was still hard. The technical details of the settings fit well into the production from the workshop from the Cologne-Trier-area (cf. fig 154). It is therefore most probable that the Hegykö-brooches originally are a Merovingian product which came to Pannonia together with the rosette-brooches found in the same grave. Originally they could very well have belonged to the prototypes of the whole series and their dating would lie in the period when the Franks and the Langobards had close connections, e.g. 530–540 (cf. Werner 1962, 131 ff.).

A limited group consists of objects with sand-putty of quartz mixed with clay, (cf. diagram, fig. 156). This group consists of a disc brooch with protruding animal heads with no provenance from Germany (BM 9), a three-zoned disc brooch with stepped cells from *Hürth-Kalscheuren* in the Lower Rhine area (Bonn 33), a three-zoned disc brooch which includes mushroom cells from *Heidenheim* (Stutt 3) and an S-shaped brooch also with mushroom cells from *Cividale* (Civi 1). There is also a disc brooch from *Faversham* (BM 12), which now lacks both inlays and gold foil. The substance remaining in some of these cells was sometimes coloured green. Samples from the surface were found to contain brochantite and quartz, i.e. copper sulphate hydrate, while below the surface the sample contained quartz and kaolin. It is therefore likely that the substance in the *Faversham*

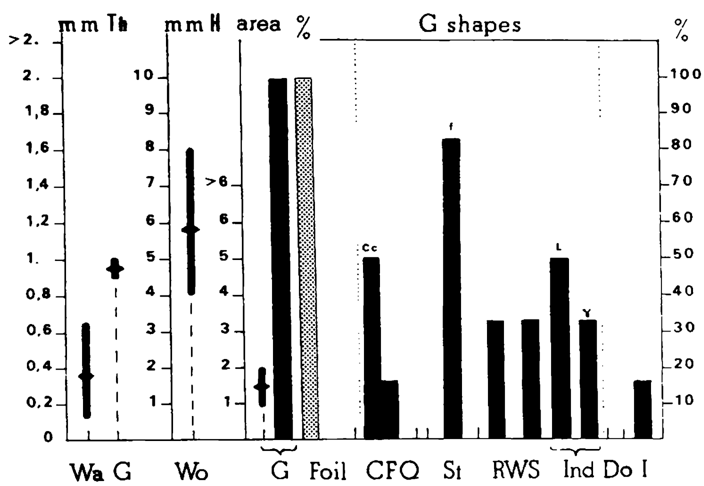



Fig. 156. Diagram showing the technical features of cloisonné with sand putty II:2b, from a workshop not located more closely than to Germany.

The diagram is based on 6 objects, one of which has no inlays.

The objects are: BM 9, 12; Bonn 33; Stutt 3, 33; Civi 1.

Considering the small number, the high frequency of stepped garnets and more unusual shapes like L and Y is noteworthy.

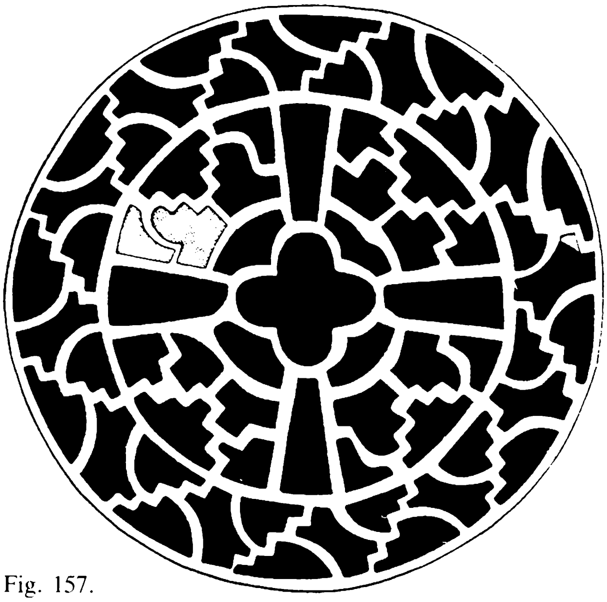


Fig. 157.

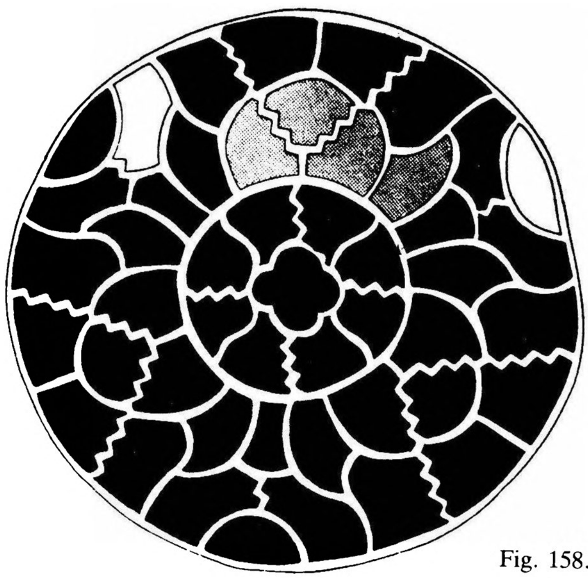


Fig. 158.

Fig. 157, 158, 160. Disc brooches with boar- (marked with grey) and cross-motifs in the cloisonné pattern. 157) St Denis (Paris 14). 158) Heidenheim (Stutt 3). 160) Marilles (Br 2) 2:1.

Fig. 159. Disc pendant from Linon. 1:1.

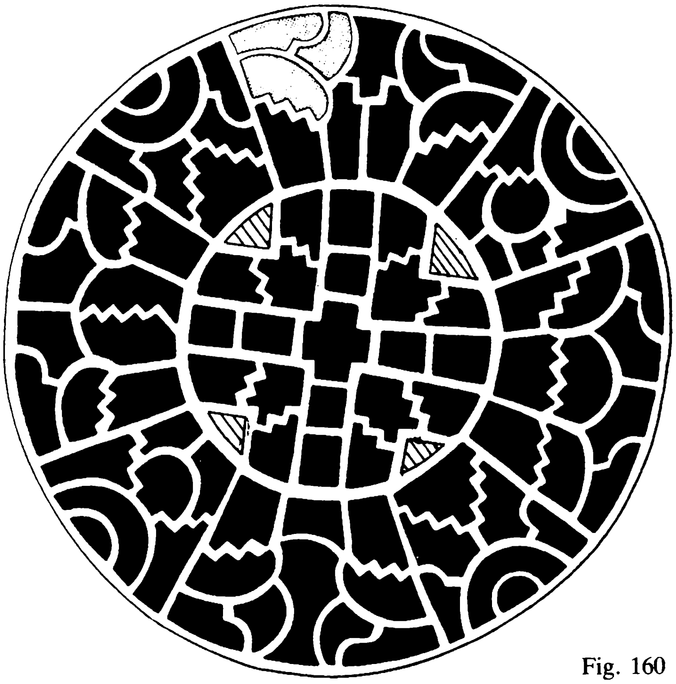


Fig. 160

brooch was in fact a paste and the brochantite the product of corrosion, or just possibly that it was a coloured layer applied to the paste which made up the actual inlay, as was the case for objects from *Sprendlingen* and *Castel Trosino* (cf. 3:e ). The irregular distribution of the green layer is inconsistent with this interpretation, while the absence of any inlay can be seen to support it.

This group has a wide geographical distribution and cannot be located more closely than to Germany. The diagram fig. 156 shows that the objects apart from the putty have several traits in common, such as f-stepped garnets (57%) and the relatively frequent occurence of shapes like mushrooms and Y- and L-shapes which are at any rate rare on the continent. It is my impression that the Continental finds form a closed group but I cannot exclude the possibility that the analysis of the material from the *Faversham* object is misleading and that the clay material was here a secondary introduction, specially as the cells had no inlays.

*Sand putty of calcite* implies several analytical problems (cf. 3:3d and below). Putty of finely-crushed pure calcite occurs, I: 2 a sometimes with very small amounts of quartz, I: 3 a which can be regarded as trace elements. The amounts of quartz are so small that they do not change the white colour of the putty, unlike the quartz and calcite putties which are grey or light brown. It is therefore likely that the quartz represents impurities added in the workshop, perhaps from the polishing agent which was used on the finished cloisonné work, or it may even have been introduced at some later stage.

As we have seen, *hardened* calcite—mixed with linseed oil or oxalic acid—was used in the cement technique. Diffraction analysis only identifies the presence of oxalate and cannot distinguish hardening with linseed oil. The hardened structure can, however, easily be detected when the material is sampled and the pastes are found to be so hard they have to be scraped away. This feature has been noted in the analysis tables for calcite, which is divided into *soft sand putty with calcite* and *firm hardened calcite paste*.

Analysis of white calcite pastes poses yet another problem, in that a large group consisted of calcite mixed with wax, which was added as a melting agent to produce a fused paste (see below). If, however, an object with wax and calcite paste was subjected to heat, as for instance during cremation, the wax melted and the diffraction analysis registers calcite only. A study of the structure of the paste in these cases indicates that wax was originally present, because blisters were left in the paste during the melting process. Objects where the calcite paste was found to be blistered originally had fused pastes.

Samples with pure calcite putty are few and therefore probably not fully representative. When objects with burnt wax and cement paste are disregarded, only two remain: a disc brooch from *Dover* (BM 11) and a mount from *Åker* (O 1). Calcite paste was also used secondarily as filling in two *pressblech* brooches from Gotland. The group can reasonably be extended to include objects with calcite putty with small traces of quartz, since these are probably secondary impurities. The following objects can therefore be added: a disc brooch from grave 91b, *Müngersdorf* (Köln 10) a buckle from *Taplow* (BM 13), a sword pommel from *Vallstenarum* (Swed 65) and probably also a button from *Tibble* (Swed 22) and a mount from *Spelvik* (Swed 24).

One of the reasons why there were few analyses of white calcite putty is that the group in which it occurs includes so many very valuable objects. It was therefore difficult to obtain permission to sample these objects, many of which are among the finest examples of cloisonné art.

I have therefore observed, but not analysed, calcite putty in the brooches from *St. Denis* (fig. 157) and *Marilles* (fig. 160). I also believe that this type of putty was used on the buckle from *Wynaldum* (Leu 1). It appears, finally, that there was calcite putty on the bossed brooch from *Rosmeer* (Roosens and Thomas-Goorieck 1970); the report describes the paste as a mixture of calcite and soda, but the presence of soda in the calcite is unlikely and this is probably a printing error.

Another reason why calcite putties are not as common as one might expect is that they are highly soluble and may therefore disappear. This seems to have been the case with many of the objects with cloisonné from *Sutton Hoo*. In the second volume of the *Sutton Hoo* publication (Bruce-Mitford 1978, 600 ff.) it is maintained that the cells were empty, and according to the small number of examinations which are recorded in the publication this appear to be the case. Bruce-Mitford argues further in support of this thesis that there are a number of superfluous rivet-holes on the back of the mounts from the purse-lid, which would have served to allow sunken garnets to be pushed up to their original position during repairs. It is argued that the garnets would have sunk down in their cells because there was no filling. This is a patently baroque argument, because it does not explain how the garnets were originally mounted to the correct height in the cells without a stabilising putty. In the cloisonné at *Sutton Hoo*, as in all cloisonné made using the sand putty technique, the cell walls are only partly soldered to each other and to the bottom plate. It is necessary for such cell work to be stabilized with putty so

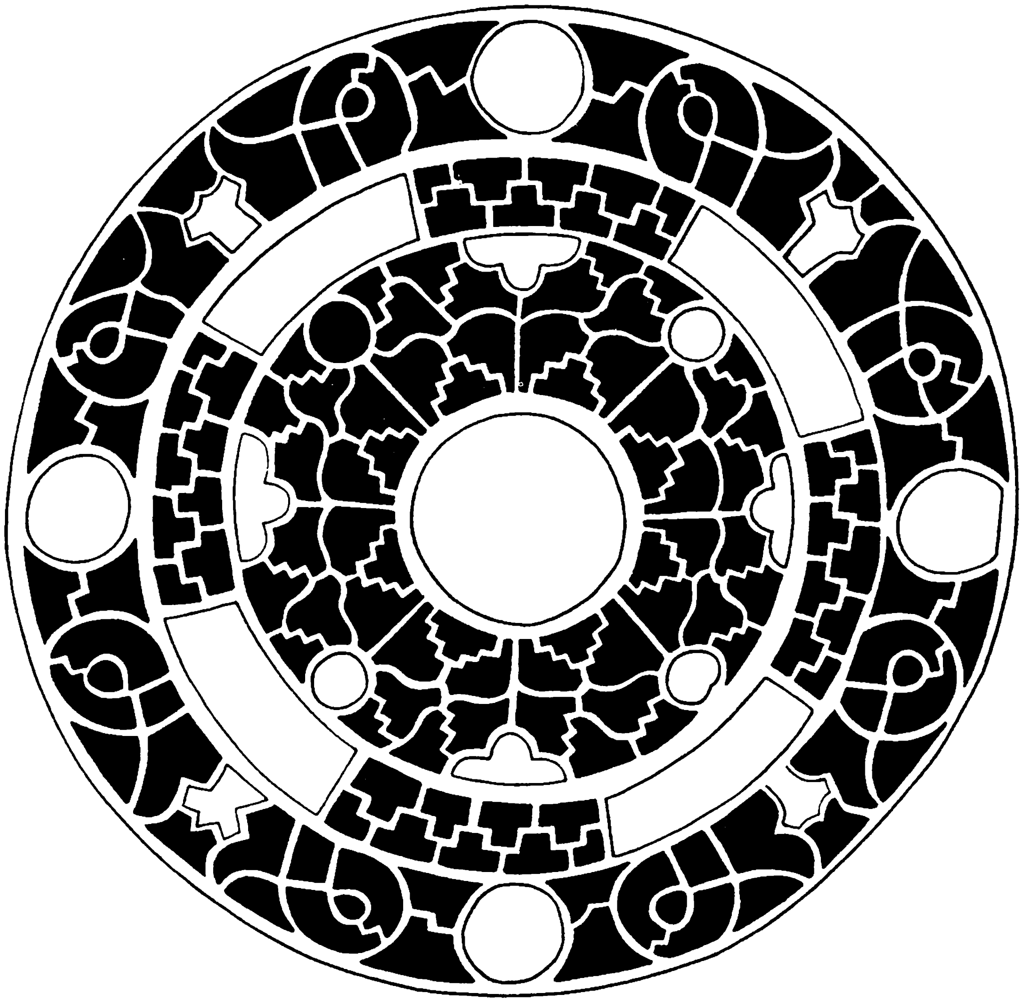


Fig. 161. Cloisonné pattern on a disc brooch from Parma. There is blue glass in the small white cells and filigree with animal ornament in the rectangular fields. 2:1.

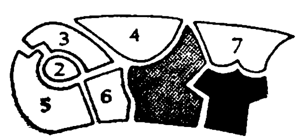



Fig. 162. Boar motifs from the brooch, fig. 161. Note the boars tusk (marked with grey).

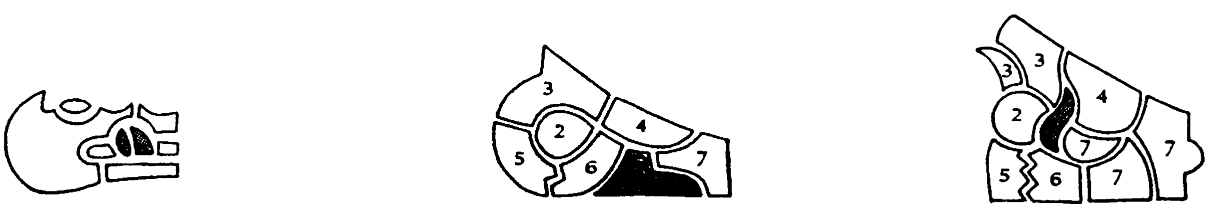



Fig. 163. Boar motifs in coisonné from a) Sutton Hoo; b) Hög Edsten (Swed 21); c) Vallstenarum (Swed 65). 2:1. Note the boars tusk (marked with grey).

that it is firm enough to stand the stresses to which it is subjected when the inlay is mounted and the tops of the walls are flattened over the edges of the garnets. Once the garnets are mounted, the putty is less important, because the inlays themselves serve to stabilize the cell work. On the other hand, if the cells were empty, the work would become very sensitive to pressure. Bruce-Mitford suggests that the gold foil being folded over the edges of the stones is a feature unique to *Sutton Hoo*, and somehow connected with the empty cells. This feature is, however, found on most objects made using the sand putty technique and is in no way unique to *Sutton Hoo*.

Why, then, is there no paste in the objects decorated with cloisonné from *Sutton Hoo?* I have already stated that calcite putties are easily soluble in acids, including the acids in humus. It is characteristic of the *Sutton Hoo* burial that all bones have disappeared, and it is likely that the more easily soluble pure calcite disappeared long before the bones had completely dissolved. In the laboratory I immersed a small cell with calcite putty topped with a garnet first in a 3 N solution of citric acid and secondly in 6 N nitric acid. In both cases the calcite dissolved in the liquid without the garnet moving from its position.

In connection with a discussion of these problems I had with the Research Laboratory of the British Museum in 1977, a supplementary investigation was undertaken on my initiative to ascertain whether traces of calcite putty could after all be detected. This proved to be the case in two cases (cf. Appendix, report). In one case, on a rectangular belt mount (no. 6), paste was found behind a garnet which had clearly been loose and was stuck back during repairs in the 1940s. The putty showed a clear impression of the foil which lay above it; it was green in colour and soft in texture; diffraction analysis showed that it consisted of calcite with traces of quartz. In the second case, on the rectangular buckle (no. 11), the paste was found in the corners of some empty cells. This putty was also soft and green in colour and the diffraction analysis gave a similar result. In the report, the occurence of calcite is interpreted as a recent addition connected with possible repair work in the 1940s. As an argument in favour of this interprêtation it is stated that a similar substance was found under the garnets of the central button of the shield boss, which was also restored in the 1940s. The conservation reports do not, however, mention that calcite was added.

I do not find these arguments very convincing. In my studies of cloisonné jewellery in a large number of museums in Europe, I have become familiar with a considerable number of techniques which were used in the restoration of cloisonné, but I have never seen cells filled with calcite, let alone green calcite. That empty cells should have been partly filled with such a substance is clearly unbelievable. The green colour appears to come from corroded copper, either from the foil, which was often made from low-quality gold, or from the gold objects themselves. The green colouring in fact indicates that the cloisonné objects had been in an acid environment. It is notable that the copper content in the objects varies considerably, with differences larger than 1% even on the same object (cf. *Sutton Hoo* II, 624 ff.). This can also be seen as an indication that a certain amount of copper may have leached from the gold.

I am therefore inclined to believe that most of the cloisonné work from *Sutton Hoo* was made using the sand putty technique with a paste of calcite and small amounts of quartz.

*Sutton Hoo* is probably not the only example of dissolved calcite paste. In the round rosette-shaped brooches in the rich woman's grave in *Cologne* Cathedral (fig. 190), the paste has also disappeared and there is a large empty space between the bottom plate and the garnets. In the bottom of this space loose black lumps were found, which proved to consist of silver chloride and silver sulphide, probably products of the corrosion of the (?)plain, silver-gilt foil which was placed underneath the garnets. Silver chloride was also found in the bottom of the cells on the strap-ends of the shoelaces in this grave, but in these there was a layer of white calcite on top of the corrosion products, and this in turn was covered by gold foil and garnets. The bow-brooches from this grave also contained calcite putty. In this find, therefore, it appears that the calcite putty did not dissolve in the case of all the objects, but only some of them, such as the round brooches. Their position in the grave may have subjected them particularly to the acid conditions which presumably resulted from the decomposition of the contents of the grave. As at *Sutton Hoo*, the skeleton in the *Cologne* grave had virtually disappeared, leaving only the teeth, a few fragments of bone from the skull or a vertebra from the neck and a fragment of bone from the lower leg. The round brooches had fallen from their original position at the shoulders and were found upside-down in the region of the clavicles. It is possible that this disturbance subjected them to more decomposition than other objects which remained in their original positions. The substantial corrosion deposits inside the brooches confirm that they had been in an acid, corrosive environment.

The presence of calcite putty in the *Cologne* grave, which was definitely present on the bow-brooches and strap-ends and most probably also on the round brooches, is of particular interest because this type of paste was also identified in the two disc brooches from grave 91b *Müngersdorf (Köln 10, 11)*. The brooches from *Müngersdorf*, like those from *Cologne*, were decorated with filigree which included rings. In the *Müngersdorf* brooches the ring filigree lies in the sunken panels between the cloisonné, which forms a design like three spokes of a wheel surrounded by a border. Doppelfeld (1960b) points out that the rosette brooches from the *Cologne* grave, with their raised central panel decorated with ring filigree and single settings, can be associated with the bossed brooches. It is likely that the bossed brooch from *Rosmeer* also had calcite putty (see above), and one can therefore assume that there were one or more workshops which produced both cloisonné and bossed brooches.

In a discussion of the cloisonné from the *Cologne* grave it is important to note that the grave contained not only cloisonné with calcite putty but also objects with fused paste in the form of sulphur. These are the pendants which belong to the necklace. It is not unusal for such pendants to have fused paste (see below), and they suggest that this type of jewellery was produced in a separate workshop (cf. 6:2d).

Calcite putty was thus sensitive to influences from the outside where acidity, perhaps caused by sulphur bacteria in association with decomposition, could bring about the dissolution of the calcite. It can therefore be assumed that cloisonné work without paste, where the cell walls are so high that there is a hollow space below the inlays, in all probability originally contained calcite putty. A typical example is an S-shaped brooch from Italy (BM 6), where analysis of the paste showed that it contained silver sulphide. At first this was interpreted as a fused paste of sulphur which had been affected by the silver in the brooch. A subsequent examination revealed, however, that most of the cells were empty and that the silver sulphide therefore was more probably a corrosion product. Thus it seems that this brooch originally contained

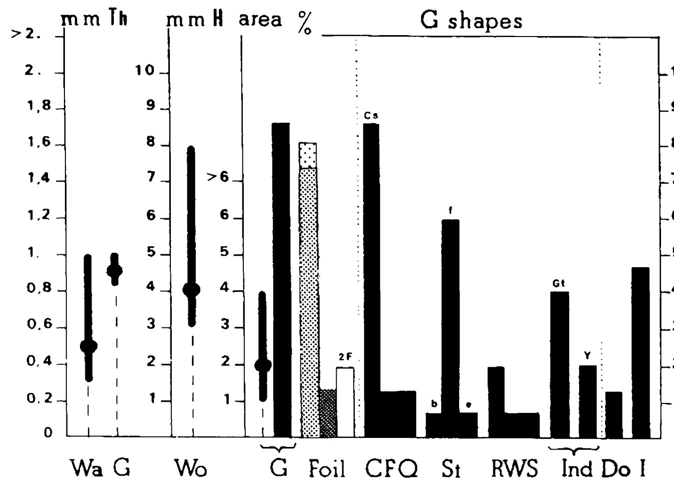



Fig. 164. Diagram showing the technical features of the North Sea group, i.e. cloisonné with sand putty I:2 a; I:3 a.

The diagram is based on 15 objects, 5 of which are from two graves, and counted as one sample each.

The objects are: BM 6, 11, 13, 17; Br 2; Köln 4, 5, 9 (=1), Köln 10; Leu 1 ; Oslo 1, 2 (=1); Paris 5; Swed 22, 65.

Of these BM 6, 17 and Köln 4 had no putty but are considered to belong to this group (cf. p. 138). Br. 2, Paris 5 and Parm 1 were only visually analysed. The notable features are the equal thickness of the garnets, the occurrence of two different foil patterns on single objects and the numerous stepped shapes as well as more individual forms like Gt and Y.

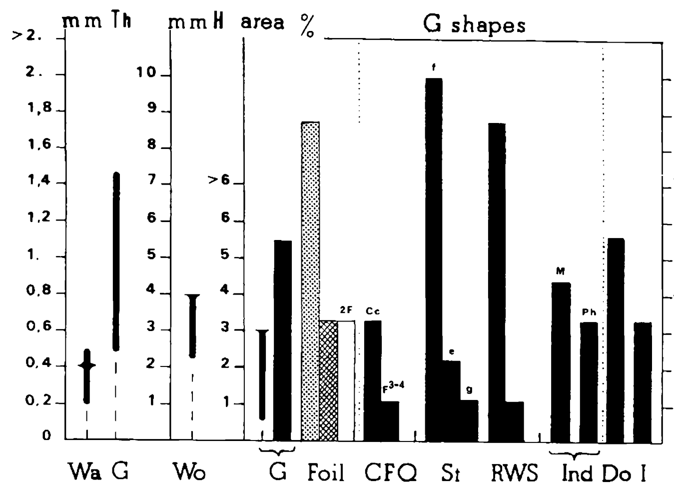



Fig. 165. Diagram showing the technical features of the cloisonné from Sutton Hoo considered by the present author to belong to the North Sea workshop.

The objects denominated after Bruce-Mitford (1978) Sutton Hoo 6–7, 10–14, 17, 18, 20, 26, 27.

Sutton Hoo 6–7 and 12–14 are counted as one sample each.

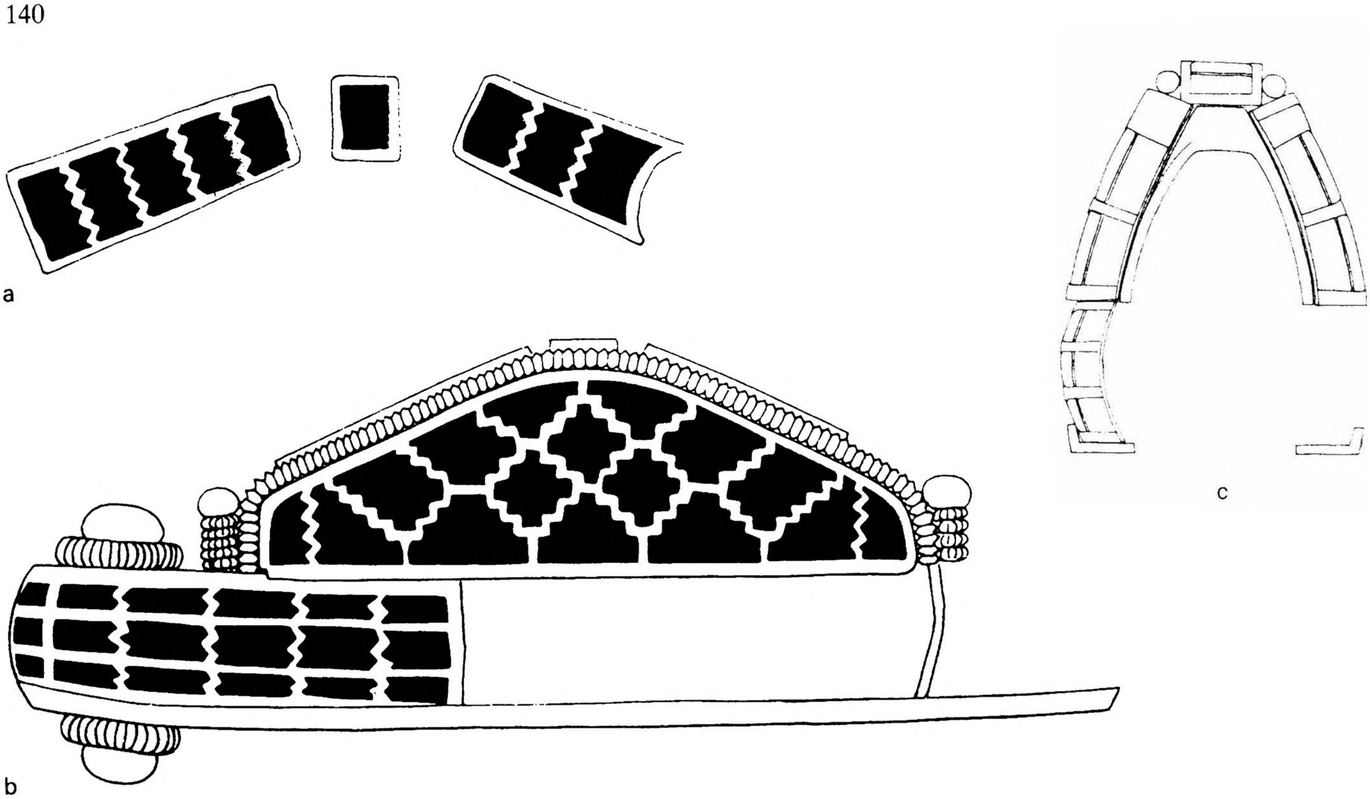



Fig. 166. a–c) Garnet cloisonné on the gold pommel from Sturkö (Swed 16). a) The upper part. b) The sides. c) In section. 2:1.

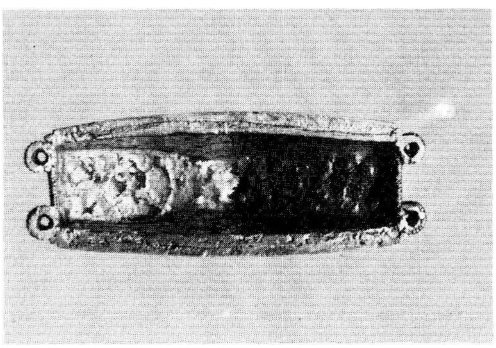


Fig. 167. The inside of the gold pommel from Hög Edsten (Swed 21). 1:1.

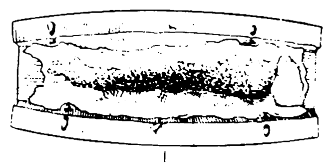


Fig. 168. The inside of the gold pommel from Sutton Hoo. After Bruce-Mitford (1978). 1:1.

calcite putty. Silver sulphide was found in other brooches, including the rosette brooch from grave 26, *Schretzheim* (Dill 2, Table XI, II: 2 a, analysis no. 194), where it occurred along with quartz putty which, unlike calcite putty, cannot be affected by acids. Corrosion products may have been formed where, for instance, the solder contained silver as well as tin and lead and thus produced galvanic elements.

While acknowledging that the analyses are not altoghether representative, because calcite putty has a tendency to dissolve, it can nonetheless be stated in conclusion that objects with a sand putty consisting of calcite mainly occur in the North Sea region. Unlike some of the other sand putty groups, calcite putties contain few other elements, so that it is difficult to differentiate between workshop groups among the objects with this type of paste. Samples of pure calcite putty have not been distinguished from those with small amounts of quartz, as it seems probable that these were not added intentionally but are secondary impurities. It was observed that quartz grains were not equally distributed in the paste and that their detection under analysis was therefore partly accidental. Carlström (cf. 3:4) describes the calcite as typically very fine-grained and probably consisting of chalk. As chalk occurs in many surface exposures in the North Sea region—not only in Anglo-Saxon England but also on the continental coastlines of the North Sea—its identification does not help to define its provenance more closely.

We have seen that calcite was also used in cement paste, although in a considerably wider geographical area than the North Sea region. It would seem, however, that the calcite which was used in fused pastes came from the same chalk deposits as that in the sand calcite putties. The relationship between sand putty and fused pastes with calcite seems to be especially significant (see below) and objects with sand calcite putty and fused pastes have been found together, for instance in the *Cologne* grave.

The material analysed included a number of objects of clearly Frankish forms, such as the round disc brooches from *Köln-Müngersdorf, St Denis* and *Marilles*.

It has not been possible to assign the North Sea group, either to Anglo-Saxon England or to the Continent and it has been suggested that workshops for this group may have existed in both areas. The close connections between the workshops is demonstrated by the diagrams figs. 164 and 165. It is likely that calcite putty was first used on the Continent and that the workshop transferred to England in connection with the work at *Sutton Hoo*. The earlier examples of work in calcite putty, that is the brooch and strap-end from the *Cologne* Cathedral grave and the rosette brooch from *Köln-Müngersdorf*, have an indubitably continental character, while the buckle from *Wynaldum*, for instance, shows a strong influence from Anglo-Saxon cloisonné art, as was pointed out by Bruce-Mitford (Bruce-Mitford 1959).

It appears that the calcite group occurred a little later than other sand putty groups. The earliest objects with calcite putty belong to a phase which is exemplified by the *Cologne* grave, and it is also present on the brooches from *St Denis*. The latest objects with cloisonné set in calcite putty appear to be those from *Sutton Hoo*. There is further evidence that calcite putty was used as filling in *pressblech* and bossed brooches.

## 5:2 Sword pommels in sand putty-cloisonné

An important part in the discussion of a possible Frankish origin are played by the sword pommels with gold cloisonné of cocked-hat form (cf. colour plate I). We have seen that pommels of this type occurred in the Swedish material from *Hög Edsten* (fig. 169–172) and *Väsby* (fig. 176) with a pure quartz putty. Pirling (1974) has pointed out that the *Väsby* pommel is very close to the one from *Krefeld-Gellep*. As the use of quartz putty is concentrated in the *Trier-Cologne* area, it is, in my opinion, probable that pommels of this sort were produced there.

On some cloisonné pommels there is clear evidence that garnets of an older type, e.g. taken from items executed in the cement-technique, were used. Some of the garnet shapes used on the pommels from *Väsby* and *Vallstenarum* are also used with cement technique: the side panels of the *Väsby* sword (fig. 176c) are identical with those on the grip of Childeric's sword (fig. 179) and there are omega-shaped garnets on both the pommel and the grip from *Vallstenarum* (figs. 173 and 175).

In the publication of the *Vallstenarum* pommel (Arrhenius 1970) I pointed out that the design with opposed boars' heads on the front of the pommel is very similar to a design in garnet cloisonné on the disc brooch from *Marilles* (Brü 2). This design can be seen in a more original and clearer version on the pommel from *Hög Edsten*, (fig. 170) which, with its quartz putty, presumably came from a Rhenish workshop. Whereas the central motif on the *Hög Edsten* pommel is a quatrefoil, on the *Vallstenarum* pommel (fig. 173), it has been somewhat distorted. This motif, like the animal motif, has been given a floral form on the *Vallstenarum* sword. The awkward treatment of the animal ornament on the *Vallstenarum* pommel is very similar to the design on the pommel from *Sutton Hoo*, where the quatrefoil motif plays an important role, and the animal ornaments can only be identified as such with the knowledge of prototypes such as that from *Hög Edsten*. The curves on the *Sutton Hoo* pommel, where the S-curves are made up of several garnet cells (cf. fig. 178), are reminiscent of the ornament on the *Vallstenarum* pommel, and also of the curves in the designs on the disc brooches from *Marilles* and *St Denis*. I am inclined to presume that all four objects came from the same workshop. It has been demonstrated above that calcite was the most common sort of putty in the material from *Sutton Hoo,* and the same type of putty was visually identified on both disc brooches.

Bruce-Mitford (1972, 80 ff.) presumes a Swedish origin for the sword pommel from *Sutton Hoo*. This attribution seems primarily to rest on the fact that it is in Sweden that most pommels with gold cloisonné have been found. The discussion above (cf. 4:1) concluded that the density of finds in an area does not necessarily indicate that they were produced there. This was particularly found to be the case for objects with a high second-hand value as raw

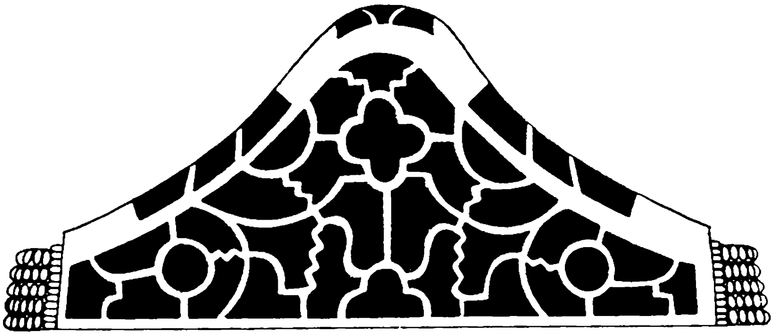


Fig. 169

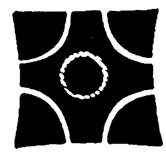


Fig. 171

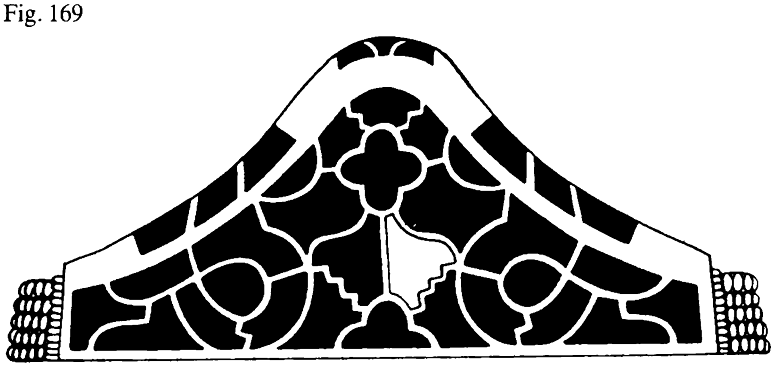


Fig. 170

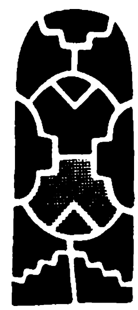


Fig. 172

Fig. 169–172. Garnet cloisonné on the gold pommel from Hög Edsten. 169–170) The long sides. 171) The top. 172) The short sides. 2:1.

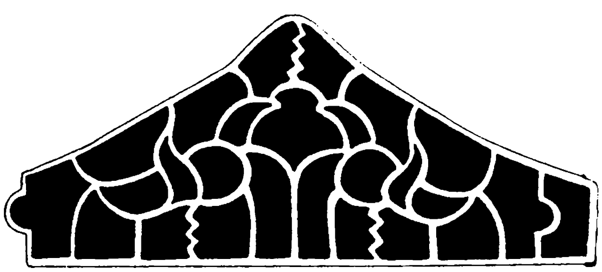


Fig. 173

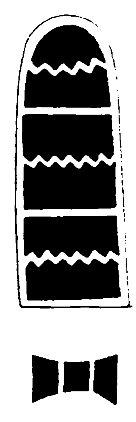


Fig. 174

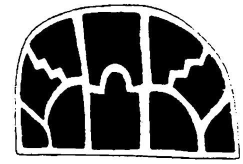


Fig. 175

Fig. 173–175. Garnet cloisonné on the sword from Vallstenarum (Swed 65). 173) The long sides (both are identical). 174) The short sides and the top. 175) The collar mounted on the handle. 2:1.

material for new work, which very much applies to gold-cloisonné pommels. In these cases, centres of production may be identified with a scarcity of finds. When workshops have been identified, the density of finds in the area has been considered, but only in a relative sense, that is the predominance of a certain type of paste in an area where other types of paste occur. The analyses also mainly considered simpler, mass-produced objects such as the Frankish silver disc brooches, because they were considered to be more relevant to determining the location of workshops than more valuable and unique artefacts.

Seven cocked-hat sword pommels of gold with cloisonné have been recovered in Sweden: they come from

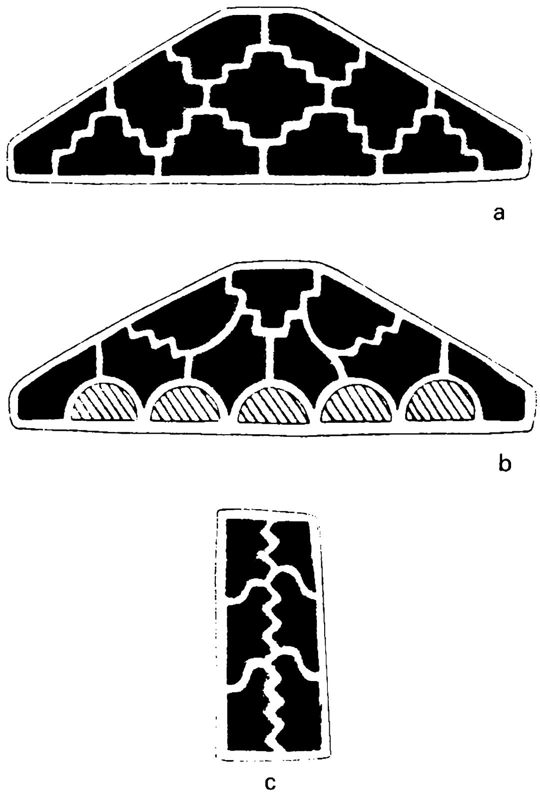



Fig. 176. Cloisonné panels from the gold pommel from Väsby (Swed 13). a, b) The long sides. c) The short sides. (Both short sides have identical patterns but one has been altered by the addition of a gold ring). 2:1.

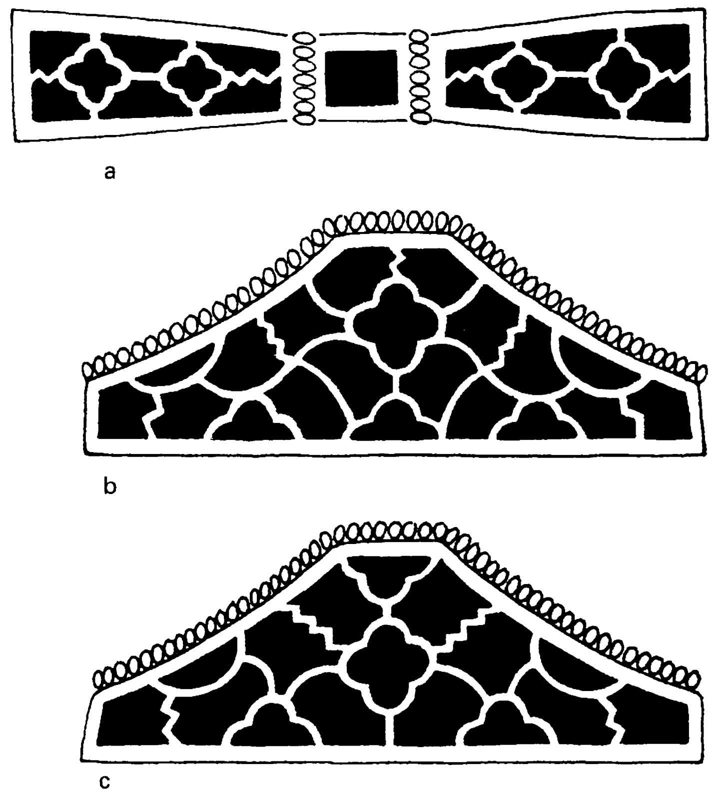



Fig. 178. Cloisonné panel on the gold pommel from Sutton Hoo.
a) The short sides. b and c) The long sides. Note the minor differences between the sides. 2:1.

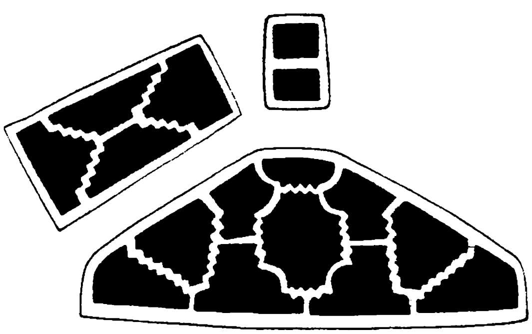


Fig. 177. Cloisonné panels on the gold pommel from Krefeld, Gr 1782 (Kre 1). 2:1.

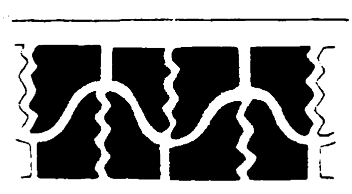
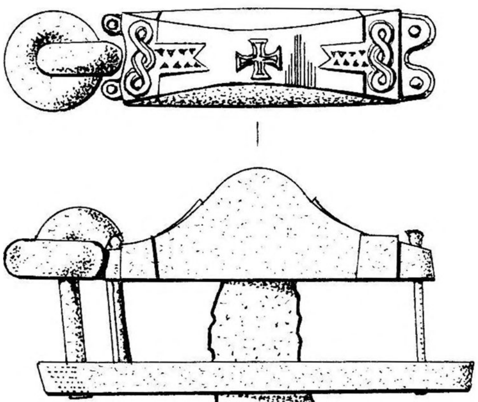


Fig. 179. Cloisonné pattern from the guards of Childeric's sword (cf. fig. 176 c). 2:1.

*Väsby, Hammarby*, Uppland (Swed 12); *Sturkö*, Blekinge (Swed 16); *Glafsfjorden*, Värmland (Swed 20); *Hög Edsten*, Bohuslän (Swed 21); *Skrävsta, Botkyrka*, Södermanland (Swed 26); *Uppsala Västhög*, Uppland (Swed 27): and *Vallstenarum*, Gotland (Swed 65) (cf. fig. 166–175, 213, 216). There are also a number of pommels of this type in silver and bronze with cloisonné inlay. The number of gold pommels in Swedish finds is particularly remarkable because no gold pommels of this type are known from elsewhere in Scandinavia. It is also remarkable that three of the seven pommels are loose finds; one comes from a hoard (*Hög Edsten*) and only three from grave finds. The pastes in four pommels with silver and bronze cloisonné were analysed and found to be fused



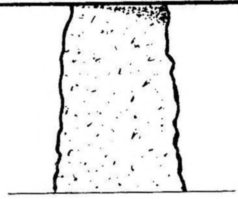


Fig. 180

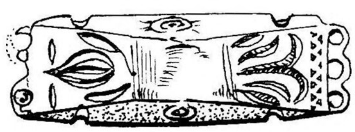
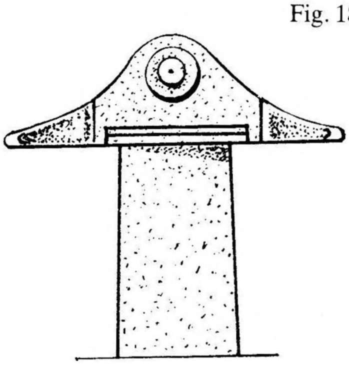


Fig. 181



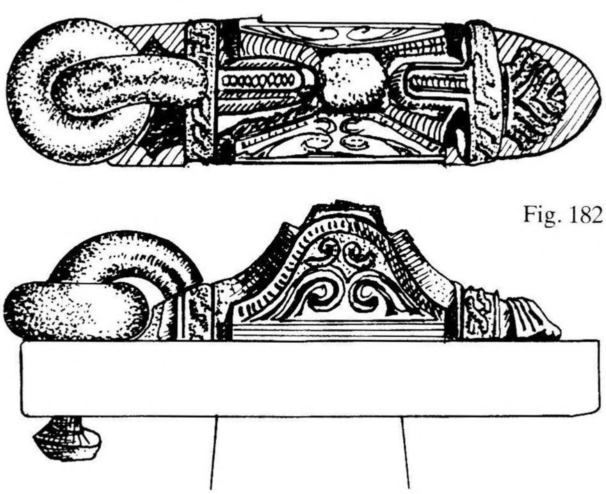


Fig. 182

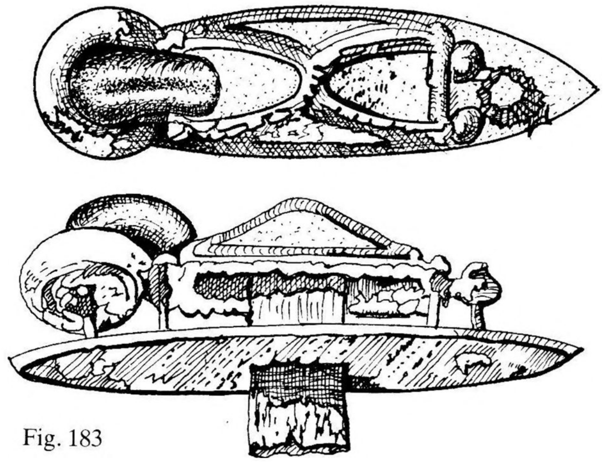


Fig. 183

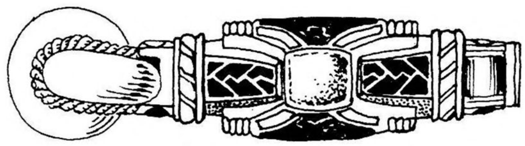
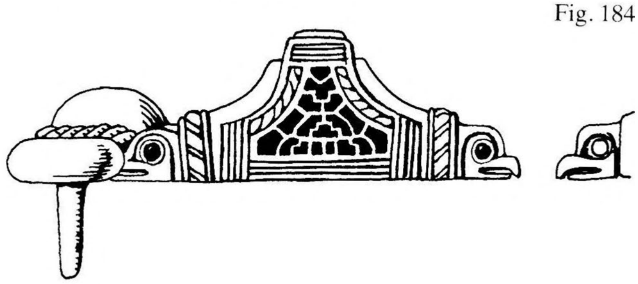


Fig. 184



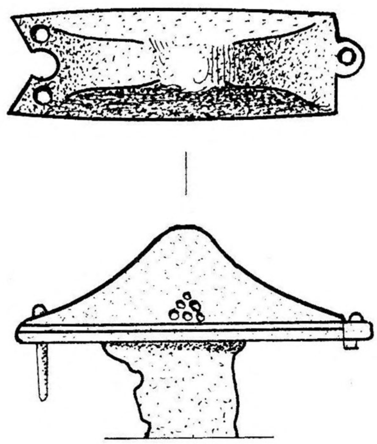


Fig. 185

Fig. 180–185. Frankish cocked-hat pommels with sword-rings or attachments for sword rings.
180) Chaouilley, France.
181) Fèrebriànges, Marne, France.
182) Orsoy, Germany.
183) Mainz Kastell, Germany.
184) Italy (?), no provenance (BM 19).
185) Chassemy, Aisne, France.

paste. Analysis of the pastes from the gold pommels shows greater variations. The pastes from six pommels were analysed, two of which, from *Uppsala Västhög* and *Skrävsta*, probably had fused pastes originally; the pommels had been burnt and the pastes consisted of blistered calcite. The pommel from *Sturkö* had quartz calcite putty and those from *Väsby* and *Hög Edsten* quartz putty, while the *Vallstenarum* pommel had calcite putty. It will be demonstrated below (cf. 6:4) that pommels with fused paste were possibly of indigenous manufacture while pommels with sand putty were imported; the quartz calcite putty in the *Sturkö* pommel indicates that it was imported, perhaps from the *Mainz* area, while the two pommels with quartz putty may have come from the *Cologne-Trier* area. Finally, the pommel from *Vallstenarum* was imported from the North Sea region.

The large number of cocked-hat sword pommels with cloisonné is unique to Sweden, where there are more than the total number of finds from the Continent and England. This type of pommels was more popular in Sweden than other types found on the Continent such as the pommels used on the gold-hilted spathae. This is confirmed by the fact that this type was adopted in the Swedish cloisonné production. There may be several reasons for this: it is likely that this type of sword was in fashion at the time when the production of cloisonné began to flourish in Sweden, and therefore this particular form was adopted and developed. It is also possible that garnet cloisonné was produced in Scandinavia, and particularly in Sweden, for a longer period than elsewhere (cf. 6:4) and that larger numbers of pommels were therefore produced. A third and perhaps more important reason is that the ring-pommels in Sweden (and perhaps in Scandinavia) and in England served a somewhat different purpose from those in the Frankish area (cf. 7:4). It appears to be significant that the gold cloisonné pommels from outside Sweden, that is the pommels from *Sutton Hoo* and *Krefeld Gellep*, have no adjustment for a sword-ring. The *Krefeld Gellep* pommel (fig. 177) is in fact fitted with a sword-ring, but as no space was left for it in the cloisonné design, the ring partly obscures the design on the narrow face of the pommel. On the Swedish pommels from *Sturkö* and *Väsby*, there is a space for the ring fitment on the lower part of one of the narrow faces (cf. colourplate I). The *Hög Edsten* pommel has no such space, and on the *Vallstenarum* pommel a part of the side was demolished in order to fit the large ring which now decorates the sword.

Evison (1967, cf. also 1976) has demonstrated that ring-swords were probably first produced by the Franks in the *Maas* area and then spread quickly to England and Scandinavia. It appears to be a feature of the Frankish ring-swords that the rings are small (not exceeding 2 cm in diameter) and detachable. The Swedish pommels from *Väsby* and *Sturkö*, which have a seating for the ring attachment on one side, were also designed to the small rings of the Frankish type. On a group of Frankish ring-swords, the rings are mounted on a projection on one side of the pommel (cf. the pommel from *Orsoy*, fig. 182); the projection was apparently originally an animal head. On one of the earliest Frankish pommels with cloisonné (without provenance, but probably from Italy, fig. 184) these animals are clearly seen as birds' heads. This bronze pommel is of cocked-hat form with curved and projecting birds' heads on both sides; an early feature is that the tang of the sword penetrates through the thickened part of the pommel. The ring lies flush against the head of the bird on one side, while on the other a domed, rectangular garnet is inlaid on top of the bird's head. The four cloisonné panels are in raised trays, their edges decorated in striped metal inlay of silver and copper wire. This type of metal inlay is particularly typical of small Frankish disc brooches with sand putty and its presence on the pommel assigns it to Frankish goldsmith's art. Evison (1976) has also published a sword pommel from *Laon, Aisne*, which is very similar to the Italian pommel. The *Laon* pommel is simpler and has cloisonné panels on the front and back only, while the sides are decorated with ribbon-like animals, but, as Evison points out, the relationship between them is obvious. This pommel is also closely associated with the sword from *Orsoy* which, however, is probably a little later and belongs to a period when weapons were no longer decorated with cloisonné in the Frankish area. The raised cloisonné panels on the pommels from *Laon* and Italy are typical products of the Frankish sand putty technique. The design on the Italian pommel is made up of shapes cut from f. St-templets while on the *Laon* pommel there are only segment- and sector- shaped garnets, shapes which are most commonly found on Frankish disc brooches. These pommels also provide a clue to the construction techniques of the more complicated pommels in gold cloisonné.

The description of the sword pommel from *Sutton Hoo* (Bruce-Mitford 1978) (cf. fig. 178) reveals that the cloisonné panels were attached to an inner lining of bronze. The same construction was observed on the pommel from *Sturkö* (cf. fig. 166 and fig. 168), although here the lining was of gold. This inner core is the equivalent of the actual pommels of bronze from *Laon* and Italy described above, the difference being that on the gold pommels, the cloisonné panels are so large that the joints between them are hidden under strips of gold filigree.

The panelled pommels, whether gold or bronze, are in fact the direct descendants of sword pommels of the early Migration period of *Porskaer* type, perhaps particularly like the one from *Dallerup* (Behmer 1939, pl. XXXIII:8 a; cf. also Arrhenius 1980, fig. 13), but they differ in that the tang of the sword no longer penetrates the top of the pommel, a new feature present in all the gold cloisonné pommels. When the pommel was attached to the metal mounts of the guard, the tang was no longer essential for securing the pommel. The metal-mounted guards also reduced the stresses on the pommel, which in turn gradually lost its thick walls or—as was the case for the cloisonné pommels described above—its internal support. The *Hög Edsten* and *Vallstenarum* pommels are typical examples of this development in cloisonné pommels, while among those without cloisonné, the swords from *Mainz-Kastell* (fig. 183) and *Chaouilley* (fig. 180) show similar trends. It is at this stage that the production of ring-swords appears to have begun in Anglo-Saxon England, Scandinavia and among the Allemanni. However, the ring-swords which were produced in these areas differ in some respects from those originally produced by the Franks. In England, the ring which is fixed to the guard mount is in a vertical position, while the horizontal ring leans up against the side of the pommel. Large sword-rings of the type found in Scandinavia and among the Allemanni were apparently only introduced at a late stage, as demonstrated by the pommel from *Coombe* (Evison 1976, 308). In Scandinavia, as with the Allemanni and Langobardi, the sword-rings retain the same shape as that developed by the Franks, but they increase to almost twice the size, with the result that the vertical ring covers the greater part of the side of the pommel.

The pommel from *Hög Edsten* has no sword-ring, but the position of the rivets, which were 5 mm apart on one side and only 4 mm apart on the other, suggests that a ring of Frankish type was intended to be fitted on the guard mount, in the same way as the ring on the pommel from *Chaouilley* (the rod from which this ring was made is 4 mm in diameter). The ornament on both pommels includes cruciform designs. One side of the *Vallstenarum* pommel was demolished when the present large sword-ring was secondarily attached; it is therefore not possible to establish the character of the original arrangement. It is likely, however, that the design of two animal heads, facing away from each other, on the *Hög Edsten* and *Vallstenarum* pommels is a translation into garnet cloisonné of the animal heads on the earlier Frankish ring-pommels. This is also suggested by the ornament on a pommel from *Faversham* (cf. Åberg 1926, 141) where the same design is produced in metal inlay imitating cloisonné. It is likely that the ornament on the *Sutton Hoo* pommel intended to represent two affronted animal heads, although the forms are purely geometrical. Mounted as at present, the pommel could not have had an attached ring. It is, however, clear that this cannot have been the original mounting, as the upper, flat guard mount with its lentoid hole does not fit this sword and must have come from another sword or dagger (cf. Bruce-Mitford 1978 fig. 218 f). The *Sutton Hoo* pommel may well originally have been mounted on another grip where there was room for a small sword-ring of Frankish type.

The paste analyses therefore demonstrate that *most of the Swedish gold cloisonné pommels were imported*. That they were imported from a Frankish area is shown not only by the character of the paste but also by the form of the fittings of sword-rings, where these occur, and by the ornament. There is therefore no reason to suppose that Bruce-Mitford's argument that the *Sutton Hoo* pommel is Swedish is correct. On the contrary, there are several indications that it is of Frankish origin. With no analysis of the paste and no information as to whether or not paste is present, the provenance of the *Sutton Hoo* pommel cannot be established with any certainty. It has been suggested that certain features of the curves in the cloisonné indicate that the pommel came from the same workshop as the *Vallstenarum* pommel.

## 5:3 The chronology and chorology of continental objects with sand putty

We have seen that all cloisonné works with sand putty typically have type 1 garnets, even though there are several cases of re-set garnets cut from b-templets. In a few finds from Hungary, type 2 garnets were identified. The shapes are mostly simple, mainly sectors and segments of circles, but in some finer work there are also garnets cut from f. St-templets.

The use of garnets taken from work using cement cloisonné and re-used in objects made with the sand putty technique is one indication that the two methods overlapped for a certain period. Another indication is that some types of objects were first produced by the cement method and later by the sand putty method. This was the case with the buckles with round plates of the type which were found, for instance, in *Pouan* and in *Hungary* and which have precursors in the cement technique, such as in Childeric's grave and the *Apahida* graves. This was probably also the case with the heart-shaped pommels for long seaxes, one of which was found in *Németkér* in Hungary and another at *Pouan*. Both of these used the sand putty technique, but the garnet inlay on the Hungarian pommel included garnets with the interlocking U-shaped projections and indentations typical of the second phase of the cement technique. This is particularly significant, as I consider it likely that one of the prototypes for these pommels is the seax in Childeric's grave (cf. fig. 114). In copying this type of seax, the method of suspension from two points on one side of the sheath, typical of the oriental seax, was not adopted. This is perhaps because there was a local tradition of carrying the one-edged swords in the same way as the two-edged swords. It can, however, be observed that the early Byzantine one-edged swords apparently did not have the two-point suspension method typical of both the Sassanian one-edged swords and the late Byzantine daggers of *Castel Trosino* type. It seems that the two-point suspension method was introduced fairly late in Byzantine art and that Childeric's seax must have been a very modern and advanced form at the time it was produced. The seax from *Planig* was also supplied with a gold mount suggesting a two-point suspension attachment of the same type as that in Childeric's grave. Here we observe a confrontation between the traditions of two different workshops: in the satellite workshop which used the cement technique and assembled weapons in *Planig* it was natural to provide a two-point suspension for the seax, while in the probably more local workshop which produced the seax from *Pouan* an earlier type of suspension was supplied.

In spite of the different types which occur it seems likely that these workshops were more or less contemporary; and this is also suggested by the use of garnet shapes which are typical of the cement technique on the Hungarian pommel.

Horse trappings also demonstrate that the magnificent cloisonné mounts using cement technique were copied using sand putty technique. This is probably the case, for instance, with the D-shaped mounts on the so-called Theodoric's armour, which belonged to a saddle of the same type as those from *Apahida II* and grave 1782, *Krefeld-Gellep* (cf. Vierck 1972). To judge from the illustrations, the Theodoric mounts were made with sand putty technique (cf. Rupp 1937, pl. VIII). This can be deduced from the picture of the back of the mount, where the cells are seen to have been partly soldered to the back plate; the work is also in two levels, which is difficult to achieve by any method other than the sand putty technique. The way the designs on the Theodoric mounts are built up is very reminiscent of the decoration on the mounts from *Domagnano*: in each case the designs are composed of small, many-sided cells in a complex pattern.

It must be presumed that not only the D-shaped saddle mounts but complete sets of horse trappings were copied from objects using the cement technique. The round strap-distributors from grave 1782, *Krefeld-Gellep* (fig. 189) are therefore directly comparable with the equivalent mounts from *Apahida II*. The mounts from *Krefeld-Gellep* are made with garnets cut from f. St-templets and set in tray-like panels by the sand putty method in a cruciform design, while the mounts from *Apahida* are decorated with a typical omega pattern in cement technique and with a raised central boss totally covered i cloisonné. Pirling (1974, 130) has accurately described the points of similarity between the round cloisonné-decorated strap-mounts of this type and the Frankish disc brooches. A raised central boss occurs early among these brooches, as for instance on the brooches from the *Cologne* Cathedral grave (Köln 4). It is very likely that the brooches from this grave originally held calcite putty which has since corroded. It is significant that there is evidence of the use of cement paste on small disc brooches. A typical example comes from the cemetery at *Baumgarten,* (Wien 2), which had a paste of hardened calcite. According to Werner (1962, 112) the graves from *Baumgarten* belong to the early Pannonian phase of the Langobards, that is the period before 527. This brooch, which is only 1.8 cm in diameter, has backing foil with ring-patterns, another early feature. Ring-patterned foil is usually associated with cement technique, but there are examples of rosette brooches with this type of foil (cf. Rupp 1937, pl. I and pl. XIV:5). I had the opportunity to examine one of these in the Bibliothèque National (Paris 15) and while I was not allowed to analyse the paste, it appeared to be a typical sand putty. Ring-patterned foil therefore occurs sporadically with sand putty technique, probably as a more or less direct inheritance from the cement technique. One of the strap-ends from the *Cologne* Cathedral grave (Köln 5) provides an example of this process: the centre of the insect design (cf. fig. 139) is inlaid with ring-patterned foil, which in this case was probably taken from an older object. It is very likely that this was also the case with the foil in the rosette brooches mentioned above. It is otherwise typical for foil in sand putty cloisonné to have diaper or waffle patterns.

Thus it appears that the Frankish disc brooches were first developed in cement technique but that there was a rapid change to sand putty technique. The same change took place in the production of the large eagle brooches, the prototypes of which may have been saddle mounts using cement technique of the kind found at *Apahida*.

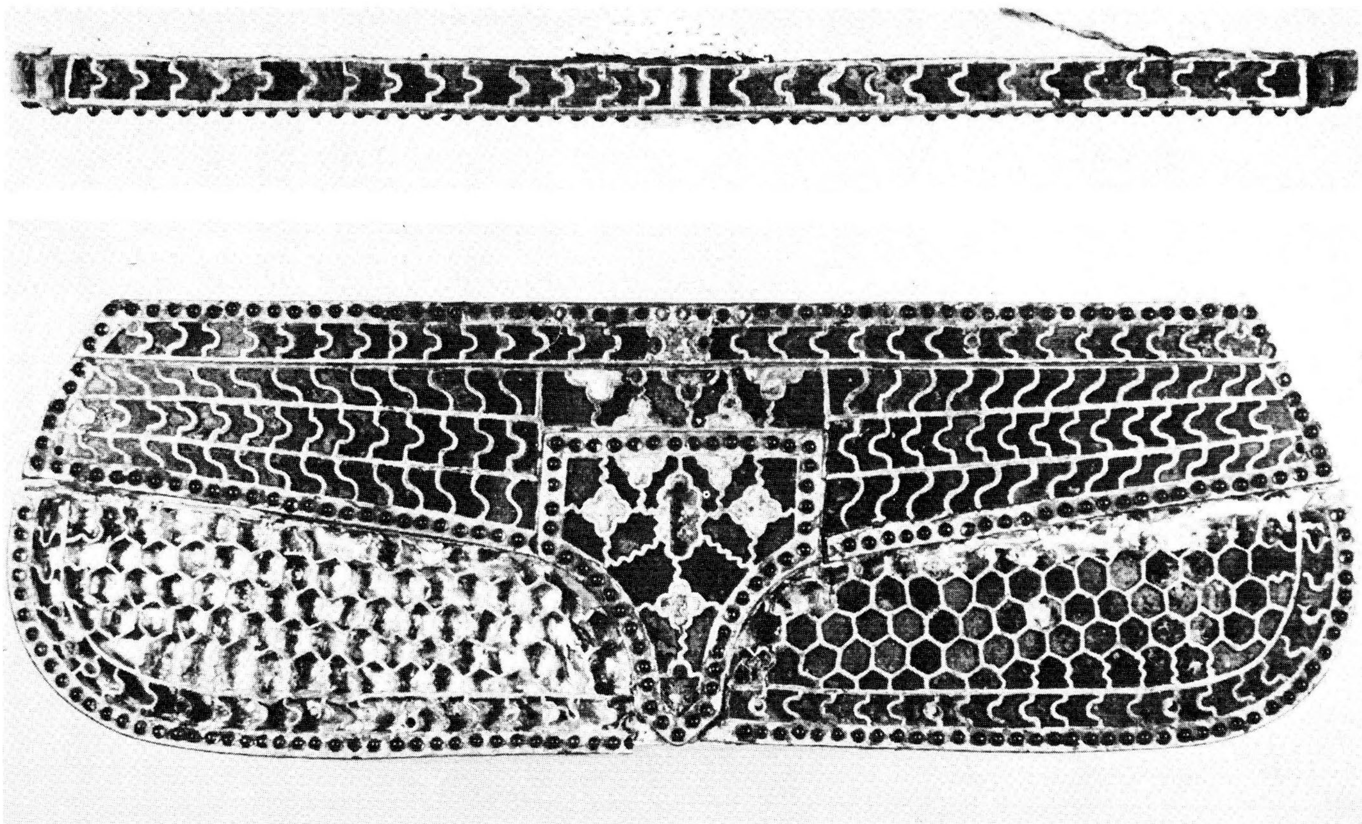


Fig. 186. Purse from Apahida II. 1:1.

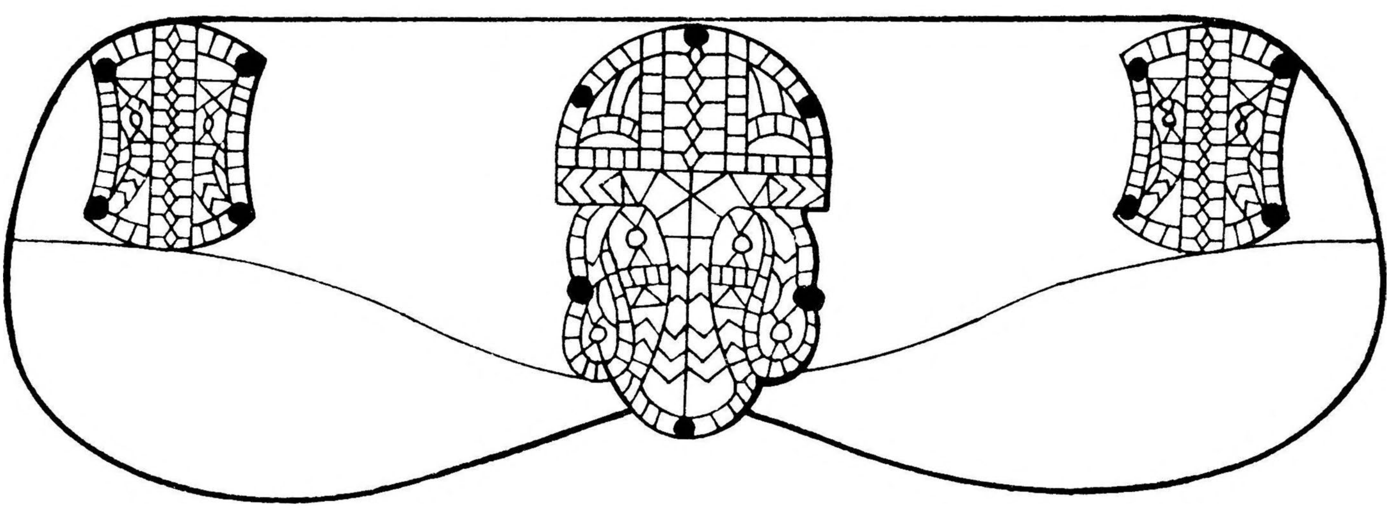


Fig. 187. Tentative reconstruction of a purse from Domagnano. 1:1.

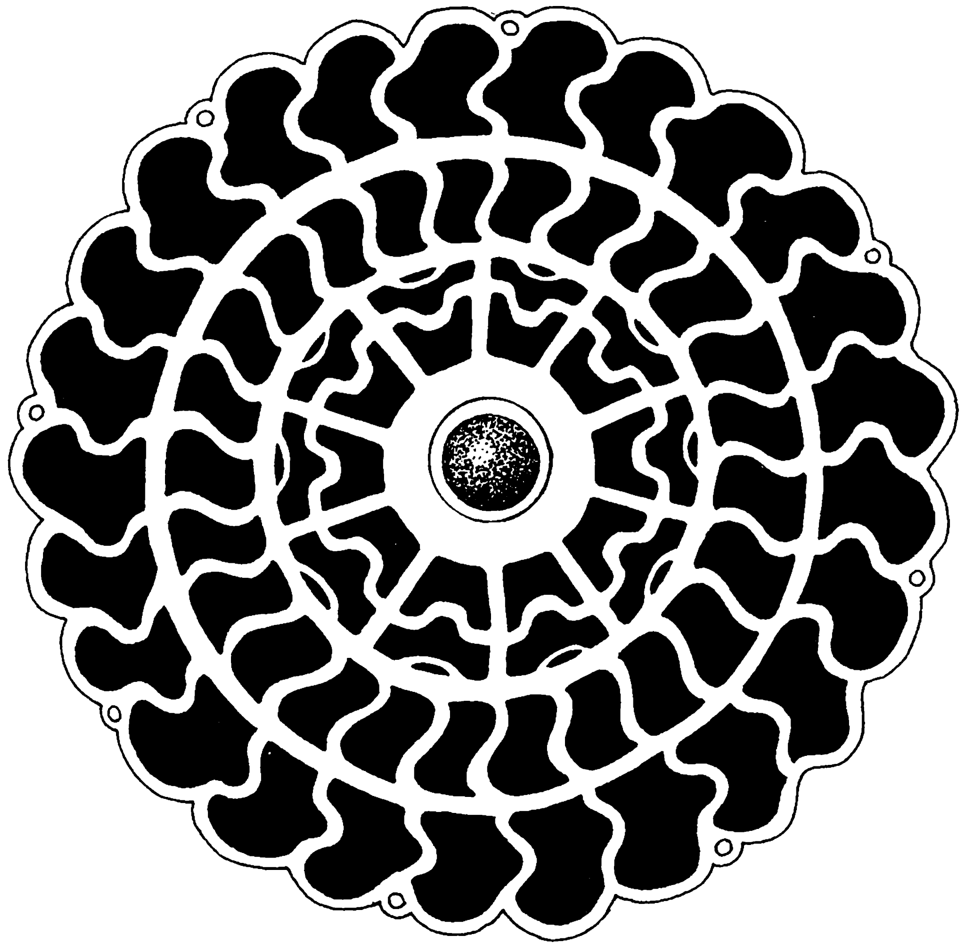


Fig. 188. Cloisonné pattern on a bridle-mount from Apahida II. 2:1.

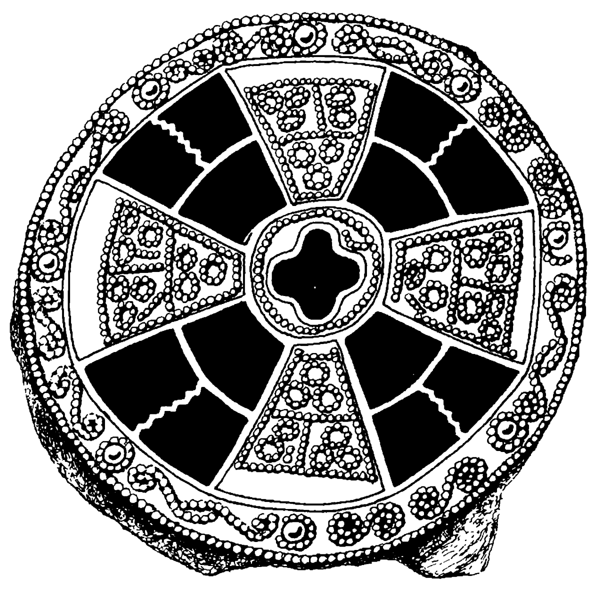


Fig. 189. Bridle-mount from Krefeld Gellep, Gr 1782 (Kre 2). 2:1.

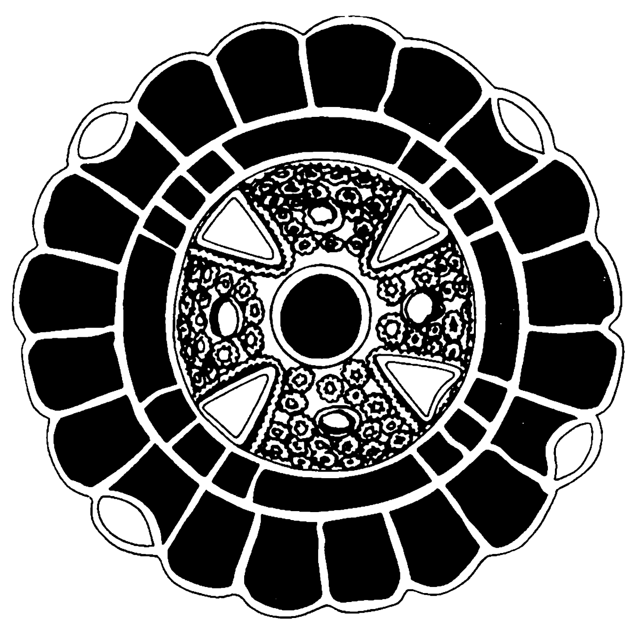


Fig. 190. Brooch from the Cologne Cathedral grave. 2:1.

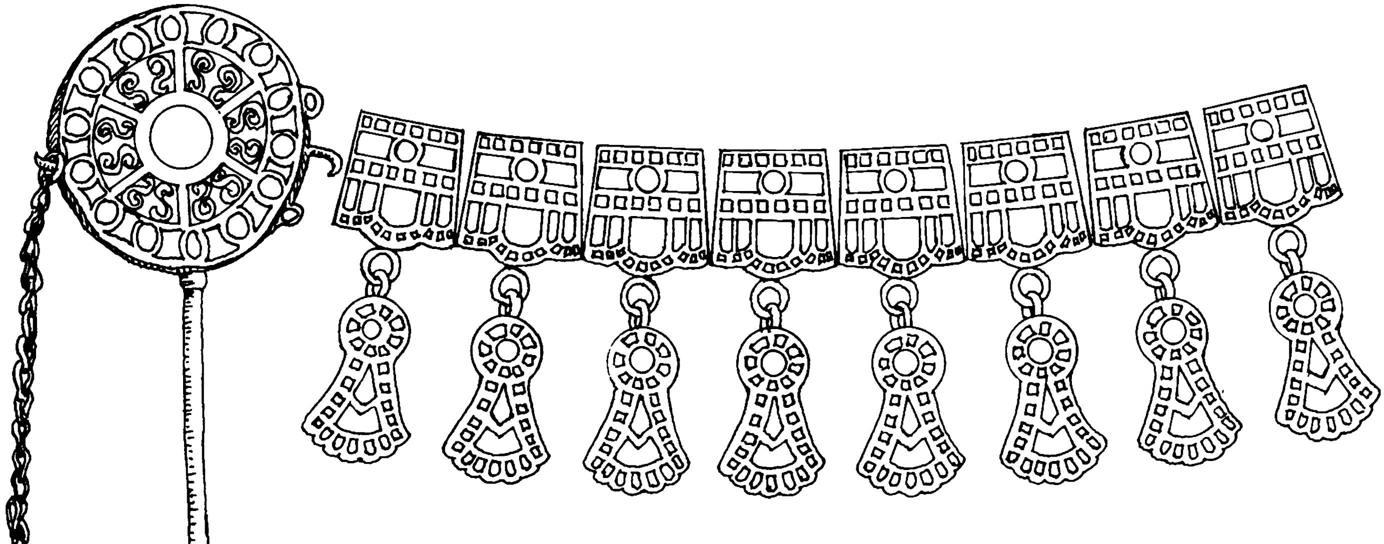


Fig. 191. Pin and pendants from Domagnano. After Bierbrauer 1975. 1:1.

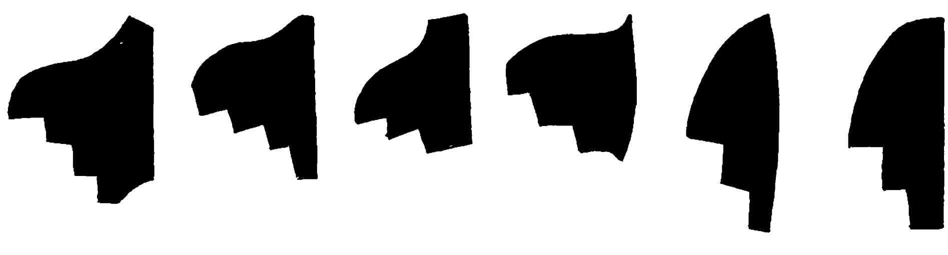



Fig. 192. More complicated garnet shapes cut from the same templet. 1–2) Wing shape (W) from Hög Edsten, (fig. 170), and Parma, (fig. 161). 3–4) Interlocking wing shapes from Parma and Heidenheim, (fig. 158). 5–6) Mushroom shapes from St Denis, fig. 157 and Heidenheim. 5:1.

Brooches of this kind using sand putty technique were found at *Domagnano* (Bierbrauer 1975, 272 ff.). The actual patterns of cloisonné, with their small cells, are very similar to those on Theodoric's saddle-mounts and it is tempting to suggest that they represent one of the workshops in which work made with the cement technique was adapted to the sand putty method—a workshop located in the *Mainz* area. The eagle brooches from *Domagnano* are particularly significant as their garnets were found to be of type 1, that is the most common type used with the sand putty technique. The garnets in these brooches are not, however, cut to the f. St-templet, but have step-patterns more closely related to b-stepped garnets although without exactly the same S-shaped curves as these. Another detail of the garnets on the eagle brooches were the slightly domed undersides of the stones, indicating that they were not cleaved quite correctly. These features suggest that this cloisonné is one of the earliest examples of the sand putty method using cut garnets of type 1 quality. In this context it is interesting to consider the oval mount and the two rectangular mounts with cloisonné of the same quality which were found at *Domagnano* (fig. 187). Their purpose has so far been unknown (cf. Bierbrauer 1975, 207), but it is my opinion

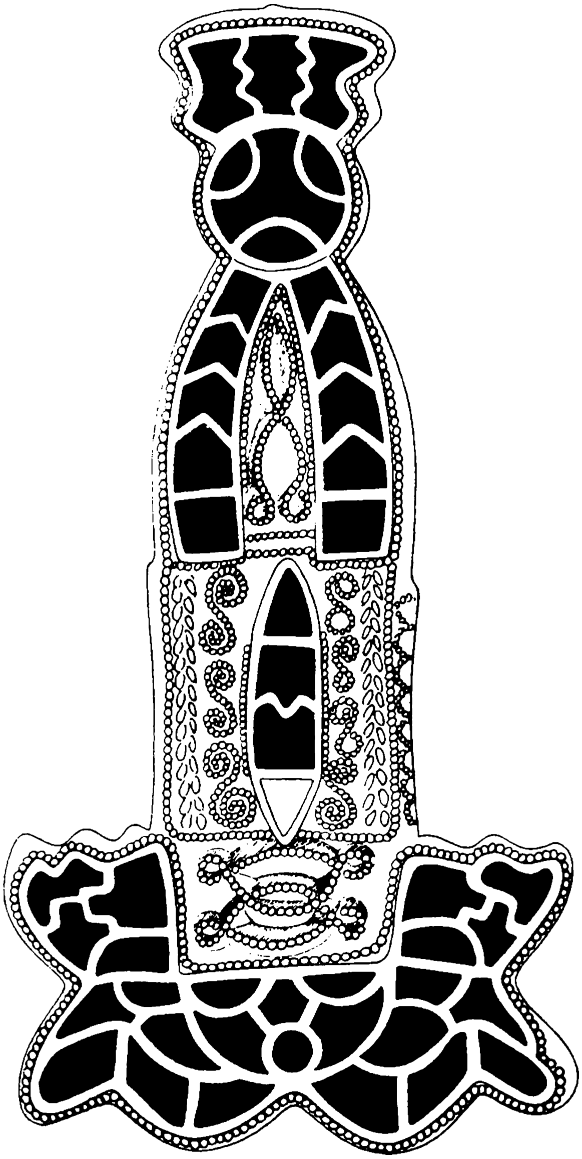


Fig. 193. Bow brooch from the Cologne Cathedral grave. (Köln 8). 2:1.

that they are purse mounts of the same type as those from *Apahida II* (fig. 186). With only three cloisonné panels, this purse is simpler than the one from *Apahida*, which was entirely covered in cloisonné, but at the same time it is more like the *Sutton Hoo* purse and the one from *Beckum* (cf. Winkelmann 1975), although in the latter case the mounts were only decorated with filigree. The *Domagnano* purse represents an intermediate stage between these purses and the Frankish purses with horses' or birds' heads which were found in Childeric's grave, for instance, and also in *Planig, Lavoye* etc.(cf. Kessler 1940, fig. 12). The large oval mount from *Domagnano* is the equivalent of the buckle mounts which occur on the Frankish purses. The ornament on this mount from *Domagnano*, with a bird and a fish flanking a Latin cross, is brought into a heightened perspective when seen in association with the animal-and-man motif on the *Sutton Hoo* purse.

Other objects from the *Domagnano* find should also be noted. The two ear-rings with flying insects and the flying insect brooch are unique. Ear-rings with flying insect motifs were found in another East Gothic find, the hoard from *Reggio Emilia* (cf. Bierbrauer 1975, 198 ff.). The upper lunular part of these ear-rings associates them with the ear-rings from *Olbia*, as Bierbrauer points out (1975, 167) (cf. fig. 63). I have not had the opportunity to analyse the cloisonné from *Reggio Emilia,* but it appears to be the type of cement cloisonné were wax was used as filling (cf. 4:3). The garnets were cut to strangely old-fashioned shapes, the stepped pattern made with a templet coarser than a. St, not comparable with anything I have yet found, and in the centre is a circular garnet pierced by a central hole. The *Reggio Emilia* objects are probably early examples of products for export in cement cloisonné. It is important to note the marked Christian character of the cloisonné design, which has a pendant cross below the flying insect. This feature suggests that this work was also Byzantine.

Flying insect brooches with cloisonné are rare, as such brooches usually have no inlay or inlays in single settings (cf. Vinsky 1948). The latter group, which includes the bee-shaped mounts in Childeric's gravė (cf. Böhner 1981), seems to occur primarily in South-East Europe (cf. Hampel 1905, fig. 820–822). The only direct parallels I know of, apart from the brooch with cloisonné from *Domagnano*, come from South Germany and Belgium (cf. Bierbrauer 1973, 512).

The flying insect motif appear only on early works using sand putty technique. As Werner (1963) points out, the motifs on the strap-ends from the *Cologne* Cathedral grave (cf. fig. 139) are flying insects.

Another object in the *Domagnano* find has no direct connection with known East Gothic artefacts. This is a pin with a large disc-shaped head with cloisonné (fig. 191). Decorative pins with cloisonné are found in richly-furnished Frankish graves like that of Arnegunde in *St Denis* (France-Lanord 1962) . They also occur in Anglo-Saxon England, where they are associated with filigree like that found on the pin from *Domagnano*. The pin with disc-shaped head from *Chartham Downs* (cf. Leeds 1936, pl. XXIX:a), has filigree in the centre as the *Domagnano* pin.

In England, the pins were used to secure expensive necklaces, often with garnet inlay, and it is likely that

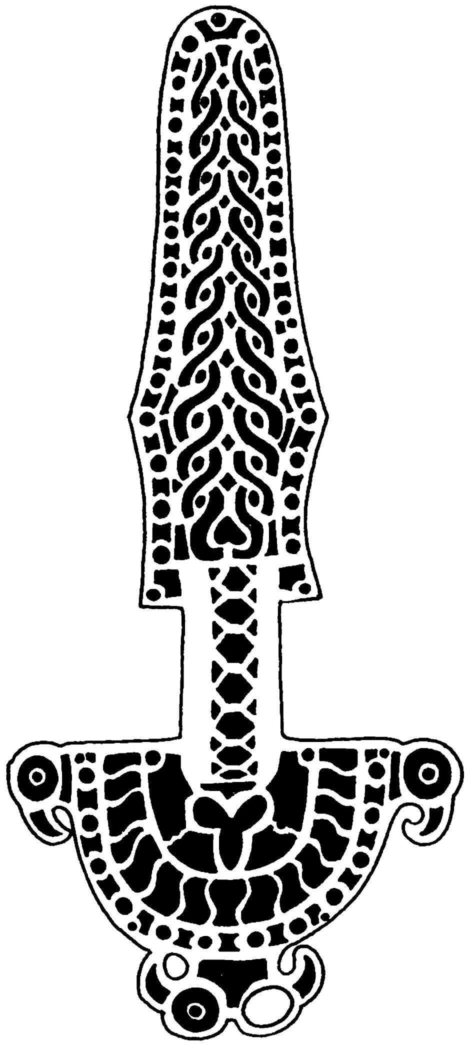


Fig. 194. Bow brooch from Desana (Turin 1) with garnets and green glass inlays. 1:1. Due to the small size of the figure the green inlays (4C, $F^3$, H, $P^4$ O, $P^5$) appear black, for this detail cf. Bierbrauer 1975, fig. 24.

their purpose was the same in this case, since a necklace with garnet pendants was also included in the find. Rich garnet necklaces have a similar distribution to the flying insect brooches, with an early concentration in South-East Europe, (cf. fig. 203), while later they occur mainly among the Allemanni, Franks and Anglo-Saxons. The necklace with garnet cloisonné pendants from *Mühlhausen* Germany (cf. Roth 1979, fig. 309b) indicates that this type of necklaces were used also by the Thüringians. Each necklace is unique and it is therefore difficult to establish direct parallels (cf. Bierbrauer 1973, 513). The necklace is technically similar to the other objects in the *Domagnano* find, which together form a fairly homogeneous group. Bierbrauer points out that the eagle brooches are different, as they have no backing foil, but this appears to be because the curved underside of the garnets in these objects made the fitting of foil inappropriate. In other objects the garnets have been better cleaved and their undersides are flat—in these cases foil with fine waffle patterns has been fitted.

It is characteristic of the objects in the *Domagnano* find that, apart from garnets, they were inlaid with green and blue opaque glass as well as pearls. Green glass is most common, while blue glass was applied in the rectangular field at the wing-tips of the eagle brooch.

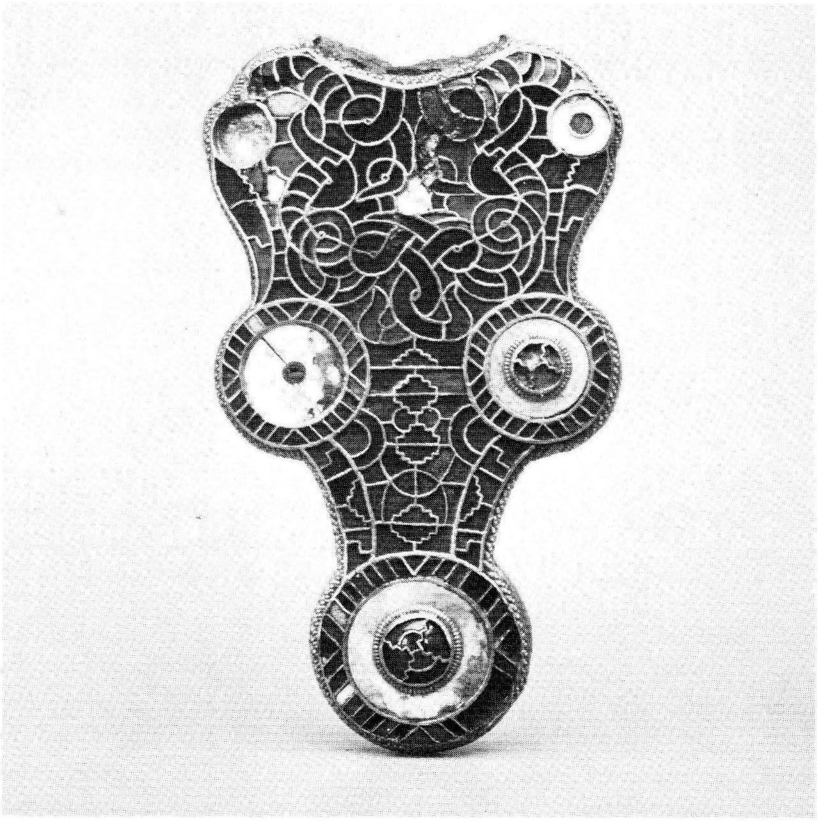
The marked polychromatic character of the *Domagnano* work is particularly significant, as this is typical of the early sand putty technique. It occurs frequently on the small Frankish disc brooches, where for instance the central panel may have a green inlay, sometimes of glass, although coloured bone (or ivory) also occurs.

Polychromatic inlay is particularly typical of work in the calcite-quartz group, but also occurs in the group with pure quartz putty (cf. fig. 152 and 154). A particularly interesting example of polychromatic inlay is the pendant from *Milton*, England (see below).

In conclusion, the hoard from *Domagnano* consists of a collection of jewellery made using the early sand putty technique, that is, before f-stepped garnets were introduced but after type 1 garnets began to be used. The composition of the paste gave rise to the suggestion that the workshop where the jewellery was produced was situated in the *Mainz* area. The composition of this hoard, with its range of more or less atypical objects, can be explained as a gift, perhaps exchanged in the early sixth century between members of the Merovingian and East Gothic royal dynasties.

The large bow-brooch from *Desana* with its typical cable-twist cloisonné inlay (cf. fig. 194) is probably one of the latest products of the workshop which produced the *Domagnano* jewellery. Bow-brooches, where the cloisonné is covering the whole brooch, are mainly typical of the Franks (cf. fig. 140–141, 143, 194), but there is no doubt that the cable-twist ornament is directly associated with the art of the East Goths. This brooch may be regarded as an offshot of a group of brooches with cable-twist designs which are mainly concentrated in the area of the Lower Rhine (Bierbrauer 1971, 150 ff.), the existence of which is perhaps connected with the supremacy of the Franks in northern Italy in 539–563 (cf. Werner 1961, 322 ff.). It is possible that the similarities with the art of the East Goths may in general be connected with political circumstances of this kind. At the same time it can be seen that contacts over long distances, in this case with the Langobards in Hungary and Italy were also a characteristic feature of the other *Mainz* workshop.

Fig. 195. Buckle plate with gold cloisonné and garnets from Leuwarden (Leu 1).



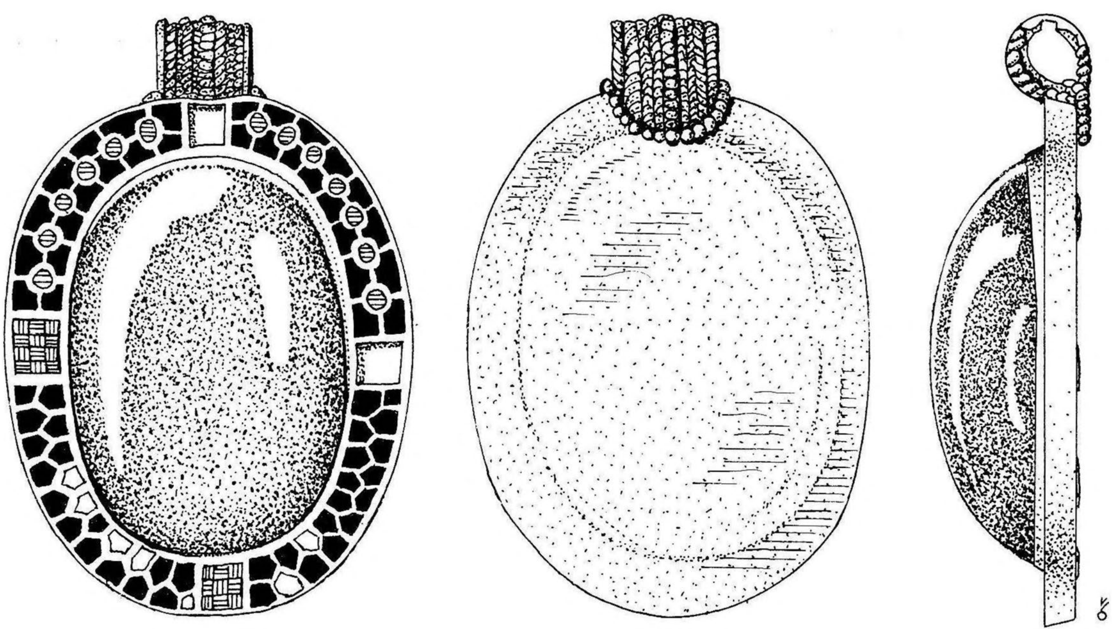


Fig. 196. Pendant from Milton (Maid 7) with a large garnet cabochon in the centre and cloisonné border with garnets, blue glass and mosaic inlays. 2:1.

We have established that several of the forms from this workshop derive more or less directly from objects mounted in cement cloisonné. Some of these, such as the bird brooches, became particularly popular in Frankish cloisonné art. It is therefore likely that this workshop, like the other one in *Mainz*, is an innovation centre for sand putty technique. The presence of these workshops in *Mainz* is significant as such a large amount of cement cloisonné work was imported to this area (cf. Böhner 1948, nos. 4, 5,6 and 7). In this context it should be mentioned that the bird-shaped mount from *Rommersheim* (Mainz 4), originally from a spatha of Böhner's type II (1948, 235), is also made using sand putty technique (the paste could not be analysed, but has a light brown colour which suggests a calcite/quartz putty of *Mainz* type).

## 5:4 Anglo-Saxon finds with sand putty cloisonné

The large cabochon garnet (2.7×1.9 cm) on the pendant from *Milton* (fig. 196) is surrounded by a border of cloisonné filled with a paste which proved to be a pure quartz putty. The pattern of the *border* consists of honeycomb-shaped garnets, interlocking in the lower part and separated by a row of round cells filled with cobalt blue glass flux in the upper part. The pattern is interrupted in four places by square cells, thus creating a cruciform design, in which there are insets in two cells of red and blue millefiore glass in a chequer pattern of the same type as found on the shoulder-clasps from *Sutton Hoo* (Bruce-Mitford 1978, fig. 429). It is notable that the millefiore insets are of different sizes which give the impression that these insets did not originally belong to the pendant.

It is likely that the millefiore glass was of Anglo-Saxon (Romano-British) manufacture (cf. Bruce-Mitford 1978, 583); the *Milton* pendant would therefore support the thesis advanced in chapter 4 that it was the customer, sometimes aided by the distributor, who supplied the workshop with material for the inlay. However, I seriously doubt that the millefiori-insets are original, their different size give the impression that they are secondary, perhaps inlayed when some of the garnets in the panel had been broken (the different parts of the panels also have diffierent number of garnets). In Anglo-Saxon archaeology the *Milton* pendant is usually assigned to a fairly late period, contemporary with, or even later than *Sutton Hoo* (cf. Leeds 1936, 108, who generally dates pendants of this type and decorative pins to after 600). Coarse honeycomb patterns are thus typical of a series of Anglo-Saxon composite brooches consisting of two brooches from *Abingdon* and one from *Faversham* (Avent 1975, no. 181–183). However, on the *Milton* pendant the honeycomb cells are very much smaller and narrower, and are thus closer to the equivalent pattern from *Domagnano* (cf. fig. 187). The coarser type of honeycomb pattern first occurs in cement technique, for instance on the purse mounts, that is around the year 500. Its reappearence in Anglo-Saxon cloisonné art around 600 is probably connected with garnets being once again imported from the Black Sea area. This is apparently indicated by the analysis of garnets from the sword in Vendel grave I, which has a coarse honeycomb pattern with garnets of type 3, that is from the Black Sea (cf. 1:3). The small flat cut garnets in the cloisonné frame and the large cabochon garnet in the middle of the *Milton* pendant suggests that this jewel was made in the transitional period, when the garnet supply in the Frankish area had diminished and a new supply had to be brought from *Byzantium*. The date of the *Milton* pendant would therefore be in the later decades of the sixth century.

One of the problems with dating Anglo-Saxon cloisonné art is that several scholars have presumed that its development in England was autonomous and unrelated to garnet cloisonné on the Continent. Analysis of garnets presented most recently by Bimson (1982, 1983, cf. chapter 1) reveals that the inlays are of garnet types, probably identical to those described in this study. The garnets used in Anglo-Saxon England seems mainly to be of the Frankish type.

It is therefore clear that Anglo-Saxon objects were produced to order in continental workshops. There is also evidence that cloisonné objects were imported from the Frankish area, particularly the small Frankish disc brooches (cf. Åberg 1926, fig. 166–169). I was able to analyse the paste from one example from *Bifrons*, grave 42 (Maid 1); it was a pure quartz and calcite mixture. Thus imports to Anglo-Saxon England probably came from several continental workshops.

It is therefore difficult to prove that this art developed autonomously in England. The rich Anglo-Saxon garnet jewellery material could perhaps be interpreted as indicating a large innovation centre for garnet cloisonné art. This is suggested, for instance, in the works of Bruce-Mitford (1949, 1978). The garnet cloisonné in England does not in fact have features not also observed in the continental finds. At present the dating of the material indicates that most of the 'innovations' occur earlier on the Continent than in Anglo-Saxon England. For instance, Bruce-Mitford sees mushrom-shaped garnets as an Anglo-Saxon invention (cf. Bruce-Mitford 1949),

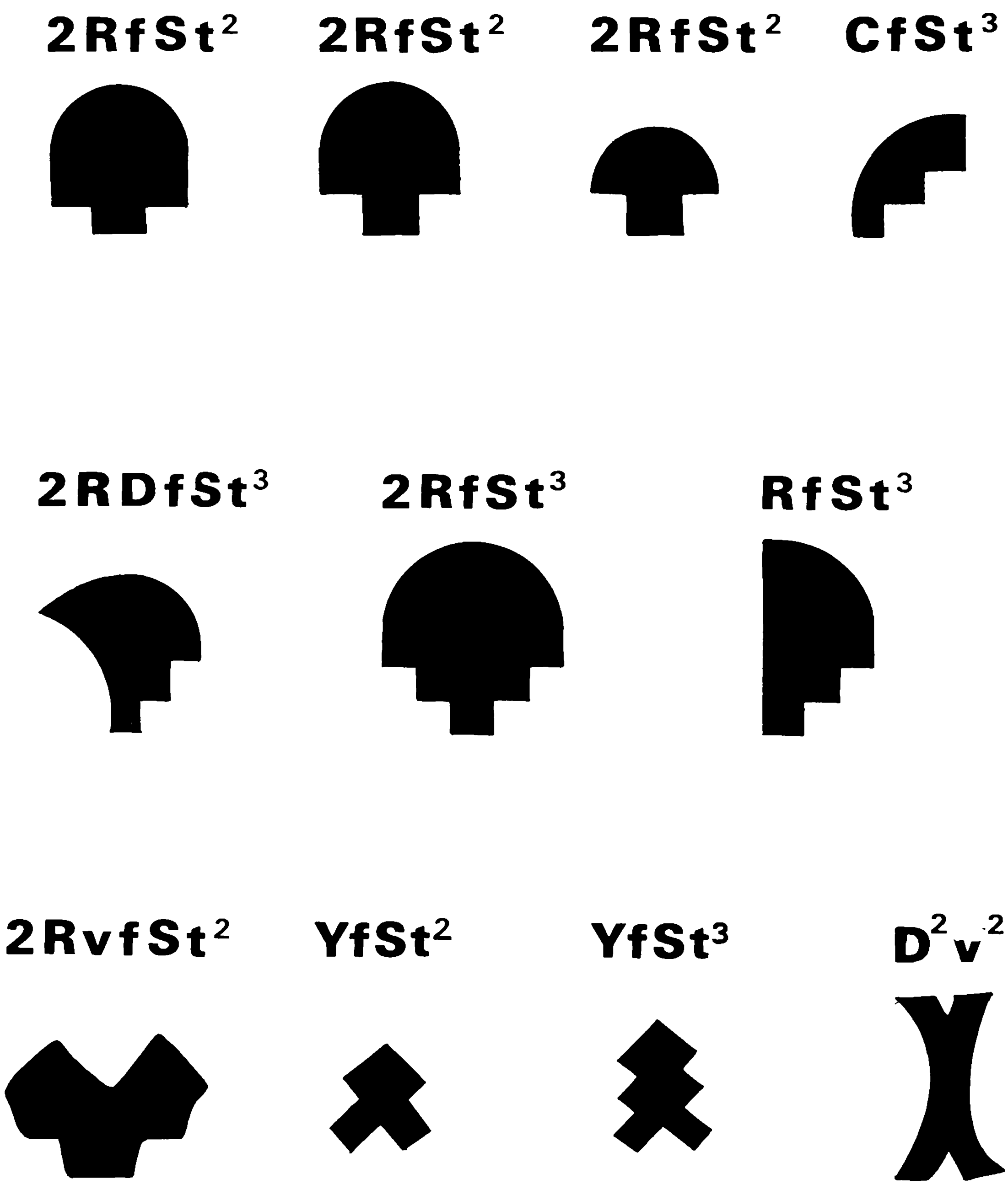



Fig. 197. Variations on mushroom shapes and their interlocking shapes with abbreviated descriptions. 5:1.

occurring in overwhelming quantities in the *Sutton Hoo* find. This shape, however, occurs on the disc brooches from *St Denis* (cf. fig. 157) which are dated to 570 and in isolated examples on other brooches contemporary with those from *St Denis*, such as the disc brooches from *Marilles* (fig. 160) and *Heidenheim* (fig. 158) and the S-shaped brooch from *Cividale* (Civi 1).

The outstanding characteristic of the garnet jewellery from *Sutton Hoo*, which is also typical of much other Anglo-Saxon jewellery, is the exquisite *composition* and *design* of the cloisonné. This aspect of the work was not necessarily the responsibility of the workshops, but was largely determined by the *customer*. In this case it probably reflects a tradition which was also evident in the Anglo-Irish manuscripts: the art of drawing cloisonné compositions. With the aid of drawings of this kind it would not have been difficult for the goldsmith to mount individual cloisonné panels using the available material for the inlays, whether he worked in an Anglo-Saxon workshop or to order on the Continent. In the Anglo-Saxon material the pastes used for cloisonné jewellery were various types of sand putty: pure quartz putty, calcite quartz putty and finally pure calcite putty. It has been suggested that pure calcite putty could have been used in workshops located in England. It seems, however, that this putty was originally a continental invention: it is found on several objects in the *Cologne* Cathedral grave, which dates from the early sixth century, that is about forty years earlier than the equivalent Anglo-Saxon objects (cf. Avent 1975, 7 f, who dates most Anglo-Saxon cloisonné works to the late sixth century, and on into the seventh entury). This paste is also typical of the *St Denis* type of disc brooch which is entirely covered in cloisonné and there is evidence of its use in *pressblech* and bossed brooches. Pure calcite occurs naturally near the North Sea and it is therefore not possible to identify more accurately the location of the workshops where it was used. Instead, the shapes of the jewels provide some indication of their provenance. It is, however, typical of the workshops using calcite putty that a large proportion of the garnets were cut to f-templets. Only one other workshop, which is characterised by the use of a quartz and clay putty, and the workshops which used fused paste techniques (see below), also used this shape to the same extent. It is significant that the continental *production* of both small and large disc brooches covered in cloisonné hardly continued beyond the last decades of the sixth century. Koch (1977, 59 f.) points out that the production in south Germany flourished briefly around 570, and then ceased. This appears to have been the case in the Frankish area as well (cf. Böhner 1958, 15 ff.). Brooches with no inlay or inlaid with coloured paste, which are known from south Germany, Italy and perhaps England (*Faversham*) and the Frankish area, seem to indicate that the supply of garnets dried up suddenly. It is also striking that the paste used in cloisonné work continues to be used as filling in bossed and *pressblech* brooches and, with the addition of a colouring agent, in cloisonné brooches without garnet inlay: therefore the workshops continued to operate, but the production changed. An example from the probably Italian workshop at *Castel Trosino* is the disc brooch with empty cloisonné cells (from grave 168), which were filled with a probably coloured paste of calcite quartz putty with clay minerals. The same paste was used as filling in a bossed disc brooch from the same cemetery (grave 115). Another example is the disc brooch from *Sprendlingen* near Worms (Worms 32), which also had a filling of paste including a coloured layer; the paste was the calcite and quartz mixture typical of the *Mainz* area.

The production of cloisonné in England generally appears to belong to the final phase of Continental cloisonné art, if we accept the normal chronology (cf. Avent 1975, 57 f.). This may be due to the fact that Anglo-Saxon cloisonné was largely mounted by the fused paste technique (cf. chapter 6).

## 5:5 Garnet types mounted by sand putty technique

In the previous section it was suggested that the change in production from cloisonné brooches to bossed brooches was basically due to a lack of garnets, and that changes in fashion played a subordinate role. There was a general move away from the use of many brooches in Merovingian dress, in favour of just one, more elaborate brooch (summarised, for instance, by Zeller 1974). This new fashion could have influenced the disappearance of cloisonné, but only indirectly, as the larger cloisonné brooches used more garnets and thus became too expensive. It can be seen that with the waning of the art of Frankish cloisonné, weapons and jewellery are decorated with silver inlay very similar to cloisonné designs, suggesting that cloisonné was still considered fashionable. It appears that cloisonné art only survives into the seventh century in Anglo-Saxon England and Scandinavia; but in these areas another type of garnet and another mounting technique were introduced (cf. chapter 6).

Production using the sand putty technique and type 1 garnets apparently ended in the last decades of the sixth century. It seems that *the Franks* played a major role in this production, probably because they supplied type 1 garnets.

In chapter 3 it was suggested that this type of garnet came from north-west Bohemia, an area which was ruled by the Franks during their eastward expansion, which culminated in the conquest of Thuringia in 531. In the early sand putty cloisonné, exemplified by the earliest of the small disc brooches and mounts of *Pouan* type, a shortage of garnets is reflected in the use of b-stepped garnets, probably taken from older objects.

There are also cases of the use of type 2 garnets in the early sand putty cloisonné; these were probably produced and cut in Pannonia, where they are found, for instance, in the hoard from *Szilágy Somlyó*. But even in this area the use of type 1 garnets gradually takes over, and they are found, for instance, on the small disc brooches in the Langobardic cemeteries in Hungary (cf. 5:1).

It is type 1 garnets which are cut to the new, finer stepped patterns which are here called f-steps. This type of stepped shape, and the cutting and finishing of type 1 garnets in general, displays a very highly-developed lapidary technique. Even with high magnification it is hardly possible to discern traces of polishing scars on these garnets, unlike the garnets from the Black Sea area. The only incidence of less skillful work was in the find from *Domagnano*, where some of the garnets were imperfectly cleaved. This was also one reason why this find was identified as exemplifying early lapidary work with garnets of type 1. A characteristic feature of this gem-cutting technique is the use of very thin cutting-wheels which worked with great precision and probably at *high speed*. Gem-cutting demands great technical skill and, when hard garnets were used, probably required a cutting-wheel that was mechanically powered, perhaps by water (cf. chapter 2).

The f-stepped garnets have a much more limited geographical distribution than the garnets used in the cement technique. *F-stepped garnets occur mainly in the Frankish kingdom, Anglo-Saxon England, Italy and Scandinavia.* It is striking that there are no examples of this step-pattern on objects made in Eastern or South-East Europe. The only object known to me with f-stepped cloisonné from Eastern Europe is a small pendant of undoubtedly Frankish origin (cf. Swoboda 1965, 346 and pl. XIII:1) found in a grave from *Phraha-Podhaba*. The locations where such objects with stepped garnets were found demonstrate a marked concentration in the Frankish kingdom and south Germany, followed by Anglo-Saxon England, Sweden and Italy. If, however, the number of step-patterned garnets in any one country is considered, Anglo-Saxon England takes first place. This is due to the great number in the *Sutton Hoo* find as well as in finds from Kent. In the Frankish area, it is characteristic that such garnets are used very sparingly on the small disc brooches; even in gold brooches they simply mark the centre, as in the brooch from grave 26, *Schretzheim,* (cf. fig. 239), or compose single features in a border pattern, as on the S-shaped brooch from *Deisslingen* (Stutt 30/Sb). The large disc brooches are different, as stepped garnets make up a large part of the design on both silver and gold brooches. It is difficult to know how to interpret this fact. It is not a chronological phenomenon, as small disc brooches are contemporary with the large brooches such as those from Arnegunde's grave at *St Denis*. It could be a question of two different workshops, one for large and one for small brooches, each obtaining its garnets from a different source. But this is unlikely, as many stepped garnets are found on the sword pommels, which have the same sort of sand putty as the small brooches. It is more likely that the different patterns were associated with the rank of the bearer and that the designs with stepped patterns were worn only by people of high social status (cf. chapter 7:4).

In chapter 4 it was established that the objects produced in a workshop are rarely found in close proximity to it, particulary in the case of objects which have such a high second-hand value, and continually run the risk of being re-worked into new objects and re-sold. The somewhat irregular distribution of the f-stepped garnets within Western Europe indicates that they were produced in a single workshop under a limited period.

As the f-stepped garnets occur only on objects made in Western Europe, the workshop which produced them must have been situated there. When attempting to establish its location, it can be argued that there are only a few places to choose from. The cutting must have taken place where the necessary knowledge was available.

We have seen that cutting garnets from templets required special equipment, probably mechanically-powered cutting-wheels (cf. chapter 2). It is therefore likely that the workshop was situated in a town where Roman craft traditions still survived, that is where there was continuity from the Roman to the Merovingian period. With this in mind, I believe that *Trier* is the most likely town. There was a Classical gem-cutting workshop in *Trier*, the production of which is exemplified by the agate bowl with carved handles, now in the Viennese Museum of the History of Art, which has an inscription stating that it was made in *Trier* by the stone-carver Flavius Aristo (cf. Bühler 1973, 70). The bowl is dated to the fourth century. It is of particular interest that the material from which the bowl was carved is a greyish-white agate which may have been taken from natural deposits in the mountainous areas between the Saar and the Nahe not far from *Trier*. This occurrence of agate later gave rise to a flourishing precious stone industry in *Idar-Oberstein* (cf. Wild 1963), and it seems very likely that this material was also utilized in the Classical period. In Trier there was certainly a knowledge of the mineral deposits of the area during this period; a study of the late Roman mosaic at the Kornmarkt, for instance, reveals that local greenstones and quartz were used (Eiden 1959, 69, note 36). There is therefore no doubt that the agate bowl provides evidence that gem-art was practiced in *Trier*, and it is particularly significant that this work was carried out in semi-precious stone.

The well-known cage-cups of Rhenish manufacture (cf. Doppelfeld 1960b) demonstrate that one particular artistically highly developed gem-cutting art had a wider

*Distribution map II, showing satellite workshops and objects with cloisonné with sand putty and the central workshop and its objects with cloisonné in fused paste technique.*

The following finds have been listed: 1) S:t Denis (Paris 14), 2) Taplow (BM 13), 3) Bifrons, Gr 42 (Maid 1), 4) Milton (Maid 7), 5) Dover (BM 11), 6) Marilles (Br 2), 7) Sutton Hoo (cf. diagram fig. 165), 8) Lede (Br 1), 9) Tongeren (Tong 1), 10) Castel Trosino (Rom 2–3), 11) Parma (Parm 1), 12) Desana (Turin 1), 13) Rittersdorf, Gr 15, 34, 36, 107 (Trier 2, 3, 11), 14) Worms (Worms 6–7), 15) Eltville (Wiesbaden 2), 16) Hürth-Kalcheuren (Bonn 33), 17) Köln-Müngersdorff, Gr 91b (Köln 19), 18) Nocera Umbra (Rom 6), 19: Domagnano (Nürn 1, BM 15)
20) Schretzheim, Gr 26, 250, 300, 583 (Dill 1, 3, 4, 8, 11), 21) Schretzheim, Gr 233, 464, 509, 586 (Dill 2, 6, 7, 9), 22) Schretzheim, Gr 23 (Dill 5), 23) Heidenheim (Stut 3), 24) Dalsheim and Abenheim (Mainz 15, 16), 25) Schwarzrheindorf (Mainz 13), 26) Cologne Cathedral (Köln 4–8), 27) Cologne Cathedral Gr (Köln 7), 28) Soest, Gr 106 (Münster 2), 29) Reinstrup (Cop 3), 30) Hög Edsten (Swed 21), 31) Åker (Oslo 2), 32) Cividale (Civ 1), 33) Sturkö (Swed 16), 34) Lejde (Swed 23), 35) Spelvik (Swed 24), 36) Tibble (Swed 22), 37) Åshusby (Swed 15), 38) Väsby (Swed 13), 39) Varpalota, Gr 5 (Westp 1), 40) Hegykö, Gr 18 (Bud 8), 41) Kajdacs, Gr 2 (Szek 2), 42) Tatabanya, Gr 24 (Bud 7), 43) Szentendre, Gr 2, 29, 54, 87 (Bud 2, 3, 46), 44) Szentendre, Gr 29 (Bud 5), 45) Vallstenarum (Swed 65), 46) Németkér (Bud 38).

= Large star, Central workshop, probable situated in Trier and black traingle, works from this workshop.

= Large spot, satellite workship probable situated
= somewhere on the North Sea coast. Small spot, works from this workshop.

= Large box, satellite workshops (a, d) probable situated in Mainz. Small box, works from these workshops. Black box, works from an Italian workshop related to Mainz.

= Large circle, satellite workshop probable situated in Cologne. Small circle, works from this workshop.

= Large triangle, satellite workshop probable situated in South Germany. Small triangle, works form this workshop.

= Triangle with spot, works deriving from an unlocalized German workshop.

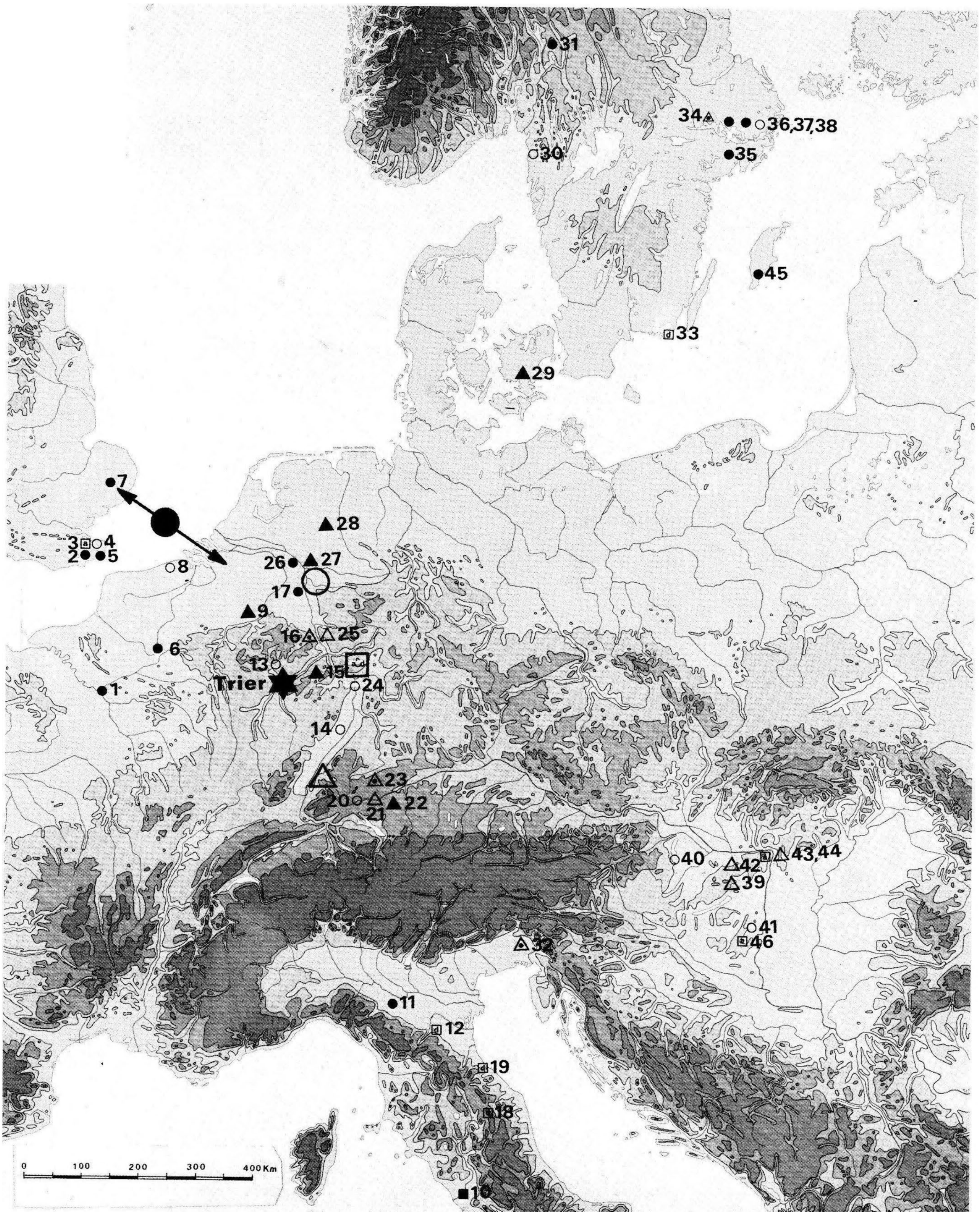
distribution in the Rhineland, being produced in both *Cologne* and *Trier*, and possibly elsewhere.

There are, however, definite technical differences between the production of glass cage-cups and the more mechanical working of semi-precious stones, as is indicated by the agate bowl from *Trier* and the tesserae. In glass-cutting a *hand-powered wheel* is preferable, and the gentle, individual forms resulting from this technique are one of the features which makes the work attractive. This is also the case when individual gem-stones are cut. However, when large numbers of objects are produced in semi-precious stone, the initial shaping is better done with a mechanically-powered stone saw, and the polishing with a rapid lapping disc.

In other words, the craftsmen who cut patterns on individually cut small gemstones and the glass-cutters were *mobile*, as the hand-powered wheel was easily carried, while craftsmen who supplied the raw material for gems, or cut tesserae or garnets for cloisonné, where the use of templets demonstrates that the cutting was not done individually, were *tied to a particular place*. The great variations in the Rhenish cage-cups, which have inscriptions in both Greek and Latin, demonstrate that the *diatrarii* who produced them were itinerant craftsmen (cf. chapter 7). It is significant that historical sources mention stone-working powered by a water-wheel on the Moselle near *Trier*. The Roman poet Ausonius, in his poem *Moselle*, described the water-mill near Trier, where the stream 'turns his millstones in furious revolutions and drives the shrieking saws through smooth blocks of marble [limestone] and so hears from either bank a ceaseless din' (*Ausonius Mosella*, lines 362–364, Loeb *ed*. 1919, vol. 1, 252).

This description is from the last decades of the fourth century, and describes stone-cutting for purposes which may have included the production of the tesserae which can be studied in the Roman mosaics. A fast stone saw can be adjusted by cog-wheel transmission to cut large stone blocks as well as thin slabs. A find from *Trier Cathedral* demonstrates that tesserae were produced from thin stone slabs. Limestone for mosaics was stored in the Cathedral in the form of long, thin sawed strips which, like glass rods of similar shape, could be cut to shape with a chisel. Wilmowsky discovered the limestone strips in association with the remains of a glass kiln which he interpreted as having been used to produce glass tesserae (cf. 1874, 24 and Eiden 1959, 69). I have made similar observations on tesserae from *Tunis:* some of the sides had clear traces of sawing, while others had been cut by chisels (cf. fig. 45).

It is difficult to establish how long this production continued at *Trier*. Parlasca (1959, 132) has shown that the mosaic industry at Trier produced *emblemata* which were sold throughout the Rhineland. Of one hundred and fifty Roman mosaics recorded in south and west Germany, Parlasca calculates that almost one hundred were produced in *Trier*. It is likely that the mosaic production, which continued after the fall of the Roman Empire, served mainly to furnish churches and other ecclesiastical buildings. Claude (1981, 226 f.) points out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22
40
42
43,44
39
41
46
32
11
12
19
18
10
0
100
200
300
400 Km

that Merovingian sources fairly often mention the production of mosaics in the sixth and even the seventh century; after this the sources fail. Theoretically it can therefore be assumed that the production of tesserae in *Trier* continued until some time in the seventh century. There is at present no evidence for this thesis from archaeological sources, partly because it appears that most churches in the area were renovated during the Carolingian renaissance. It is striking that during this period in *Aachen*, for instance, parts of late antique *opus sectile* floors were imported from *Ravenna* (cf. McClendon 1980, 164 f.)

Archaeological evidence for the continuation of this art form after the late Roman period can perhaps be adduced from the garnet art where, in my opinion, *Trier* was important as the place where most of the type 1 garnets were cut.

The raw material for these garnets was probably transported via the rivers Moselle, Rhine ((?) Maine) and Danube ((?) Naab), and may have been part of the trade which was carried out along these rivers from Roman times (Ellmers 1972, 260). A Merovingian source mentions a regular trade along the Moselle in the sixth century (cf. Petrikowits 1959, 81). The historical evidence of the connections between the Thuringians and the Langobards in Bohemia as well as the subsequent Frankish conquest of Thuringia (cf. Schmidt 1940, 104 ff.) may reflect the importance of this trade route from East to West in the sixth century.

According to the definitions which have been established here, one would expect to find a central workshop in *Trier*, where both the cutting of the garnets and the mounting of cloisonné jewellery took place. In the material from the Frankish cemeteries around *Trier* there are, however, no definite traces of this workshop. The material is sparse and the small Frankish disc brooches which occur, as for instance from *Rittersdorf* (Trier 2–11), have quartz putty of the type attributed to the Cologne-Trier area. This is not the type of material which suggests a central workshop. It has, however, been pointed out by Böhner (1958, 294) and Schindler (1973, 136) that the Frankish settlement arrived late in the *Trier* area, and only towards the seventh century is there an economically significant Frankish population. The few disc brooches which have been found may well have been brought by the first generation of settlers, from *Cologne* for instance. Both Böhner and Schindler believe that *Trier* had a Latin population. As they were Christians, and their burial customs did not therefore include grave goods, it cannot be expected that objects from the central workshop should be included in the material from the graves of this population. What little material exists suggests that the central workshop did not produce small disc brooches, but instead concentrated entirely on more expensive objects for which fused paste was used. This workshop will therefore be discussed in more detail below in connection with fused paste work.

## 5:6 Sand putty cloisonné: summary

It has been demonstrated above that the production of the workshops which used sand putty technique mainly belongs to the early Merovingian period, I and II according to Ament's divisions (1977), beginning around 520 and ending around 580. The home of the sand putty cloisonné appears to have been mainly in the *Rhenish area of the Franks* (cf. distribution map II).

It is possible that the earliest objects with sand putty, such as the Hungarian gold buckles (Bud 1 and 30) and the seax from *Pouan* (fig. 147) are a little earlier and contemporary with the cement technique, but the sand putty workshops in Western Europe seem generally to have taken over from workshops using cement technique more or less directly. It is likely that in one or more of the workshops where work using the cement technique was mounted—probably in the Rhineland—there was a gradual change to the use of sand putty technique. The sand putty technique is certainly older than the use of type 1 garnets. It is clear that in the Rhineland the production of this type of cloisonné ceases towards the last decades of the sixth century. A similar tendency can be observed in South Germany and Langobardic Italy. In Italy it would seem that brooches of this kind belong to the first generation of Langobardic settlers (cf. grave 87, *Nocera Umbra* (Rom 6)), while in the next generation bossed disc brooches of grave 115, *Castel Trosino* type (Rom 2) were produced. These were also filled with a sand putty, but of a type not encountered in the Rhineland. There are also objects with sand putty in Hungary, including early examples as well as later objects of typically Frankish form, like the disc brooches from the Langobardic cemeteries at *Szentendre* and *Varpalota*. It is significant that almost all types of sand putty are represented in Rhenish finds to varying degrees, which has led to the suggestion that there were a number of sand putty workshops in locations which include *Cologne*, *Mainz* and *South Germany*. There was a sand putty workshop of short duration in *Italy*. Another workshop was in the *North Sea area.* It is possible that this continental workshop transferred to *Anglo-Saxon England,* where it appears that production continued longer than on the mainland, perhaps because garnets were obtained from the *Black Sea* area. However, an insufficient number of analyses have been carried out to provide conclusive answers. There is no doubt, however, that Anglo-Saxon cloisonné work received cut garnets as well as the sand putty technique from the Rhenish stone-cutting workshops. It will be shown below that the fused paste technique was also adopted in England.

# Chapter 6. A central West European workshop for cloisonné

## 6:1 Fused paste technique and the central workshop for the f-templet

The fused paste technique probably developed to simplify the work involved in making cloisonné, and was therefore initially used on small objects where the cell walls were inaccessible for soldering. In these cases sulphur paste was used. When sulphur is heated and then gradually cooled, it becomes a glutinous mass which adheres to metal; in Classical antiquity these properties were well known and sulphur was commonly used as an adhesive, to fasten the tang of a knife in its handle, for instance. As Sicily seems to have been the main source of sulphur, sulphur paste was less frequently used on objects produced north of the Alps. The purity of this paste makes it unsuitable as an indicator of the location of workshops, as it was probably used in most late antique workshops, at least south of the Alps. Cloisonné using the sulphur paste technique is therefore likely to have a wide distribution. A sample of paste from a polyhedron ear-ring from *Szekzard* in Hungary (Bud 32) (Bierbrauer 1975,162) was identified as sulphur. The sample was taken from beneath inlays (no longer present) which had apparently been mounted without foil. I have seen sulphur on several other polyhedron ear-rings, but it is not the only paste used. Bierbrauer has pointed out that polyhedron ear-rings were originally a late Roman form which, when decorated with garnets, became particularly popular with the East Goths, the Gepidae and the Franks: for instance, there are a pair in the *Cologne* Cathedral grave. It has not been possible to analyse these, as they were apparently already damaged at the time of burial (cf. Doppelfeld 1960a). One of the earliest finds of sulphur paste may be from a finger ring in the Gepidic grave at *Beregszász,* (fig. 199), which also included the bird brooch with cement paste which was described in section 4:2. There is at present no trace of inlay or gold foil in this ring and one may speculate that the ring was filled with sulphur alone. Csallány (1961,220) describes the ring as having garnet inlays, which his photograph confirms (pl.LLIV:12). It is possible that the garnet which appears in his photograph was later lost. The flat, round disc on the ring has a design of a central quatrefoil surrounded by four half quatrefoils which together form a cross. Around the edge are eight small inlays, now also empty. The shapes are compatible with cement technique settings, and the cell walls are firmly soldered together and so stable that the adhesive qualities of sulphur were not in fact needed. My impression is that this ring was originally made using the cement technique and then, after being damaged, the cells were filled with sulphur and perhaps garnets. It also appears that the disc may originally have been taken from another object and had been secondarily soldered on the thin, strip-like ring. It is possible that this was a pseudo-ring, especially made for the burial.

The grave find from *Beregszász* was not excavated professionally and was purchased by the museum (cf. Csallány 1961,220). Apart from the bird brooch and the ring already mentioned, it contained two radiated brooches with animal-head-shaped foot-plates and spiral ornament, a so-called *Kolben* ring of gold, polyhedron ear-rings with garnet inlay and beads, three of which were of gold foil (cf. fig. 199). According to Csallany (1961,331), the geographical location of the grave assigns it to the kingdom of the Gepidae, that is the period 454–472. It is clear that the grave belongs to the latter half of the fifth century, but I am uncertain whether the date can be so closely determined. It certainly cannot be based on the archaeological objects in the find as they all have a wider chronological spread. The *Kolben* rings, for instance, clearly belong to the time of Childeric (cf. Werner 1980) although they continue to appear in women's graves as late as the sixth century, such as the *Cologne* Cathedral grave (Doppelfeld 1960a, pl. 14:8).

It can be seen, therefore, that sulphur paste was already used with cloisonné at a period when the cement technique was current. This is not surprising, given that sulphur paste was probably available in most goldsmiths' workshops with Byzantine connections. It must also be remembered that the magnificent bird-shaped saddle mounts from *Apahida* (fig. 133) were attached to their leather base with sulphur paste (cf. chapter 3). This was probably the case with many metal mounts where riveting was not sufficient.

However, sixth-century objects with sulphur paste are of a different character (cf. diagram fig. 198). Here the adhesive properties of the sulphur paste were used to produce cell work as thin as possible. At the same time it was possible to avoid difficult soldering on step-pattern designs, for instance. The pendants on the large bead necklace from the *Cologne* Cathedral grave, are typical examples.

This piece includes three cloisonné pendants, two of which are of a flower-like, three-lobed shape, while the third and largest is of a pear-shaped design, probably an animal head, a bucranium (or bull's head) divided into a nearly geometrical cloisonné pattern with garnets cut using the f. St-templet (fig. 201). Other parts of this jewel included five filigree-decorated disc-shaped pendants and filigree gold beads of cylindrical, double-conical and multiple shapes, double shapes, seven solidi made into pendants and a number of glass beads (Doppelfeld 1960a,97 ff.).

The bucranium is a motif that was frequently used in Hellenistic jewellery and is also found on a garnet cloisonné pendant in a Georgian grave (fig. 202) dated to around 400 (cf. Lekvinadze 1975). The now lost bull's head from Childeric's grave (fig. 200) which Böhner postulates belonged to the horse trappings (cf. Böhner 1981) demonstrates that this motif was also used in royal Frankish art at an early stage

Most of the pendant solidi were struck in Italy (*Milan* and *Ravenna*). The association with Italy is further strengthened by the presence in the find of East Gothic half-siliqqua which provide a date after 534. Doppelfeld (1960a,113) emphasizes the lively connections between the Frankish kingdom and East Gothic Italy and Byzantium during the reign of the Merovingian king Theodobert (534–548). Theodobert also had close ties with the Church, and with Roman culture through his first wife, who came from a Gallo-Roman family in Provence.

The great bead necklace probably reflects the results of these contacts, as analysis shows that the garnets on the cloisonné pendants were set in sulphur paste; we have seen that sulphur probably came directly from Byzantine Italy. It is interesting to note that sulphur paste was also used on two pendants from grave 106, *Soest* (Werner 1935, no. 30). These differ from the large *Cologne* pendant in that the design consists of a bi-lobed pattern which could be interpreted as an animal head with eyes and semi oval nostrils, but the garnets are again cut by the f-templet. The designs of the *Soest* pendants are, however, more advanced, the garnet panels are smaller and all are part of the complicated animal-head pattern (fig. 212b). The slightly later date of the *Soest* pendants is confirmed by the solidi which belong to the bead necklace, which give a *terminus post quem* of 554. Werner (1935,54) maintains that the gold solidi must have been mounted in Langobardic Italy as they have the double-conical loops of twisted filigree wire typical of Langobardic finds. However, the same type of mount also occurs on solidi in the *Cologne* Cathedral grave, demonstrating that this mounting technique was known by the Franks long before the Langobards came to Italy. This is one of many features which I believe demonstrate the Franco-Byzantine connections which are particularly reflected in cloisonné art. This will be discussed further below, but it is worth mentioning that there is probably another example of pendants of this type: the bead necklace from *Hellmitzheim* (Dannheimer 1962,63 ff.). The pastes in these pendants could not be analysed, but they have the appearance of sulphur paste work. The pendants are roughly pear-shaped and are decorated with geometrical designs of rectangular garnets cut by the f-templet. Dannheimer dates the find, which also contained two bow-brooches of so called Anglo-Saxon type, to about 600, that is contemporary with grave 106 in *Soest.*

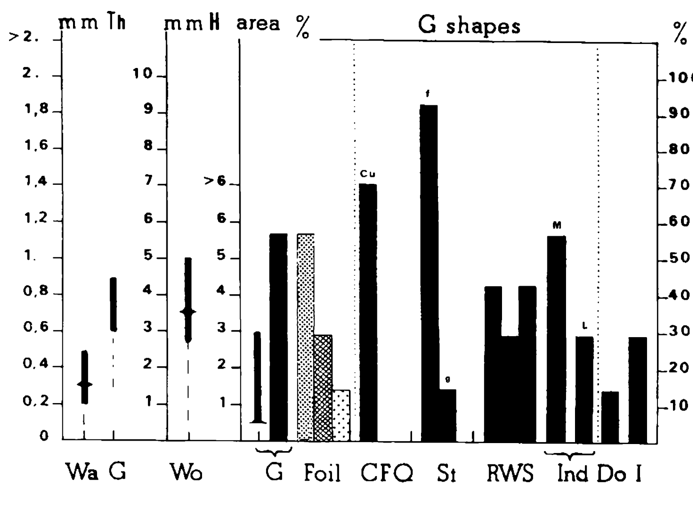



Fig. 198. Diagram showing the technical features of the cloisonné from the central Trier workshop. The cement is fused sulphur. There are 9 objects of which 4 come from 2 graves, i.e. 7 units. The objects are: Cop 3; Dill 5; Köln 6–7; Münst 1–2; Trier 1; Tong 1; Wiesb. 2.

Noteworthy features of this cloisonné workshop are the high frequency of f- and g-stepped garnets and the occurence of the comb-shaped garnets, i.e. the M shape.

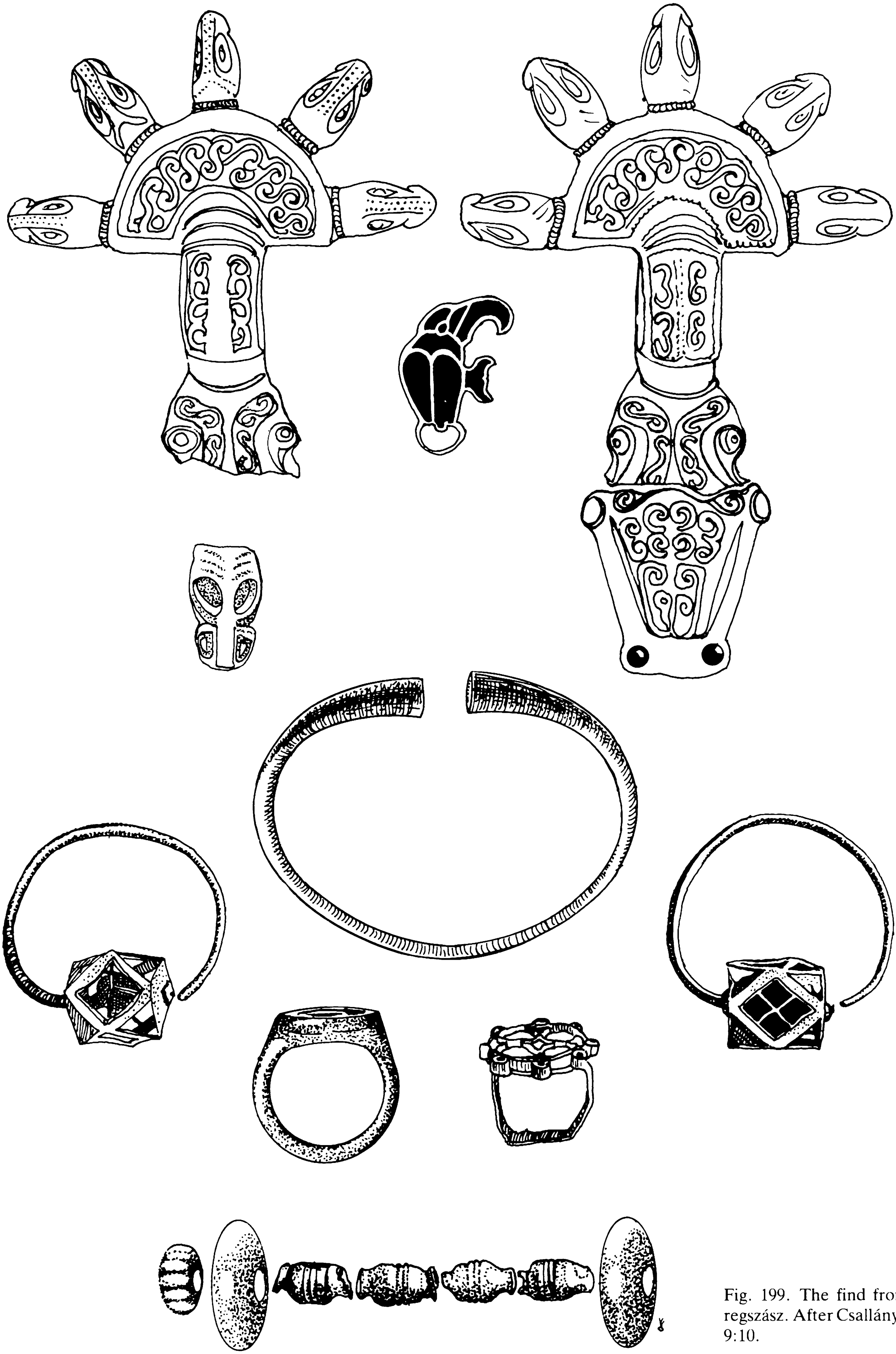
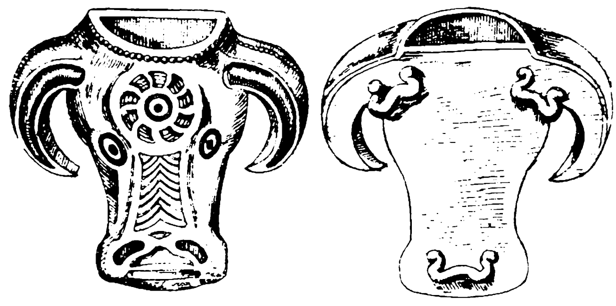
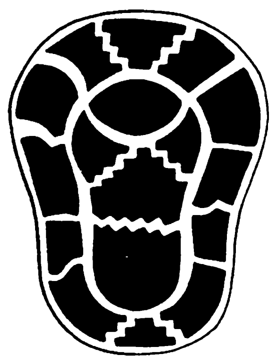


Fig. 199. The find from Beregszász. After Csallány 1961. 9:10.





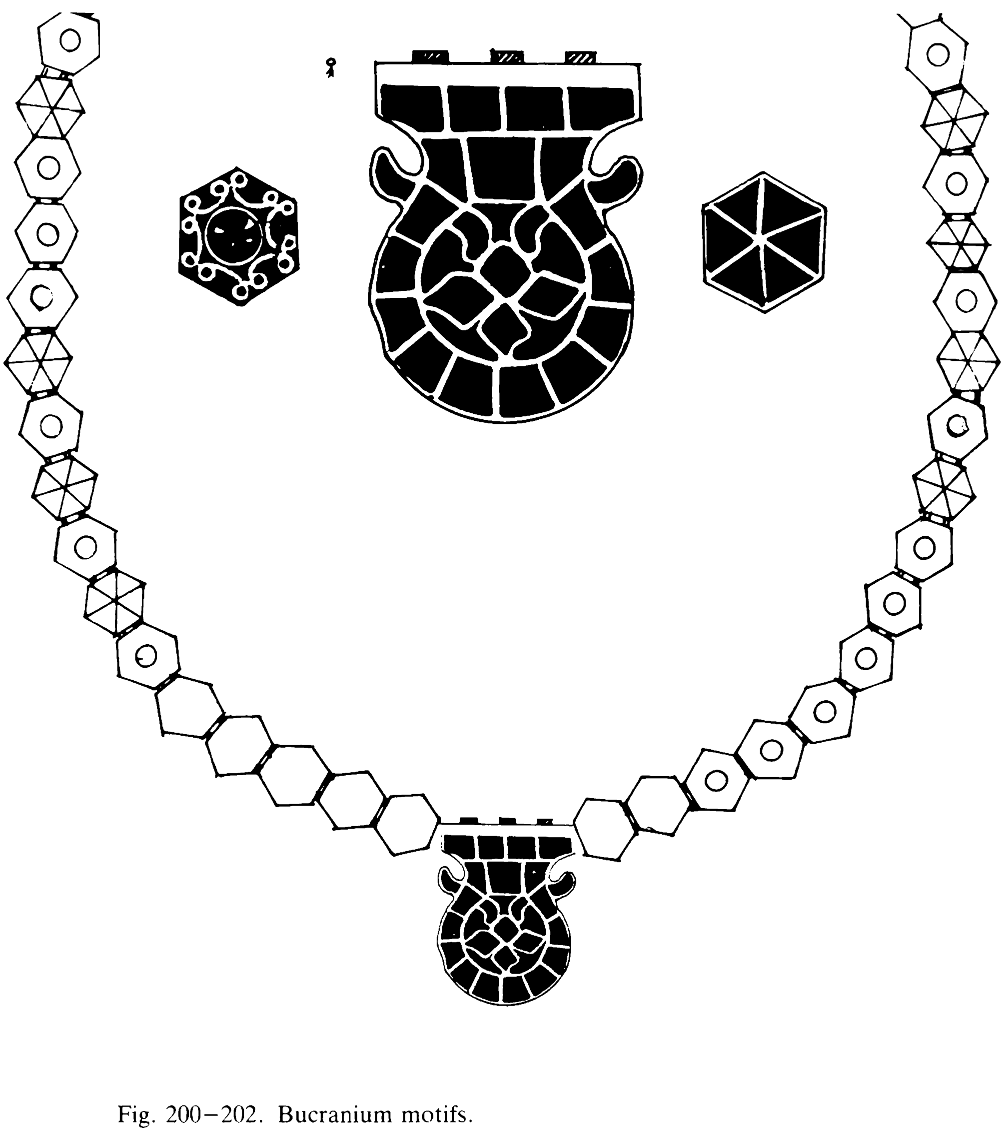


Fig. 200–202. Bucranium motifs.
200) Bucranium motif from Childeric's grave. After Babelon (1919). 1:1.
201) Bucranium on a garnet cloisonné pendant from the Cologne Cathedral grave. (Köln 6). 2:1.
202) Bucranium on a garnet cloisonné pendant (clasped cloisonné) from Soupsa, Georgien. 2:1 and 1:1 respectively.

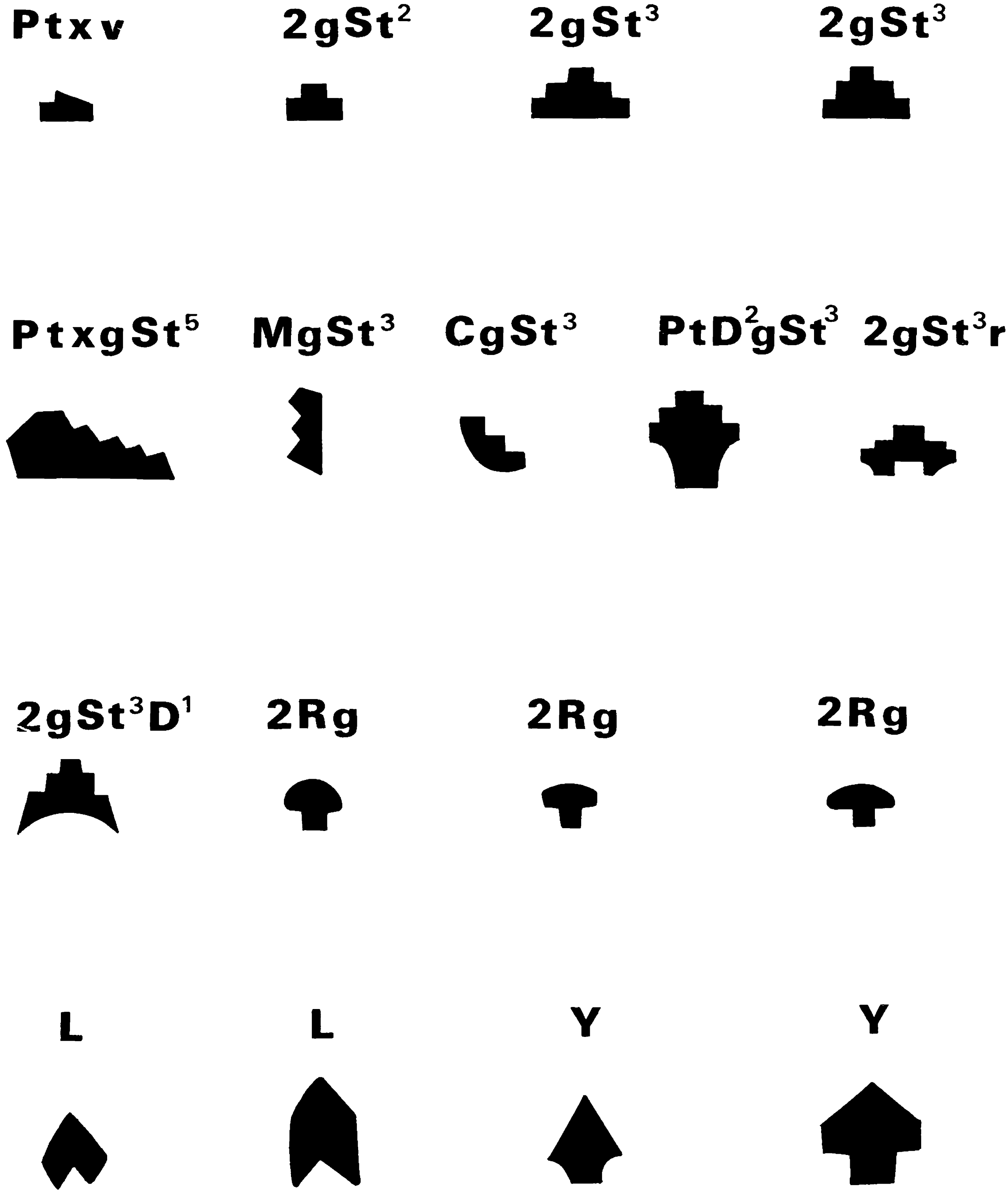



Fig. 203. Variations of g-stepped garnet shapes most commonly found in Sutton Hoo but also used in fused paste technique, where more individually cut, larger garnets are often found. 5:1.

Fig. 204. a) Plaque from the Trier-Egbert shrine reconstructed in its original shape. b) Section showing an empty space below the coin, probably a reliquary. 2:1.

However, the cloisonné pattern of these pendants suggests an earlier date, as the multi-stepped rectangular garnets represent an early stage of the f-stepped shapes. Without reference to the other objects in this find, the cloisonné could best be placed in the middle of a typological series where the pear-shaped pendant from *Cologne*, with its slightly irregular f-stepped pattern (cf. the triangular garnets in the centre, fig. 201), is the earliest type, and the pendants from *Soest,* where the step-patterns are subordinate to the animal ornament, are the latest. It is notable that the pendants from grave 106 at *Soest* also have a mushroom-shaped cell between the hanging heads. This grave also contained a large disc brooch with cloisonné, probably set in sulphur paste; the relationship between this brooch and the pendants will be discussed in more detail below.

It appears, therefore, that the pear-shaped pendant from the *Cologne* Cathedral grave is one of the earliest objects with sulphur paste in Frankish finds. It was accompanied by two three-lobed pendants which were also made with sulphur paste. It is interesting that while the large pear-shaped pendant has step-cut garnets, no step-patterns occur on the two smaller, three-lobed pendants. This demonstrates that step-patterning was a refinement which was not the only product in the gem-cutting workshop's repertoire which included many other

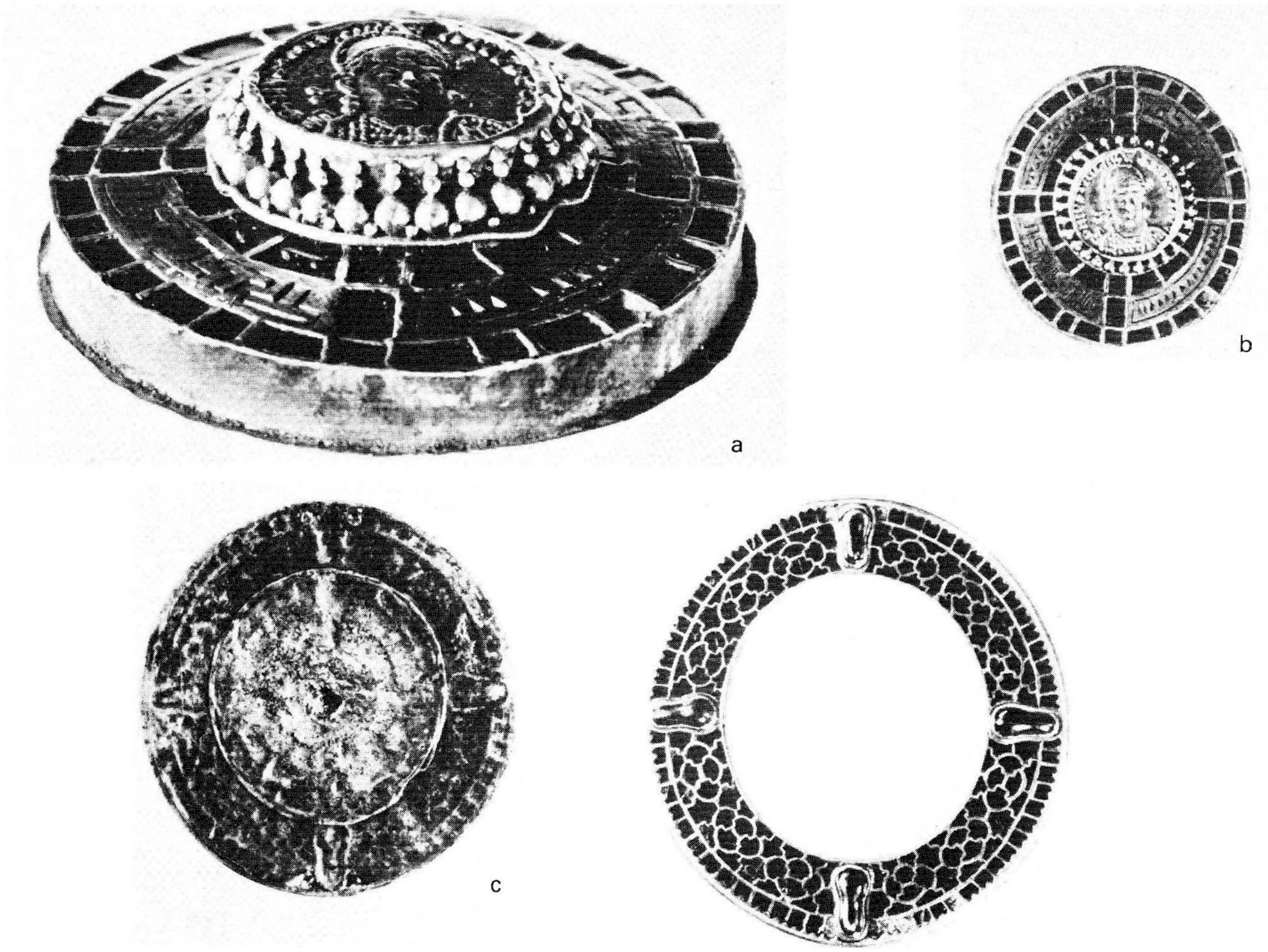


Fig. 205 The separate parts of the Trier plaque. (after Vierck 1974).
a) The inner central part, seen from the side. 2:1. Note the irregular edges of the protruding backplate. b) Seen from above. 1:1. c) The reverse side of the plaque. Note the irregular edges of the back plate of the central part. 1:1. d) The outer border. 1:1.

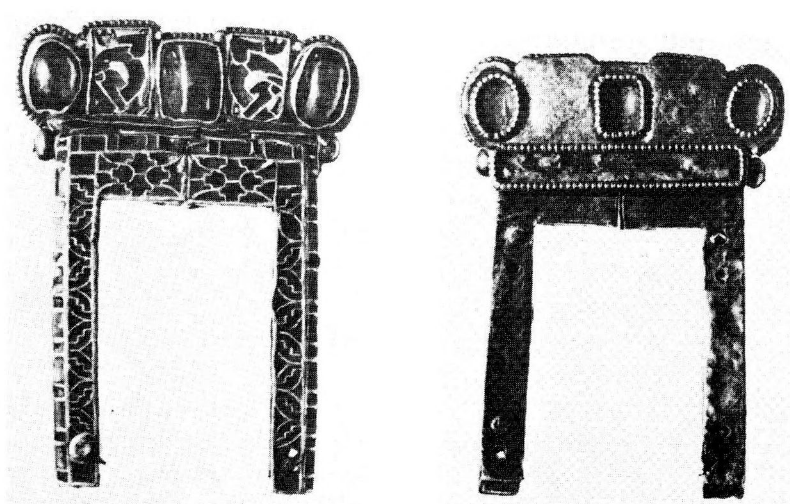


Fig. 206. a–b) The Tongeren mount in its present form.
a) Front. b) Reverse. 1:1.

shapes. The f-stepped garnets must therefore be regarded as one of many distinctive features of this workshop. We have already suggested that this workshop was situated in *Trier*. The strong Byzantine element implied by the very presence of a gem-cutting workshop also makes it likely that some of the work with sulphur paste could have been produced in *Trier*, particularly as there is a higher frequency of f-stepped garnets on objects with fused paste than with sand putty. Only one object with fused paste has been found in *Trier* itself, but the quality of this example is so high that it deserves special mention. The object in question is the plaque with mushroom-shaped garnets from Egbert's shrine; in his description, Rademacher (1936 in agreement with Vierck 1974) opined that the plaque came from an earlier Frankish object.

The plaque (cf. fig. 204–205) consists of an outer oval frame in the shape of a broad border of mushroom-shaped cloisonné cells set with garnets in the shape of quatrefoils and surrounded by a row of rectangular garnet cells, whose outside cell walls form the toothed edge of the plaque. The quatrefoil border is interrupted in four places by a design of pear-shaped relief-cut garnets (probably representing animal-heads) set in the shape of a cross. Three animal-heads are turned narrow (nose) end outwards, while the fourth is turned to the centre. On the back of this head there are traces of two holes, probably from rivets for a suspension loop. In the centre is an oval setting, made as a completely separate piece and attached only by being forced down inside the quatrefoil border. This setting has a raised centre with a coin of Justinian surrounded by a beaded border, outside of which, and following the oval outline of the inset, is a double border of alternate red and green glass inlaid in cloisonné. These borders are interrupted in four places by cross-arms, also made up of cloisonné with rectangular cells. In the panels between the cross-arms and the borders are decorations in niello consisting of triangular and T-shaped stamps of different designs in each of the panels. Rademacher (1936,155) considers the whole central section to be an Ottonian addition, while Vierck (1974,362) maintains that only the raised central panel is Ottonian. One of the reasons for Rademacher's opinon is that the cloisonné of the inner borders was inlaid in red and green glass. The green glass, however, only occurs every four cells, and I am not convinced that all the red inlays are glass; my impression is that the intended composition involved a sequence of inlays with green glass, pale red glass, almandine garnet, pale red glass again, followed by green glass, but as the glass has corroded this is difficult to determine. Other objects with fused paste have a polychromatic character, even including pale red glass (se below). I therefore agree with Vierck that, apart from the raised central panel, the inset comes from the same work as the outer border. It can be seen that the bottom plate of the inset is a little irregular and that it protrudes beyond the cell walls (cf. fig. 205b). It seems likely that the inset was simply cut from the plate which originally covered the whole work. The double plates which cover the back of the outer frame were probably fitted to strengthen the part which was subjected to most stress.

There is every reason to believe that this plaque was originally a pendant. The reversed animal head and the two rivet holes suggest the position of the suspension loop. Vierck, however, considers that the plaque came from an earlier Merovingian reliquary from Eligius' workshop. I cannot endorse Vierck's argument, which includes the hypothesis that the earlier reliquary was handed down to Egbert through relatives in Flanders. It is not unknown for parts of older shrines to be re-used, but the explanation seems too far-fetched in this case. The attribution of the cloisonné to Eligius' workshop cannot be correct as there is no evidence to suggest that cloisonné of this type was produced in his time. The garnets used in Eligius' work were of a different quality from those on the plaque, and were cut with e-steps (cf. 4:3). The *Trier* plaque is one of the finest examples of Merovingian garnet cloisonné and can hardly have been produced after about 600. Kendrick (1933,37f.) emphasises the similarities between the *Trier* plaque and Anglo-Saxon pendants of Bacton type; Bruce-Mitford (1949,37) takes this argument a stage further when he suggests that the plaque was manufactured in the workshops at *Sutton Hoo*. But pendants of this kind are not exclusive to Anglo-Saxon England: they were probably equally common in the Merovingian lands and would have derived from Byzantine enamelled medallions (cf. Roth 1979 fig. 3a and 3b). Thus Gregory of Tours refers to a golden reliquary worn as a pendant (Tunc extractum a pectore crucem) (Weidemann 1982, 186). The fact that these pendants are seldom represented in Merovingian material, which is based on grave goods, is probably due to their Christian associations; in Christian areas they would not have been worn by the common people. The Langobards and Allemanni used gold-foil crosses as grave goods; the designs of these crosses are sometimes related to these pendants. The crosses from *Ulm* and *Brenz* in south Germany include portrait medallions where the Emperor is seen as the equal of Christ the King (Haseloff 1975,67,107). A casual find from *Linon*, Puy de Dome (fig. 159) of a jewelled disc is relevant here. The disc, which has a hole for suspension, showing that it was worn as a pendant, is decorated with a double-armed cross with a face at the centre surrounded by a pattern of rays simulating square inlays in niello. The cross-arms have animal ornament in early Salin style II together with the letters R, $\alpha$ and $\Omega$.

The animal ornament consists of paired, interlaced heads: boars' heads on three of the cross-arms and what are probably birds on the other three. The boars' heads are accompanied by pairs of paws, while the bird figures terminate in a simple ribbon loop. The eyes of the boars and of the human face are inlaid with small, lentoid garnets with fine waffle foil. The character of the ornament is further enhanced by the dots and lines of the niello.

The pendant from *Linon* is of the finest quality and is particularly important in this context as it is indisputably a representation of Christ on a Frankish pendant (Arrhenius to be printed). Animal ornament in early Salin style II of the same type occurs, for instance, in Arnegunde's grave in *St Denis*. In my discussion of the sword pommel from *Vallstenarum* (Arrhenius 1970) I suggested that discs of *Linon* type were the prototypes of the cross and boar designs on disc brooches of the type found in Arnegunde's grave. As these brooches also had mushroom-shaped garnets, there is a direct link with the Egbert shrine. The association of early style II, Christ symbols and cloisonné is an important combination which reflects the strong Franco-Byzantine connections. Their occurrence in Arnegunde's grave emphasises that these connections existed in the sixth century. A dating of the *Linon* disc to the seventh century, as suggested by Schultze (1979,285) cannot be upheld, particularly as gold jewellery of such high quality and fine ornament of this type is unknown in the seventh century. Animal ornament is represented on the Egbert shrine plate by the pear-shaped animal heads in cut garnet. The pear shape—that is an animal head seen from above—also occurs at Kragehul, for instance, and probably belongs to early Style II (cf. Ørsnes 1970,XVI). The large pendant from the *Cologne* Cathedral grave also took this form.

Thus there is reason to believe that the *Trier* plaque was originally a pendant, while the Justinian coin, which is now re-mounted, was originally in a (?) sunken setting and represented Christ the King. Vierck's suggestion that the plaque is in two parts because it contained a reliquary is quite plausible; it would indeed have been possible to house a relic, perhaps under the gold coin, where there was plenty of space between the inset and the bottom plate (fig. 204). Concealed reliquaries of this kind are known from the sixth and seventh centuries, such as in the rectangular Burgundian buckles which, according to Werner (1977 a, 324 ff.), were mainly worn by clerics, and in the pectoral cross from St Cuthbert's grave (Bruce-Mitford 1956,282). The large gold buckle from *Sutton Hoo* may also have been a reliquary of this kind (Werner 1982, 200). The pendant from *Trier* was presumably also a clerical object, and it is likely that Egbert took if from some church treasury there. The plate was probably not mounted on Egbert's shrine by chance, but as a direct result of the politics of the church at that time. I have in mind the violent tenth-century controversies over the primacy in the Rhineland, which led to Benedict VII giving bishop Egbert the privileges of a primate in Gallia Belgica in 977 (cf. Ewig 1959,141). In this conflict it was important for the episcopate of *Trier* to emphasize its seniority, its imperial and apostolic traditions. Although Roman gems are fairly common on medieval reliquaries, and on those from Egbert's workshop in *Trier* (cf. Westermann-Angerhausen 1973), the use of earlier cloisonné work as decoration on shrines from the Ottonian period is unique, even though objects such as Frankish disc brooches from demolished *Reihengräber* cannot have been altogether unusual in the Rhineland at this time. Thus when a cloisonné object was used, it indicated that this pendant was considered valuable and of particular significance. The front of the shrine also bears traces of the outside row of cells of another cloisonné panel (cf. Vierck 1974, pl. 32:2). Single garnet gems, in the form of larger plates with engraved rings, are also mounted on the shrine.

All these garnets, some of which were of high quality, were probably taken from older garnet jewellery. Hiltrud Westermann-Angerhausen (1973) observed that all known work from Egbert's workshop (except the Petrus staff) has single mounted garnets, suggesting that there was a good supply of older garnet work, which was used to the full.

It seems likely that the whole jewelled plaque was mounted on the Egbert shrine with the specific intention of emphasizing *Trier's* tradition of garnet work. The garnet manufacture could be seen as evidence of a Byzantine tradition. One may even hypothetically speculate that the pendant was the pectoral cross of one of the clerics who served under Bishop Nicetius in Trier in Theodobert's time. It is known that Bishop Nicetius called in Italian building workers for his work on the cathedral (Schindler 1973,144). The strongly Byzantine elements in fused paste work have been frequently mentioned here, and it is not impossible that Byzantine goldsmiths and gem-cutters worked in *Trier*. There was a moneyer in this city in the sixth century (after 527) who struck coins with the inscription *Treveris civitate* (Schindler 1973,144). The presence of a moneyer—someone who cuts the coin dies—in sixth-century *Trier* is of particular interest in this context, since the cutting of coin stamps involved a technique similar to gem-cutting, and both could be carried out by the same person (cf. 4:1). The garnets cut in *Trier* show many innovations, like the production of the complicated shapes with f- and g-stepped patterns and probably also more individually cut garnet gems, exemplified by the plaque under discussion here.

Before developing this argument further, the value of the jewelled plaque from Egbert's shrine as source material must be examined in more detail. It has been assumed that the plaque is a fused paste work, produced in *Trier* in the second half of the sixth century. The chronology will be discussed below. It was not possible to carry out *chemical analyses* on the paste under the foil. However, a close inspection of the plaque under magnification revealed that the outside border had all the typical indications of fused paste work. The cell walls were extremely thin, with no sign that they had been flattened over the edges of the garnets at the top. The surface was also found to be slightly and irregularly domed, a feature typical of fused paste work (cf. 3:3 f.). The very thin back plate revealed that only the cell walls of the animal-head garnets had been properly soldered to the back, while the remaining cell walls had not left any such clear impressions (cf. fig. 205c). If this had been mounted using the sand putty technique, the bottom plate would have been a thick, rigid sheet and the border would have had thickened cell walls on either side to ensure stability. There is now only a thicker wall around the edges of the plate, and this toothed strip is probably not original, but was apparently added in connection with the Ottonian mounting of the plate. I was not permitted to sample the paste which could be observed, and which carried the imprint of a waffle pattern from the gold foil. It consisted of a hard, greyish substance apparently identical to the sulphur paste from the pear-shaped pendant in the *Cologne* Cathedral grave, for instance; the possibility that it was an adhesive added in the course of modern conservation cannot, however, be excluded. The paste cannot have been a wax calcite paste, as this has a characteristic yellowy-white colour, but sulphur paste is more difficult to distinguish from other types of adhesive, including modern ones. Where the garnets had fallen out, the gold foil remained in place; this is unusual in sand putty work, where the cells are usually quite empty when garnets have fallen out. Rademacher describes traces of *gebleichert Wachs,* that is wax mixed with calcite, on the back of the plaque (cf. chapter 3), and Westermann-Angerhausen (1973,31) points out that such wax was used to secure the red glass in the Ottonian openwork which also decorates the sides of the shrine. This is a very likely, since this type of paste was used for a long period. However, the fused paste of wax and calcite used in cloisonné work is characterised by its fine grain size and also by a fairly high proportion of calcite in the mixture. Westermann-Angerhausen's observation that the paste in the openwork had shrunk and cracked suggests that the admixture in the paste had been slight; I have never observed this process of deterioration in cloisonné work. The cloisonné in the outside border of the plate shows no such damage. This conclusively proves that the paste in the cloisonné was different from that behind the plate and in the openwork. All the indications are therefore that the fused paste in this cloisonné work was a sulphur paste, but this identification is based only on visual evidence. I see no reason, however, to doubt its validity.

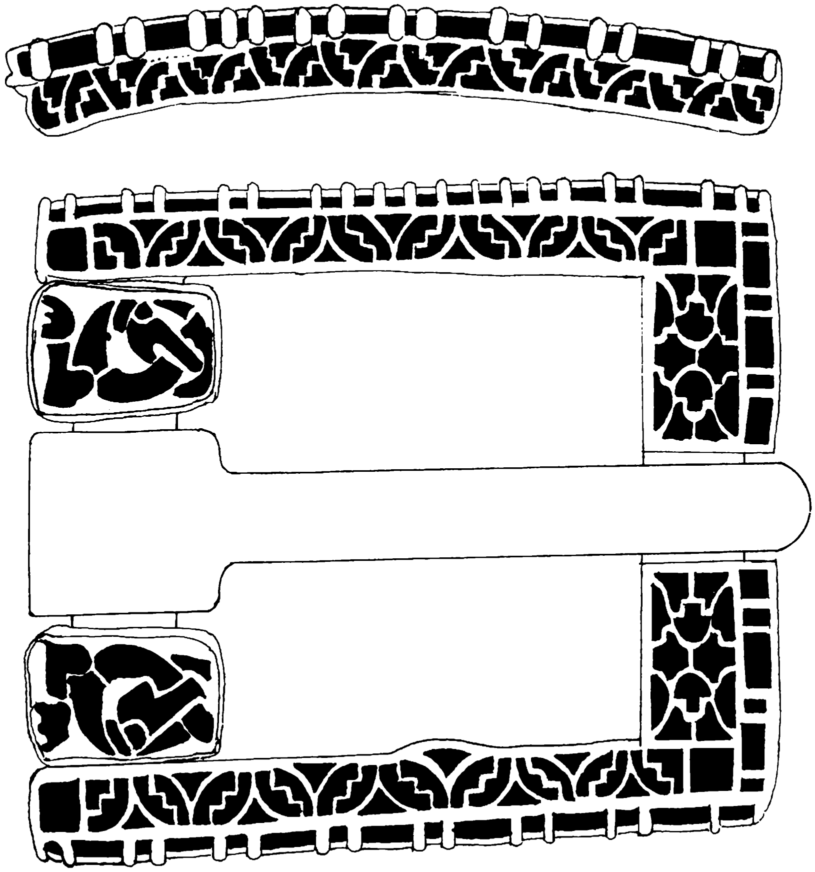
Despite the lack of analyses, it appears to be overwhelmingly likely that the *Trier* plaque was a fused paste work with sulphur paste and that it was a pendant with Christian associations, the coin of Justinian symbolizing Christ the King. The hypothesis was stated above that the presence of this plaque on Egbert's shrine was connected with the issue of the primacy. In order to test this hypothesis it is necessary to establish whether the making of shrines and reliquaries was in fact related to church politics. Westermann-Angerhausen's studies appear to confirm that this was indeed one of the reasons for the production of Egbert's workshop in *Trier.* Her conclusions are as follows:

> Die Arbeiten aus der Goldschmiedewerkstatt Erzbischofs Egberts erweisen sich als Dokumente, die, wie der Petrus-stab bewusst im Dienst der Trierer Bistumspolitik stehen oder, wie der Buchdeckel und in gewissem Sinne der Egbertschrein allgemeiner das neue Verständnis der ottonischen Reichskirke illustrieren (Westermann-Angerhausen 1973,137).

The political significance of the objects produced in Egbert's workshop in *Trier* is therefore evident, but it is also apparent that Westermann-Angerhausen makes a distinction between the Petrus staff, which she connects specifically with local politics, and the Egbert shrine, which she sees as related more generally to Ottonian church politics. This is due to her interpretation of the plaque on the shrine as nothing more than an eccentric addition to an ornament in which enamel and *opus interrasile* otherwise predominate.

Westermann-Angerhausen (1973,66,87) emphasizes that the designs of the enamel panels and the *opus interrasile* were strongly influenced by the contemporary local

Fig. 207. a–b) Reconstructed buckle from Tongeren. 2:1.



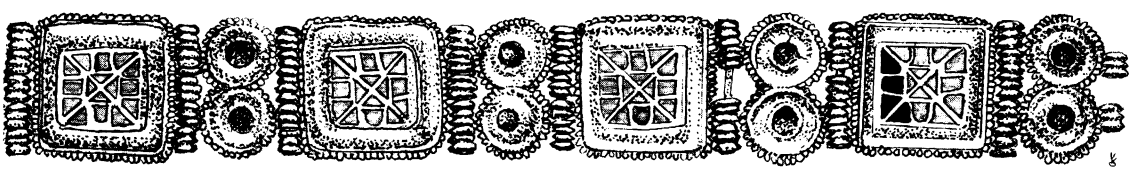


Fig. 208. Bracelet from Turin (BM 2). The garnets with fused calcite paste. 1:1.

scriptorium in *Trier*. She even suggests that both workshops could have been attached to the same church, St Maximin (1973,137). The design of Egbert's shrine is therefore very closely associated with local traditions.

According to the inscription, the shrine contained relics of the apostles Peter and Andrew, and it was also consecrated as an altar to the apostle Andrew, whose foot is represented at the top of the shrine. Westermann-Angerhausen (1973) suggests that this is a reference to the Byzantine tradition whereby Andrew was seen as the first bishop. Egbert's enthusiasm for this cult, with its local associations, is further demonstrated by his dedication of a chapel to Andrew where Henry, his predecessor, was interred and where he himself wished to be buried. The cloisonné plaque with the coin of Justinian, like the dedication of the shrine to Andrew, was in my opinion intended to emphasize the Byzantine traditions in *Trier*. Whether this pendant originally belonged to one of Egbert's predecessors, or whether it had just been kept in a church treasury, the plaque could be regarded as a symbol of Byzantine *Trier*, whose apostolic traditions confirmed Egbert's primacy.

The presence of a jewel of this kind on a shrine which is known to have been made in *Trier* can, in terms of a critical evaluation of source material, be seen as evidence that such cloisonné work existed in *Trier* and that it was

Fig. 209. Bossed disc brooch from Amiens with fused paste (BM 16). 1:1.

Fig. 210. Gold button with garnet cloisonné from Enger (Münst 5). 2:1.

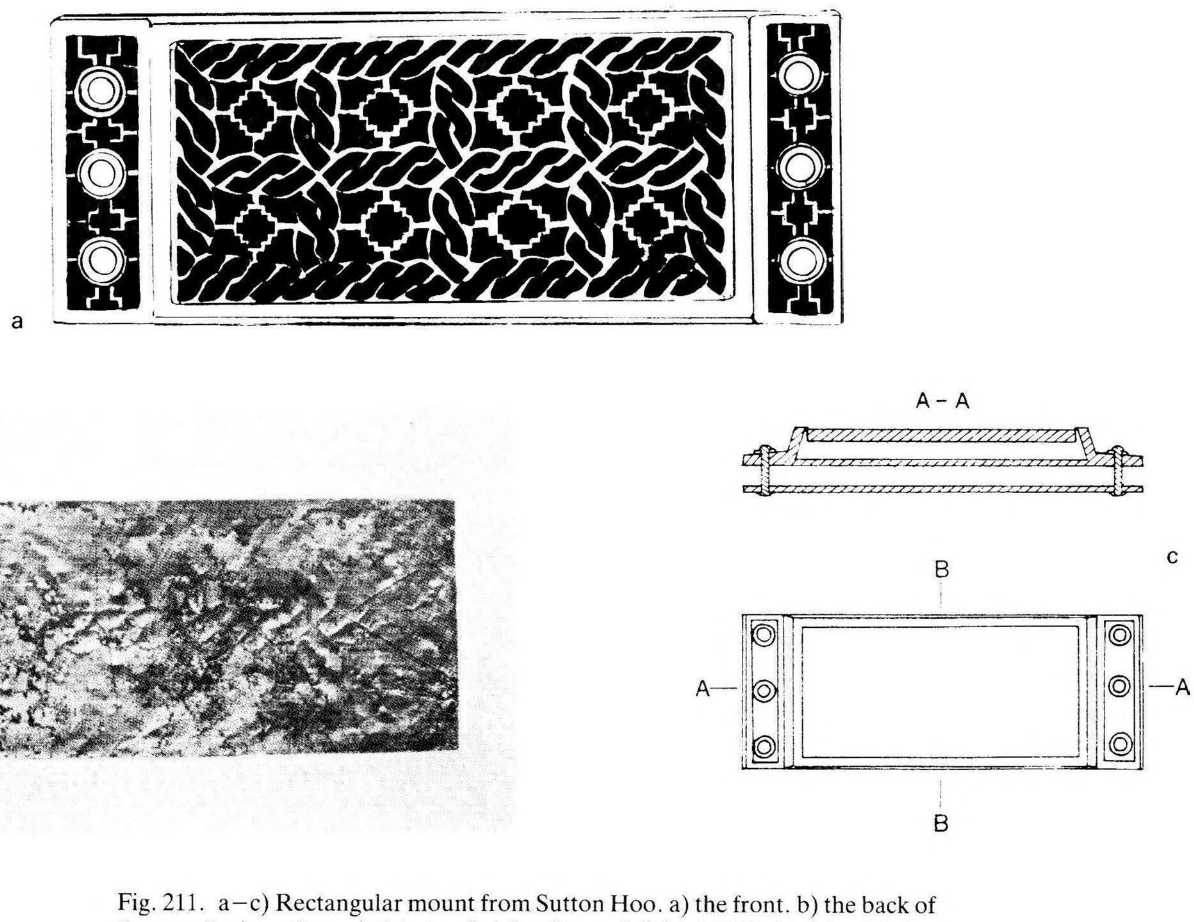



Fig. 211. a–c) Rectangular mount from Sutton Hoo. a) the front. b) the back of the panel. c) section. a) 2:1. b–c) After Bruce-Mitford 1978. b) 2:1. c) 1:1.

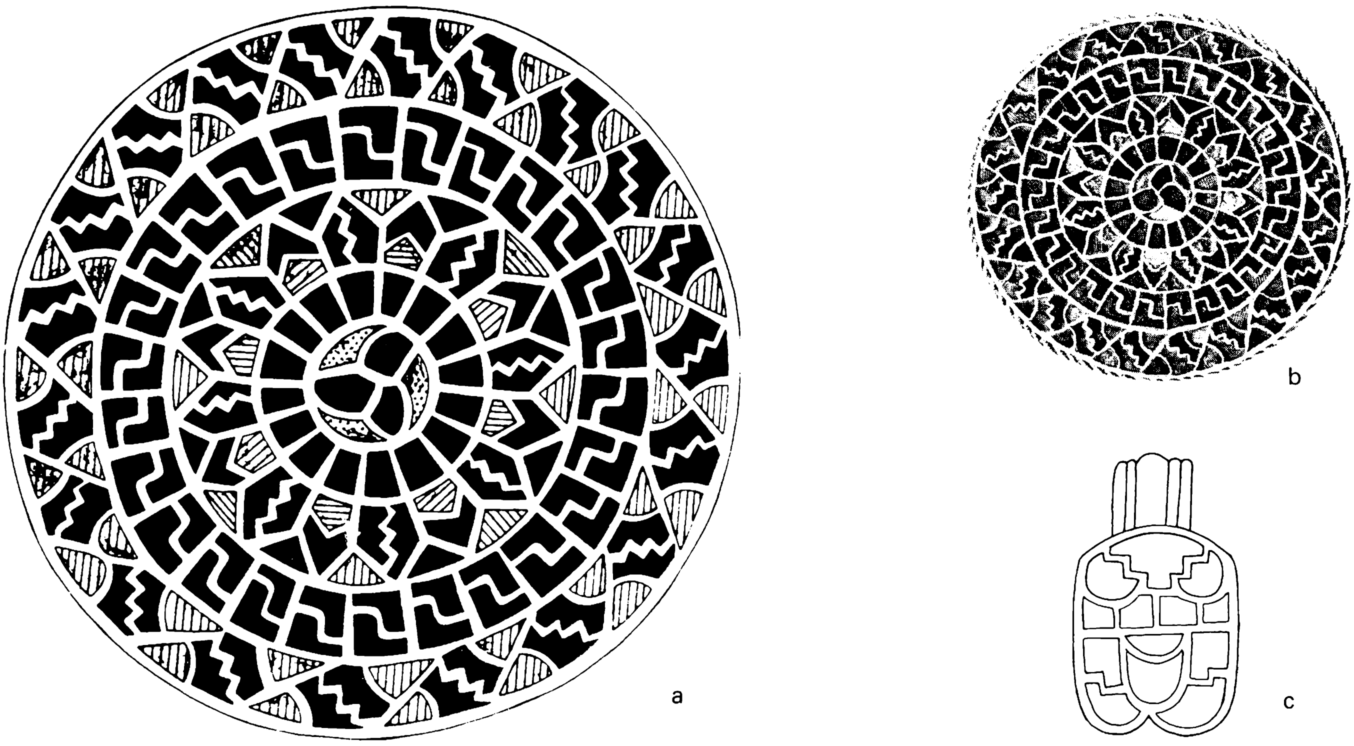


Fig. 212. a–c) Disc brooch and pendant from Soest, grave 106 (Münst 1–2). 2:1. a; c) The cloisonné pattern. 2:1 b) The gold disc brooch 1:1.

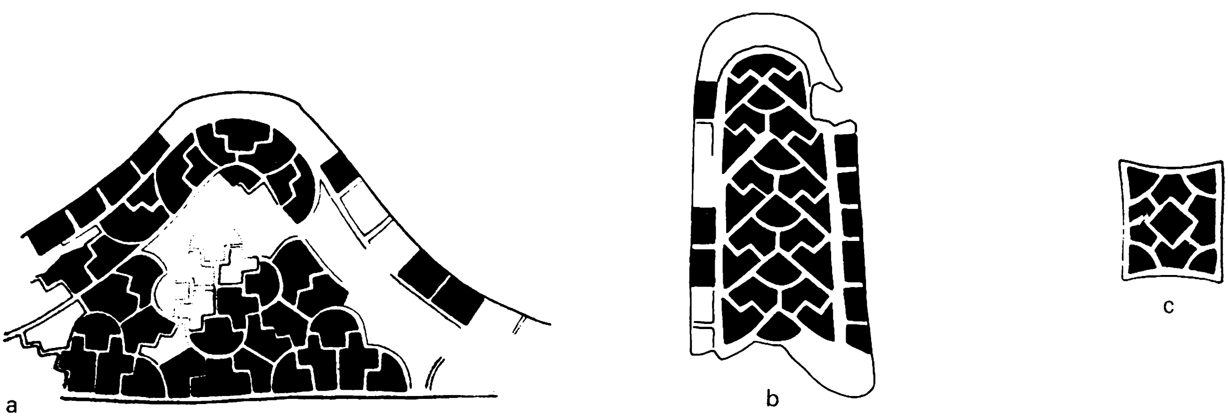


Fig. 213. Garnet cloisonné on the sword pommel from Skrävsta (Swed 26). a) the front. b) the side. c) the top.

Fig. 214–215. Cloisonné fragments from Uppsala Västhög (Swed 27 b).

Fig. 216. Pyramid-shaped cloisonné fragment from Uppsala Västhög (Swed 27 c).

highly valued. In my opinion this suggests that it was produced locally. Further evidence for this is the fact that, while the plaque discussed here was on the back of the shrine, it is likely that another similar plaque, of even higher quality, decorated the front of the shrine. The outside border of this remains: thick, facetted garnets set *à jour,* while the centre has a secondary covering of a silver plate with a mounted (?) sapphire. Thick, facetted garnets of this kind are uncommon and were probably regarded as particularly valuable; they made great demands on both the gem-cutter and the raw material.

Facetted garnets like these are found, for instance, on the pyramides from *Sutton Hoo* (Bruce-Mitford 1978,303 ff.) and on two sword pommels from Sweden, from *Hög Edsten* (Swed 21) and *Skrävsta* (Swed 26). The paste on the *Hög Edsten* pommel is sand putty (cf. chapter 5), while on *Skrävsta* it was a fused paste of calcite and wax. The pommel from Skrävsta is of exceptional quality with thin cell walls and foil, as on the Trier plaque. Also similar is the design, which is of quatrefoils composed of mushroom-shaped garnets, further refined by the insertion of arrowhead-shaped garnets.

## 6:2 Other fused paste work from the Trier workshop

Some other objects using fused paste cloisonné are associated with the *Trier* workshop (cf. diagram fig. 198). One of these comes from the cathedral in *Tongeren* (fig. 206–207), only ninety kilometres from *Trier. Tongeren* belonged to the diocese of *Trier* and lies at a distance which was identified in chapter 4:1 as being within the range of a workshop (i.e. three days' travel). The *Tongeren* object is now very fragmented and has been re-worked as a hinge at an unspecified date. This included the mounting of two irregularly-shaped amethysts and an emerald, a combination of stones often found in Merovingian objects such as the bossed disc brooches (cf. Rademacher 1940,16), but this type of inset also occurs in the Carolingian period and later. The hinge may have been the mount of a reliquary or possibly a *pyxis.* The mount consists of two right-angled cloisonné borders which meet at the actual hinge, while the opposite, rectangular plate has the three domed stones already mentioned, interspersed with two small cloisonné panels with designs of two backward-biting animals. These panels are very similar to the animal ornament on the shoulder-clasps from the *Sutton Hoo* grave, for instance. As in *Sutton Hoo,* some of the cells are lidded, that is there are panels between the garnets where sheets of gold have been soldered to the tops of the cell walls. The gold panels dominate the design by the strong contrast in colour between the gold and the garnets. Other than at *Sutton Hoo,* where it is used with great mastery, this technique is found on some objects from *Uppsala Västhög.* One is a cloisonné panel, probably from a buckle (cf. Werner 1950a), with an animal ornament where the eye probably consisted of a round plate of plain gold (fig. 214). This fragment, and another which probably came from the buckle frame (fig. 215), are both of fairly coarse sand putty work. Analysis revealed the presence of cristobalite, that is quartz heated above 1470 degrees. The fact that the temperature of the cremation at *Uppsala Västhög* reached this level is further indicated by slagged glass and the fact that the surfaces of the garnets were affected, producing a pitted surface and destroying their translucence. A very little paste survived, more or less burnt to the cells, and it is possible that the paste protected the cells from melting completely. However, the preserved fragments indicate that most of them were completely destroyed. If this interpretation is correct—and this is difficult to determine, given the fragmentary character of the remains—the find from *Uppsala Västhög* (fig. 214) provides evidence that lidded cells were produced in the workshops of the quartz sand group. A triangular panel from *Uppsala Västhög* with this type of cellwork was, however, probably made by the fused paste method, although the paste has been completely burnt away and only the paper-thin walls and occasional burnt garnets now remain. The design represents an arched animal, perhaps a boar; two of the cells are turned over to form a small gold panel (fig. 216). Small gold panels of this kind, formed by folding over a cell, also occur on the rectangular strap mounts with cable-twist design from *Sutton Hoo* (Bruce-Mitford 1978,460). The cable-twist design also occurs in garnet cloisonné on a couple of Byzantine strap-mounts (Fettich 1951) (cf. fig. 217a). In chapter 4 it was maintained that the Byzantine mounts were produced in the central workshop at *Constantinople,* but there is no evidence of cement paste at this late stage and it appears that the mounting was carried out with fused paste. The *Sutton Hoo* strap mounts are in my opinion also fused paste work; the paper-thin walls and the thin bottom plate, on which the pattern of the cell walls has left clear impressions (cf. fig. 211b), can hardly have been joined to the garnets by any other method. Bruce-Mitford describes how the cloisonné panel was mounted in an outer tray which gave the thin work added stability, a method very reminiscent of the technique on the *Trier* plaque (cf. figs. 204 and 211). If this had been sand putty work, the bottom plate would have been thicker and extended over the whole back of the strap mount, and the outside walls of the cloisonné panel would have been attached to the back by soldering. Bruce-Mitford maintains that as the cable pattern can be clearly seen on the back, the cell walls were soldered to the back plate. However, these impressions are of a different kind from those sometimes seen on the back of sand putty work; they take the form of zones, circular or linear, and do not include the individual transverse cell walls which could not be soldered to the back plate. The impressions on the back of the *Sutton Hoo* mount probably resulted from the thin back plate being pressed up against the cell walls, to which it was probably only lightly fastened by occasional spot soldering. Together with the adhesive action of the paste this would have secured the work more firmly. There is a damaged portion at the edge of the cloisonné panel, and Bruce-Mitford points out that there is no paste here.

This was probably the result of damage during the actual mounting. When the outer tray was heated and the cloisonné panel was pressed into position, a little of the fused paste could easily have melted and poured out if there was any damage. There is now an empty space between the cloisonné panel and the tray; this space was probably originally filled with a calcite substance which has since corroded (cf. chapter 5). In the absence of this filling, it would have been very easy accidentally to push the inlays to the bottom. The hypothetical suggestion that the rectangular mounts with cable-twist design from *Sutton Hoo* were mounted by the fused paste technique must be compared with Bruce-Mitford's description (1978,463):

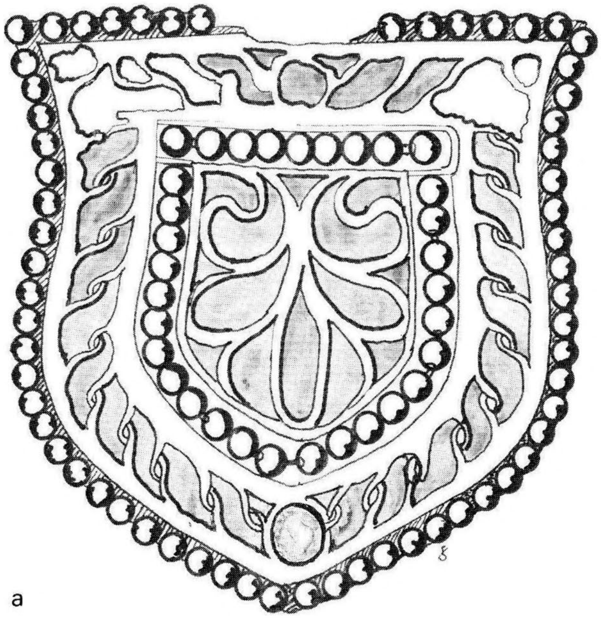
> . . . the cloisonné work of the central panel, with the interlaced design, is abnormally shallow and is on a separate tray which was then inserted into the mount. This device is not resorted to in the matching pieces inv. 6 or 7, *or in any other piece of the Sutton Hoo jewellery* (author's italics).

It was established above that lidded cells occur not only on the mounts from *Tongeren,* but also on Byzantine mounts with cloisonné in cable-twist patterns mounted by the fused paste technique, and on fragments from *Uppsala Västhög* using both sand putty and fused paste techniques together with animal ornament. The last example with lidded cells is a button from *Enger* (fig. 210) with a calcite putty lightly blistered. The button probably originally had a fused wax calcite paste, however there is now no trace of wax perhaps due to heating in connection with remounting, (cf. Vierck 1980). It is true that examples of lidded cells are most numerous at *Sutton Hoo,* where they occur with cable-twist patterns, probably using fused paste technique, and probably also using sand putty technique with animal ornament (on the purse).

The complex distribution of this type of cloisonné however makes it impossible to accept without further consideration Bruce-Mitford's (1974,274) statement that the mounts from *Tongeren* were a product of the *Sutton Hoo* workshop.

There have been no chemical analyses to prove that the *Tongeren* mounts are fused paste work, but from my visual examination I judge them to be characteristically so, with paper-thin cell walls and bottom plate mounted in the trays which now compose the L-shaped mounts. A hypothetical reconstruction of their original form (fig. 207) gives a fairly broad buckle frame, with the L-shaped mounts as the actual outer frame and the two small mounts with animal ornament situated on either side next to the hinge. A very similar buckle comes from grave 9, *Niederstötzingen;* this is decorated with metal incrustation imitating cloisonné. Paulsen (1967,341) points out that the incrustation ornament on this buckle is related to that found on many other objects in Frankish and Allemannic areas. Mushroom cells frequently occur, often arranged to form a quatrefoil. Other typical motifs are the cross, animal ornament in Style II and various fish designs (cf. Paulsen 1967,36). There is a definite strong influence from Christian art. The Trier plaque was associated with Christian art, as it was probably originally a clerical pendant. If the suggested reconstruction is correct, the *Tongeren* mounts may also originally have belonged to a buckle worn by priests. These buckles were broad and tailored to the wide clerical sash (cf. Werner 1977a). The reconstructed buckle from *Tongeren* is the same size as the buckles described by Werner.

Another object directly associated with the *Trier* plaque is the disc brooch from grave 106, *Soest* (fig. 212). We have already seen that two pendants from the necklace in this grave had fused paste work with sulphur paste. They are closely associated with the large pear-shaped pendant in the *Cologne* Cathedral grave, but were probably of a considerably later date. While the pendants from *Soest* now have no inlays, and only the paste remains, all the inlays on the disc brooch are intact. The brooch is unusually polychromatic; the central rosette has a trefoil design inlaid with almandines surrounded by yellow glass, while in the four concentric borders green transparent glass and pale blue opaque glass alternate with almandine and stones which may be either hessonite garnets or pale red glass. As the brooch was intact I could not collect a sample of the paste, but under microscopic examination a greyish-yellow shiny hard substance could be observed along the cell walls; in my experience this represents sulphur paste. The slightly



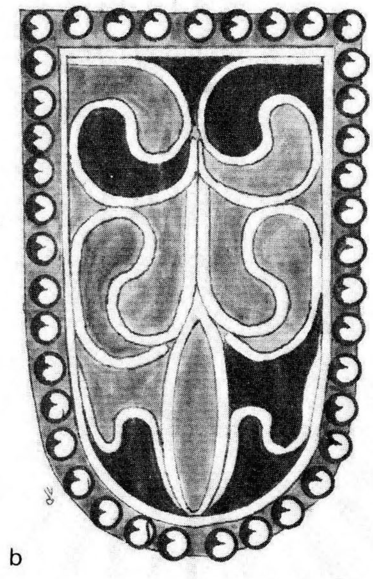


Fig. 217. Gold mounts from Kerch. Garnet cloisonné with fused paste (most of the garnets are missing). 2:1.

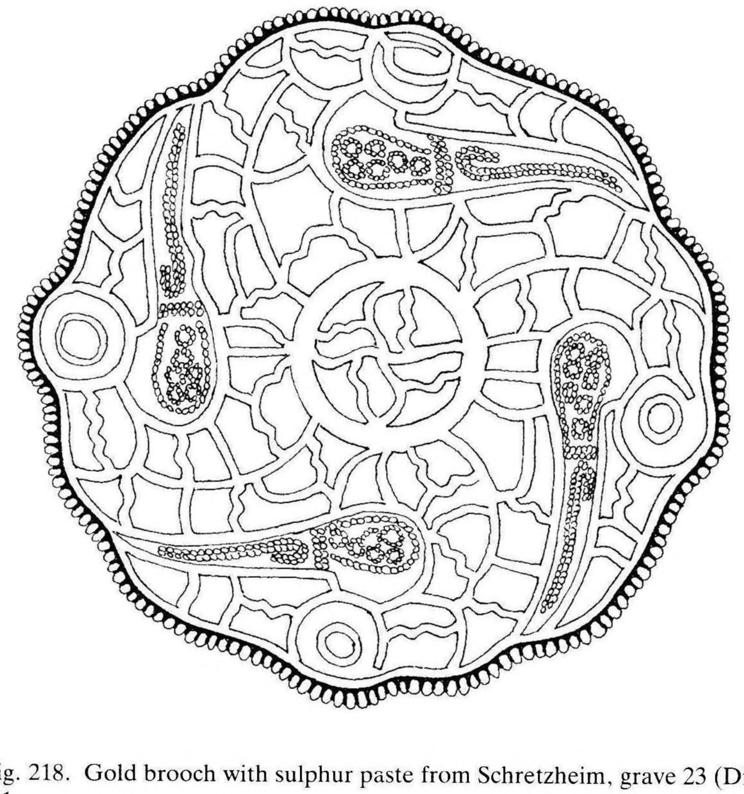


Fig. 218. Gold brooch with sulphur paste from Schretzheim, grave 23 (Dill 5). 2:1.

domed surface of the brooch, along with the fact that the brooch appears to have been made in two independent parts, perhaps like the *Trier* plaque, supports the suggestion that the brooch was a fused paste work. The outer zone seems to have been made as an independent unit, because the cell wall along the inside edge is of double thickness, apparently formed by two joined walls (cf. fig. 212c). This may be because it was originally intended to place a reliquary inside the brooch. It is not now possible to establish whether or not this was done, as the brooch has a thick gold back plate soldered to the cloisonné, the seam, and therefore the internal structure, being covered by a twisted filigree wire. On the back plate a runic inscription states that 'Rada and Dapa' [gave this] and 'Attano' [carved the runes] (Krause 1966); the inscription clearly indicates that the brooch in its present form was a gift. The brooch is linked to the *Trier* plaque primarily by its polychromatic character, but also by the cell shapes, which are of the closer stepped variety, cut from the g-templet (step height 0.5 mm), which also occur on the mushroom-shaped garnets on the Trier plaque. As with other examples of g-stepped patterns, they occur along with the f-stepped variety, even on the same garnet (cf. 2:7). However, on the *Soest* brooch the closer step-pattern is used on comb shapes, and in this context it is important to note that the comb-shape also occurs not only on the *Tongeren* mounts (fig. 207) but also on other sulphur paste work (see below). It is a striking feature of the *Soest* brooch that the design is completely geometrical, with no hint of animal ornament. This is particularly conspicuous because the two pendants in sulphur paste work in the same grave had animal ornament in the form of a be-lobed animal head. These pendants also had mushroom-shaped cells.

We must therefore consider whether it is possible that the brooch and the pendants came from the same workshop, in other words whether sulphur paste of itself can be said to distinguish an individual workshop. The *Soest* pendants are one of many examples where there are no inlays and only the sulphur paste remains. One possibility is that the paste itself constituted the inlay material, but this is unlikely, as it does not reach the top of the cell walls, but leaves room for an inlay.

Amorpous sulphur is not a particularly suitable inlay material as sulphur has a tendency to become crystalline and gradually crumble on exposure to the air.

In these objects the sulphur paste has a more pronounced yellow colour than when the paste is found intact behind gold foil, thus indicating that the process of transformation to crystalline sulphur has begun. The absence of gold foil or the impressions from such foil also suggest that the inlay material was not translucent—garnets, for instance—but that the inlay in the now empty cells was opaque, perhaps some organic substance which has since corroded, possibly due to the effect of the sulphur. The abundant use of glass and enamel was, as we have seen, typical of fused paste work, a fact which, along with the use of very small garnets, suggests that it was produced at a time when there was a shortage of garnets. It is therefore most likely that the fused paste work with garnet inlay, and that with empty cells, comes from the same workshop, the difference being that inlays of different materials were used. There is a parallel here with sand putty work, where coloured sand putty was sometimes used as inlay material.

As the sulphur used in fused paste work north of Italy must have been imported, the presence of sulphur cannot in itself be used to identify a workshop. There are, as we have seen, early examples of sulphur paste in cloisonné work where it was used in the same way as any other paste. In these cases I have drawn no conclusions other than that the sulphur indicates Byzantine connections. More significant, however, are cloisonné works carried out using the fused paste technique, with paper-thin cell walls point soldered to each other and to the back to enable the paste to adhere and pull the walls tight around the inlays. Used in this way, the fused paste signifies the introduction of a completely new cloisonné technique; in these circumstances sulphur may be seen as a valuable indicator of an individual workshop. The sulphur was still an imported material and does not in itself suggest any particular locality. But cloisonné work using the sulphur paste technique also has other features in common, such as the choice of cell shapes and, where the inlays are preserved, a certain tendency to use polychromatic designs.

The oval brooch from *Reinstrup* in Denmark (fig. 221) provides an interesting example. The design on this brooch combines a strictly geometrical design, related to that on the brooch from grave 106 at *Soest,* with an animal ornament associated with the designs on the pendants in the same grave. The *Reinstrup* brooch is a typical fused paste work with sulphur, and the eyes on the human masks are inlaid in a porous enamel of the same quality as is found in grave 106 at *Soest.* The long-beaked birds' heads on this brooch are, however, also closely associated with the cloisonné designs on the disc brooches from grave 23 in *Schretzheim* (fig. 218) and *Eltville* (Wiesb 1), which are both sulphur paste works with empty cells.

The *Reinstrup* brooch has been seen by earlier scholars as very similar to an oval disc brooch (fig. 219) from *St*

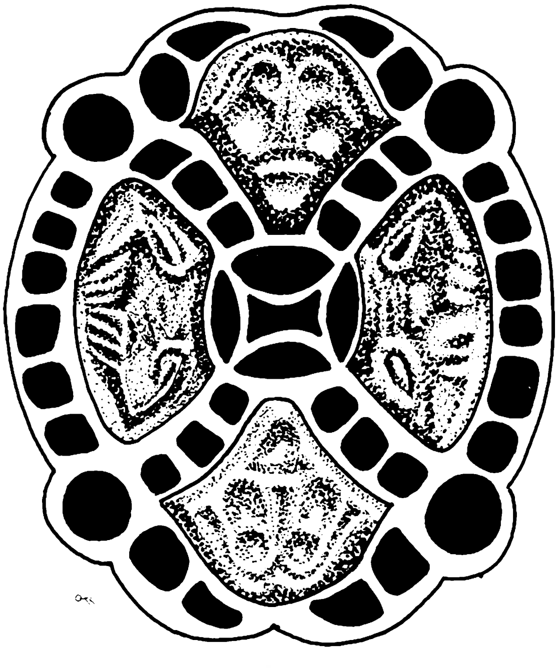


Fig. 219. Bronze brooch with garnets in narrow borders from Trier, St Maximin. 2:1.

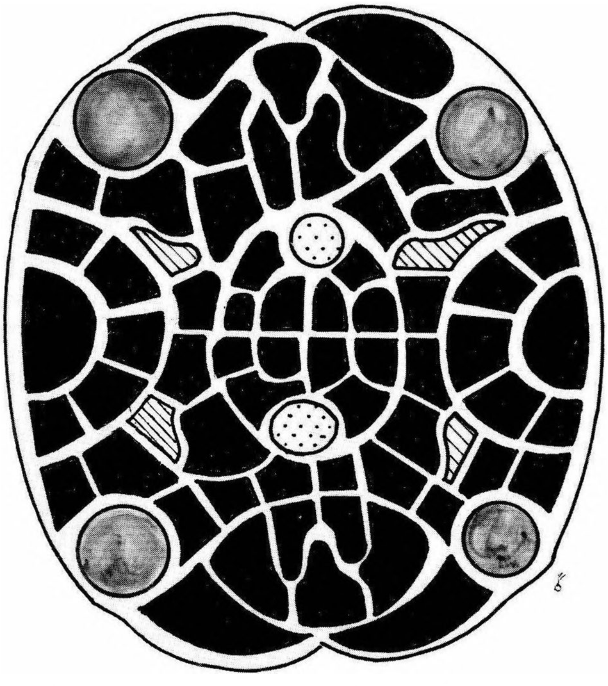


Fig. 220. Bronze brooch with garnet cloisonné from Soest, grave 165 (Münst 3). 2:1.

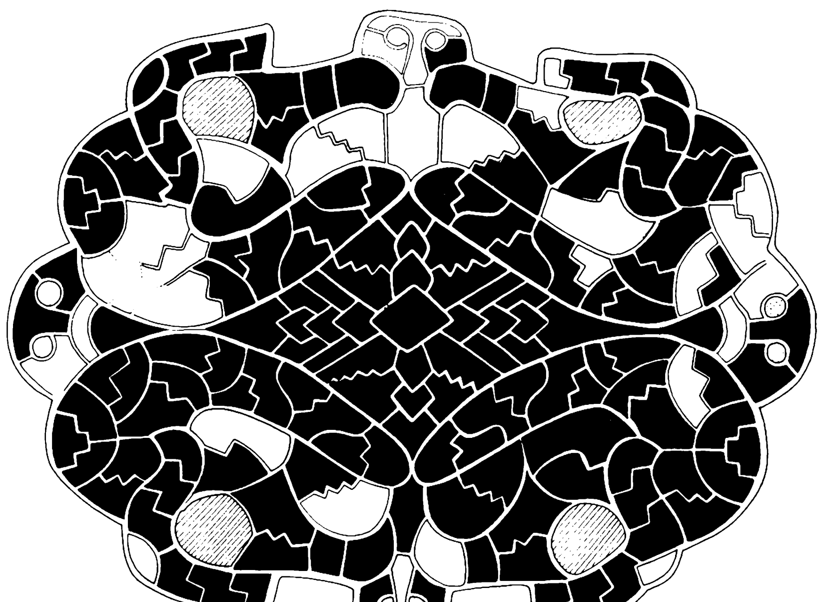


Fig. 221. Gold brooch with garnet cloisonné from Reinstrup, Denmark (Cop 3). 2:1.

*Maximin* in *Trier* (Böhner 1958,100). The motifs of the design on this brooch are indeed like those on the *Reinstrup* brooch, but the design is only partly in cloisonné, consisting of borders of rectangular cells set with garnets by the clasped technique. The raised central panel with birds' heads is inlaid with individually shaped garnets. Between the cloisonné borders are chip-carved masks and on the long sides there are designs of opposed animal paws. The *Trier* brooch is rather early in appearance, with its garnet borders and chip-carving, and I cannot agree with Böhner's (1958,101) date in late period III or early period IV. Borders of rectangular garnet cells or single garnets in clasped cloisonné with chip-carved ornament are particularly typical of Germanic bronze brooches from the second half of the fifth and the first half of the sixth centuries. A human mask between two animal heads is also an early motif in the Germanic animal ornament of Style I (Haseloff 1981,131 ff.). Böhner points out that the solitary paired animal paws are a common feature of the Langobardic bow-brooches, but it already occurs on brooches from Langobardic grave finds in Pannonia, that is in finds before 568 (cf. Werner 1962,94 ff.). Another brooch similar to the one from *Reinstrup* is a disc brooch from *Brez* in Italy (Werner 1962, pl. 37:1); this has a design which proves that the complete motif of a human mask between animal heads was known in Langobardic art. The degenerate character of this motif makes it difficult to imagine that Langobardic examples could have served as a prototype for the brooch from *St Maximin* in *Trier*. Instead it would seem that the brooch from *Brez*, for instance, was a Langobardic copy of a Frankish type. It is important to stress that this motif is found in Frankish cloisonné art. It is also important to note that the oval brooch from *Trier* with this motif was found in a church, indicating that it came from a Christian burial. It was established in chapter 5 (cf. 5:5) that the Frankish settlement in *Trier* was late, and that Trier itself played an important role in introducing Christianity to the Franks. In this context, ornamental representations like those on brooches of the *St Maximin* and *Reinstrup* type were used (cf. Arrhenius to be printed). It is therefore not unlikely that a workshop in *Trier* also produced the *Reinstrup* brooch and the disc brooches and pendants with empty cells. The pendants from Egbert's shrine and other objects indicate that this workshop was directly associated with the church, and there is no evidence that cloisonné for weapons and horse trappings was ever produced there. It is therefore likely that there were contemporary secular workshops which would also have served the Latin population of the town. It is likely that the *St Maximin* brooch came from such a workshop. It is interesting to note the Frankish influence in the design of this brooch, an influence which is also reflected on other objects such as the remarkable bow-brooch of silver of unknown provenance in *Trier* which has a geometrical chip-carved ornament and a circular head (cf. Böhner 1958,83,pl. 10:1).

The ecclesiastical workshop in *Trier* is therefore characterized by the use of sulphur paste, a high frequency of stepped garnets and polychromatic inlays of enamel and glass.

The earliest phase of this workshop is typified by the pendants from the *Cologne* Cathedral grave, where stepped patterns occur only occasionally. During this stage the workshop appears to have used chequer-patterned gold foil. The production consisted mainly of jewellery, particularly pendants, with flower-like motifs, while animal ornament was also known, since the pear-shaped pendants probably represent bulls' heads, e.g. bucrania.

This earlier phase, which also includes pendants from *Hellmitzheim*, can be dated to the period around 540; in the 560s there is a change to the use of very small garnets cut to complicated shapes like mushrooms, combs, chevrons and arrowheads (cf. fig. 203) with step-patterns, including those from f- and g-templets.

Apart from these garnets the inlay material included glass and enamel and perhaps some organic substances.

## 6:3 Fused paste work with calcite/wax paste

Fused paste of calcite mixed with wax could have had almost the same properties as the sulphur paste while being considerably cheaper, at least in areas north of Sicily. Analyses of samples taken from below the enamel work on the large so-called Castellani brooch (BM4) and a bracelet from *Turin* (BM2) of typical Byzantine form show that this type of paste was used in Byzantine art. A bossed disc brooch, perhaps from *Amiens* (BM16), had a filling of this type of paste. It has already been mentioned that paste of this kind, probably with a larger proportion of wax, was used on the Egbert shrine at *Trier*, behind the round cloisonné panel. Rosenberg (1910,117) points out that enamel panels can also be mounted in this manner. It is therefore clear that this type of fused paste was used in Byzantine art, doubtless as a substitute for sulphur paste, and it is important to note that it was used in Byzantine cloisonné work, as on the *Turin* bracelet (fig. 208). The shallow panels with garnet cloisonné (where most of the garnets are now missing), are attached to one another with hinges with circular inlays, now missing but originally probably of glass or flux. There are several examples of similar Byzantine bracelets with inlay of coloured stones and glass flux, as for instance those from *Desana* (cf. Bierbrauer 1975, pl.X,XI) and *Varna* (cf. Roth 1979, pl. 256). In these cases, however, the inlays are not mounted in cloisonné. The simple cloisonné pattern on the *Turin* bracelet which recalls settings on late Byzantine cloisonné, (cf. Werner 1984, pl. 25–26) suggests a later date than these other bracelets, that is in the second half of the sixth century or in the early part of the seventh century. The cloisonné can also be compared to the Byzantine mounts from *Kerch* (Eri 1–4) mentioned above. A bracelet from *Dumbarton Oaks* (no. 2) demonstrates that such bracelets were still produced in the Byzantine Empire in the second half of the sixth century (cf. Dosogne-Lafontaine 1979, no. 7a).

The *Turin* bracelet belonged to the Castellani collection in *Rome* and may have come from the Langobardic cemetery in *Testona, Piedmont* (cf. Bierbrauer 1975,31).

The bossed disc brooch from *Amiens* (fig. 209) demonstrates that calcite/wax paste was known in Frankish goldsmiths' art. In this case, however, the calcite/wax paste was not used for cloisonné. All the examples of fused paste work associated with the Byzantine jewellery mentioned here have a more coarse-grained calcite than the Germanic cloisonné work, which will be described below. It is particularly notable that the paste filling in the bossed disc brooch from *Amiens* has this coarse-grained texture.

Grave 165 at *Soest* provides probable evidence of this paste in a continental cloisonné work. This oval bronze brooch has a cloisonné design with a human mask between birds' heads which is very reminiscent of the *Reinstrup* brooch. As on this brooch, there is also enamel (e.g. yellowish-orange glass frit) inlay as well as garnets. The garnets are well cut but there are no f-stepped shapes, demonstrating that this is a simpler work than the *Reinstrup* brooch, which has an abundance of f- and g-stepped garnets. The human mask has a slightly different form: it merges with the birds' heads, that is to say, the beaks also form the eyebrows of the mask (cf. fig. 220). The brooch from this grave has been much restored and it was not possible to take a sample of the paste. The indications were, however, that this was not a sand putty but a fused paste work with a calcite/wax paste. However, analyses showed that a round disc brooch from grave 350 in *Schretzheim* (Dill 10) was definitely a fused paste work. The brooch has three zones, the middle zone and the central panel having depressed fields with *pressblech* ornament in the form of human masks (cf. fig. 241). This brooch will be discussed in chapter 7.

In the discussion of the sand putty technique it was stated that the North Sea group was characterised by pure calcite paste. In the finds from the *Cologne* Cathedral grave, this type of paste was used on the bow-brooches, while the pendants from the necklace had fused paste work with sulphur paste. It is therefore natural to look for the transition to fused paste with a mixture of calcite and wax in the cloisonné workshops of the North Sea group. It was established above that the location of these workshops is difficult to identify because there could have been workshops using this technique both on the Continent and in Anglo-Saxon England.

The same difficulty arises with the workshops which used fused paste of a calcite and wax mixture. The brooches from grave 165 at *Soest* and grave 350 at *Schretzheim* are forms which are known only on the Continent, suggesting a continental workshop. In England one object with clear evidence of this type of paste is a keystone garnet disc brooch from grave 14 in the *Kingston* cemetery (cf. Avent 1975,120). In this case the adhesive property of the paste was not used, as the settings are single. However, Avent (1975,18) has pointed out that many of the composite brooches were probably also mounted with this type of fused paste. Avent refers to the continuing investigations of the *Sutton Hoo* find which may further illuminate this point.

Above has been maintained that the construction of the rectangular belt mounts with cable-twist ornament from *Sutton Hoo* (fig. 211) indicates that these were probably fused paste work, but as there were no traces of the paste on the surface, I was unable to establish whether the paste was of calcite/wax or sulphur. A calcite/wax cement is however found on the shield from Sutton Hoo which will be further discussed below, cf. 6:4.

In the Swedish material there is evidence of one or perhaps two examples of fused paste work, with calcite/wax paste, whose inlays are very similar in quality to the cable-twist mounts from *Sutton Hoo*. These are the sword pommel from *Skrävsta* (Swed 26) and another probably similar pommel from *Uppsala Västhög* (Swed 27). Both objects have been extensively burnt and the wax can only be traced in the blisters it left in the calcite mass. The analysed sample from *Uppsala Västhög* was taken from the bottom plate of the sword pommel, while the quality of the garnet inlay was judged from a triangular panel which I, like Lindqvist (1936), have interpreted as the central field of a sword pommel (cf. *Valsgärde* 5, fig. 232). Bruce-Mitford (1949), however maintains that this panel was part of a pyramid like those found in *Sutton Hoo*. The triangular panel had no paste which could be analysed, but under the microscope traces of calcite paste could be observed.

I have already mentioned that these objects are closely connected with the *Trier* workshop. There can be no doubt that the *Skrävsta* pommel at least had calcite/wax paste. There is no evidence from the *Trier* workshop, which we can assume was managed by the church, that cloisonné was produced for weapons or mounts; its production seems to have been limited to jewellery, often in the form of reliquaries, and buckles, which may also have contained reliquaries.

These objects with calcite/wax paste were of the highest quality, and suggest the existence of a secular workshop with close contacts with the stone-cutting workshop in *Trier*, from which cut garnets of fine quality and suitable for complicated patterns were purchased, but without a source of Byzantine sulphur paste.

The material does not suggest a location for this workshop. It may have been in England, or somewhere in the Frankish kingdom, but it could also have been situated in Uppland. The latter alternative is not altogether unlikely, given that at a slightly later date there is evidence from *Vendel* and *Valsgärde,* for instance, of a cloisonné workshop where, however, mostly garnets of a quality (here called type 3) were mounted with the same calcite/wax fused paste. The shapes of the garnets were simpler and only e-stepped forms were used. The objects from the Upplandic workshop, in contrast to the present workshop ,are all made of gilded bronze or silver. This workshop will be discussed below (cf. 6:4). Considering the wide distribution of the objects mostly of gold from this workshop, I find it most probable that it was in Anglo-Saxon England that a workshop of this kind was situated. The necessary economic basis for this distribution could only be provided by a powerful kingdom with courtly splendour such as we find demonstrated in the grave at *Sutton Hoo,* cf. chapter 7. It is however necessary to do more analyses of the cements in Anglo-Saxon cloisonné objects to prove the existence of this workshop.

## 6:4 Scandinavian cloisonné art

In the Scandinavian material—that is objects of Scandinavian types—fused paste cloisonné predominates. This type of cloisonné achieved its finest expression in the button-on-bow brooches, cf. diagrams fig. 222–223.

The Scandinavian button-on-bow brooches are generally related to Frisian and Anglo-Saxon forms. Ørsnes (1966,105) has most recently considered this material and has introduced typological groupings (E0–E6) which underline their large variations in size and detail. I will

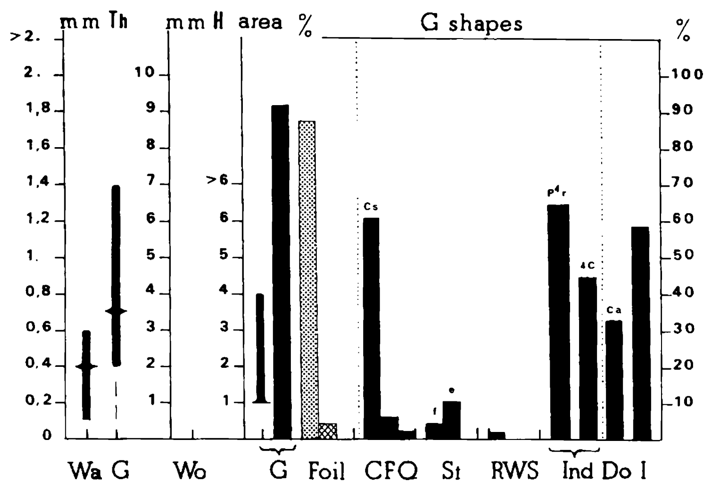



Fig. 222. Diagram showing the technical features of the cloisonné on button-on-bow brooches from the early Vendel period, i.e. Nerman 1969, period VII:1–2.

The diagram is based on 51 objects from Gotland: Swed 51–61, 66–106.

Notable features are the e- and f-stepped garnets and the frequency of cabochon garnets.

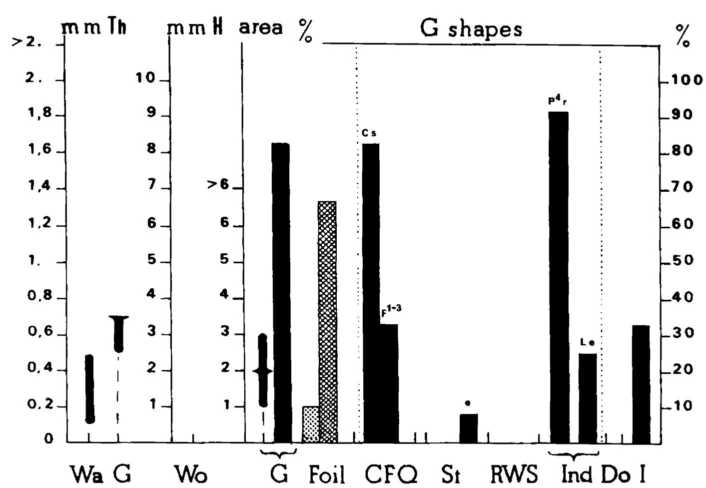



Fig. 223. Diagram showing the technical features of the cloisonné on late button-on-bow brooches, i.e. brooches with animal ornaments on the bow. The diagram is based on 12 objects from the Swedish mainland, Gotland, Norway and Denmark: Swed 38–41, 107–110; Trond 1; Cop 7 and 9.

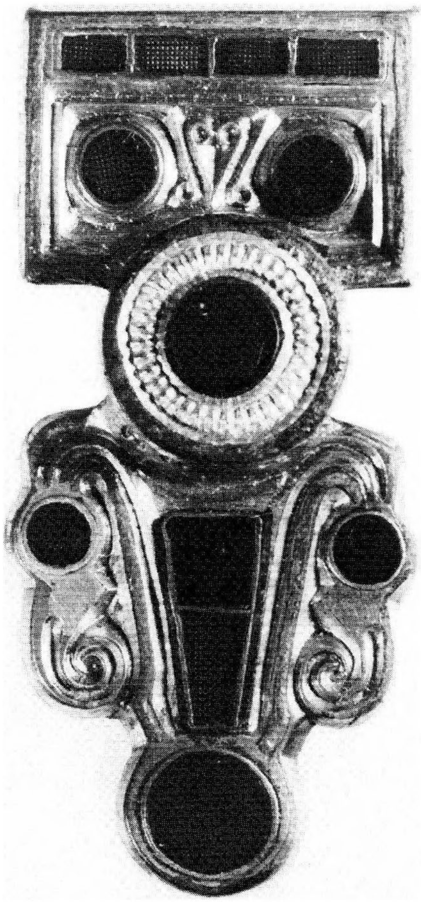


Fig. 224. Button-on-bow brooch of gilded silver from Trullhalsar, Anga, Gotland (Swed 69). 2:1.

Fig. 225. Button-on-bow brooch of bronze from Tofta, Gotland (Swed 74). 2:1.

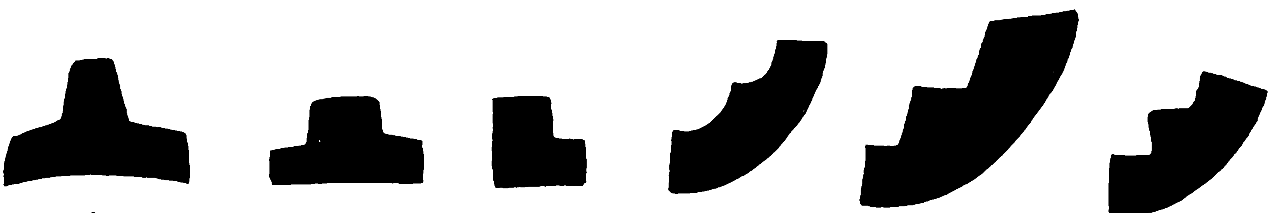
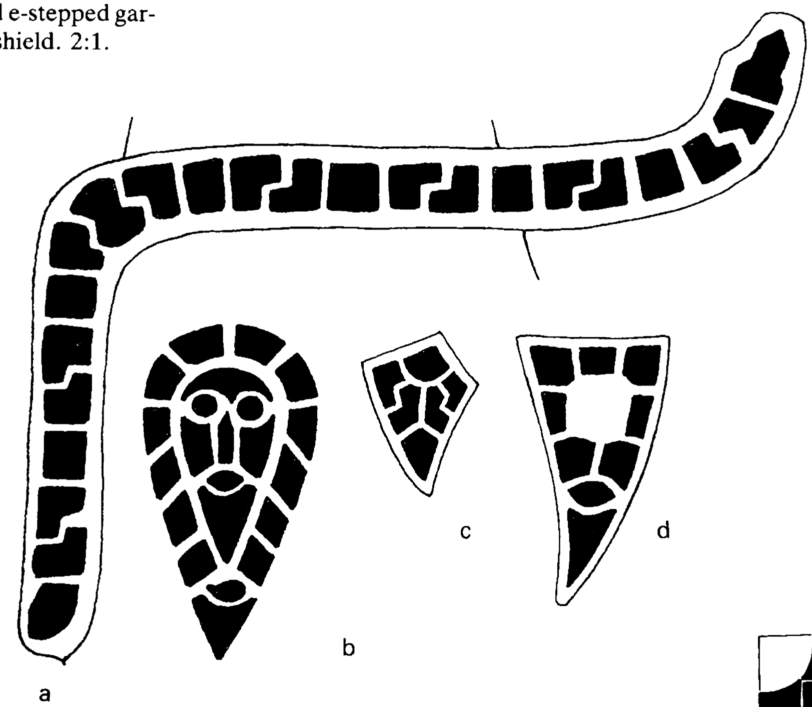



Fig. 226. Some e-stepped shapes used on button-on-bow brooches and Anglo-Saxon disc brooches. 5:1.

not here discuss this typology but it should be noted that in the *List of examined finds* E7 corresponds to Gotlandic brooches from the late Vendel period. The rich typology of the button-on-bow brooches reflects a mobility in the jewellery production similar to that of Scandinavian cloisonné art. For the purposes of this study only such details will be considered as are relevant to an understanding of those Scandinavian satellite workshops which used fused paste.

On the button-on-bow brooch from *Trullhalsar, Anga,* Gotland (Swed 69), (fig. 224) garnets are set in cloisonné in a rectangular tray. Unlike most button-on-bow brooches from Gotland this brooch is of gilt silver. A large flat garnet is mounted on the button, surrounded by a chip-carved cast border with transverse grooves. The birds' heads on the foot have curled beaks and eyes of large, flat garnets in band settings. There are further round flat garnets mounted on the head plate on either

Fig. 227. Human masks and e-stepped garnets from the Sutton Hoo shield. 2:1.



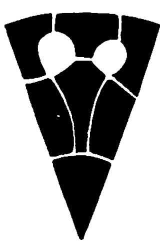



Fig. 228. Human mask from a button-on-bow brooch from Misterby, Gotland (Swed 189). 2:1.

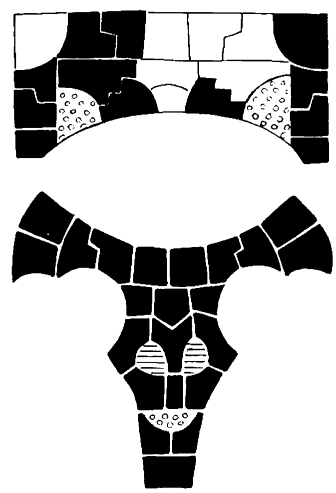
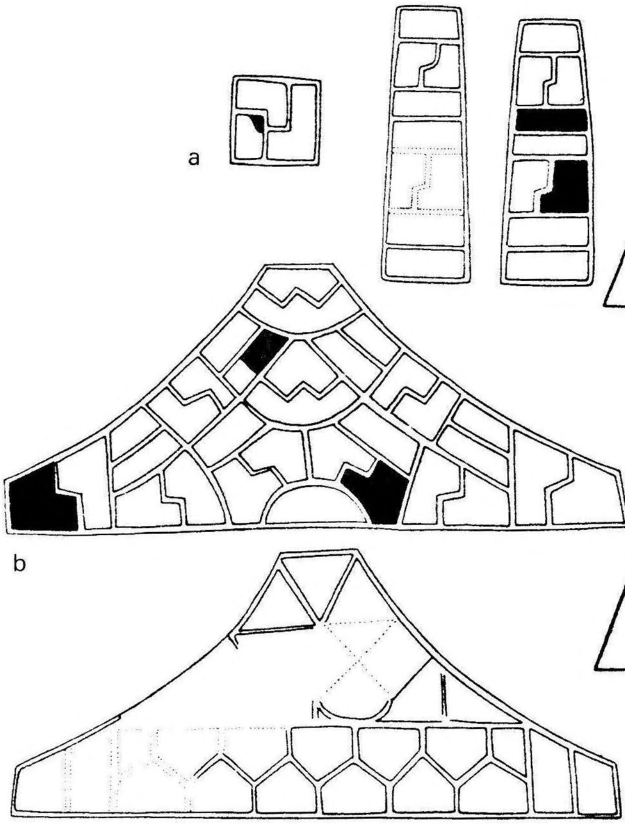


Fig. 229. Cloisonné pattern on a button-on-bow brooch from Sanda, Gotland (Swed 90). 2:1.

side of a loose ribbon motif in chip-carving.

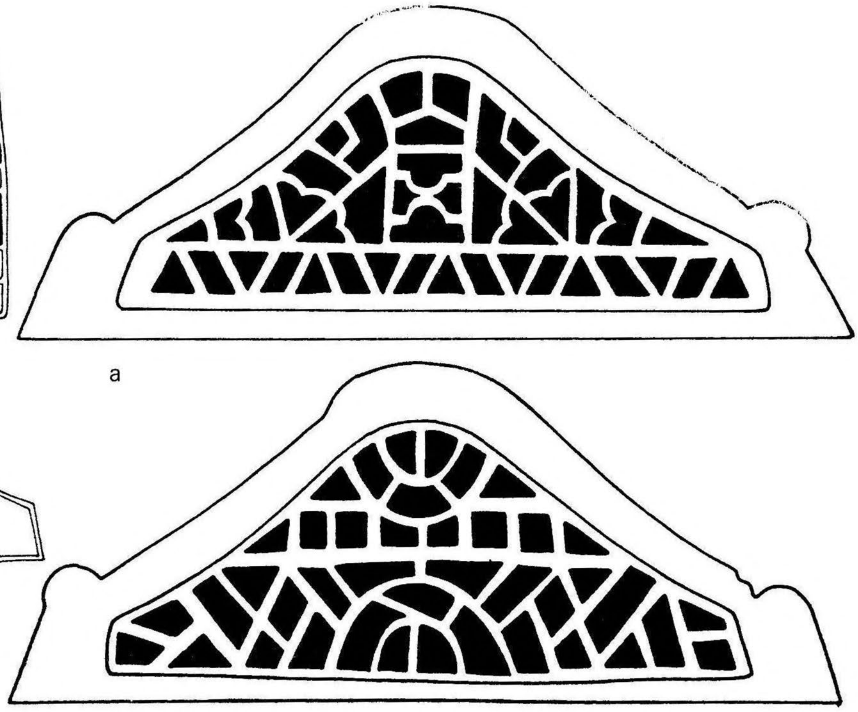
The button-on-bow brooch from *Tofta* (Swed 74) (fig. 225) is very similar to the *Anga* brooch but is made from bronze, and it is likely that both brooches came from the same workshop. Unlike the *Anga* brooch, the *Tofta* brooch was slightly damaged; I therefore had the opportunity to carry out analyses on this object. The garnets were of type 1, the type used in the Frankish area, and the paste was a blistered calcite which indicates that it was originally a calcite/wax fused paste, burnt in the course of the cremation. The paste was here used in cloisonné work where its adhesive properties were irrelevant, as the garnets were secured by the flattening of the top of the cell walls, the clasped cloisonné technique. I have compared the band settings on these brooches with similar settings on a buckle from grave XIV, *Tuna, Alsike* (Arrhenius 1980), where I stressed the Frankish connection in both the form of the buckle and the animal ornament with loose ribbon motifs. As in Anglo-Saxon England, the fused paste was used in the mounting without producing the true fused paste cloisonné.

However, other examples demonstrate that the true fused paste technique was used on objects of almost the same date. On the foot of a small button-on-bow brooch from *Sanda* (fig. 229), a human mask in cloisonné is set between the cast birds' heads. The mask was made from small garnets, the eyes were inlaid in blue glass and the mouth in white bone, possibly ivory. White bone was also



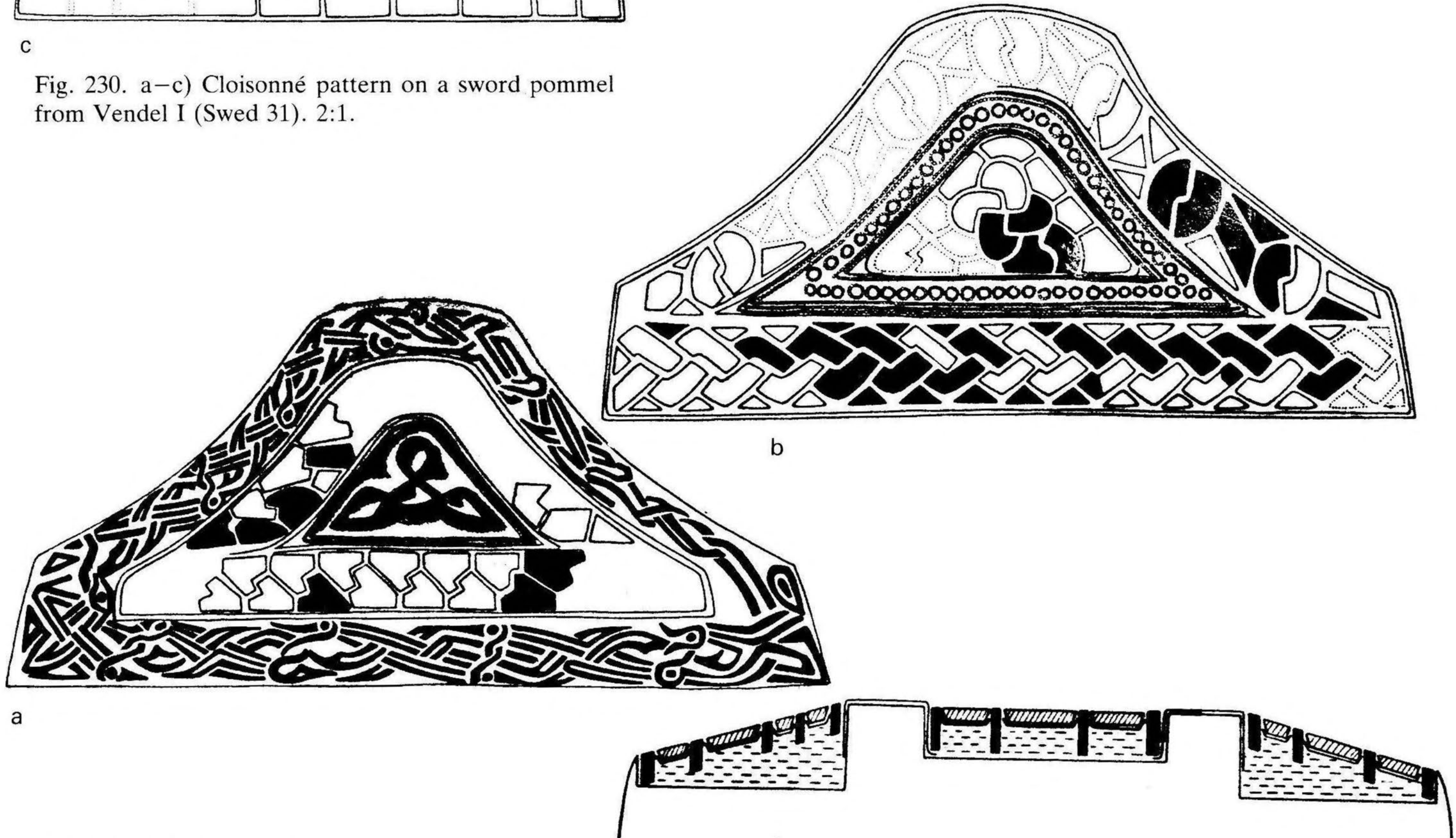
a b c

Fig. 230. a–c) Cloisonné pattern on a sword pommel from Vendel I (Swed 31). 2:1.



a b

Fig. 231. a–b) Cloisonné pattern on a sword pommel from Valsgärde 7 (Swed 30). 2:1.



a b c

Fig. 232. a–b) Cloisonné pattern on a sword pommel from Valsgärde 5 (Swed 29). c) In section. 2:1.

used on the rectangular head plate, where there are also half-mushroom shaped garnets similar to those on the brooch from *St Denis* (fig. 157). Other garnet shapes include the coarser L-shape which occurs on several fused paste works along with the finer f. St-shape. I wish finally to draw attention to the T-shaped garnet which forms part of the nose and eye surrounds on the mask, which (without the V-shaped indentation) also occurs on the closely related mask on a brooch from *Misterby*, Gotland (fig. 228) and on the *Reinstrup* disc brooch (fig. 221) and in a distorted shape on the human mask on the shield from *Sutton Hoo* (fig. 227), where this motif most probably also occurred with a fused paste of calcite/wax (cf. East 1978,123 ff. It is unfortunate that East has failed to appreciate that the samples should refer to *intact cloisonné work,* and not to work in *pressblech* etc. As the results of the analyses of the samples from the dragon head identified a coarse paste of calcite/wax, I am inclined to assume that this also occurs on other cloisonné work on the shield).

The *Sanda* brooch belongs to a type of button-on-bow brooch which is characterised by its small size and by the elongated form of the birds' heads: their beaks are not curled. The closed grave find from *Allekvia* in *Endre* (Swed 95) demonstrates that this shape occured in Gotland early in Nerman's first Vendel period. The type also occurs in Denmark, where it is the equivalent of Ørsnes's type E1, which he dates to Phase 1 by the grave find from *Kobbeå* on *Bornholm* (Ørsnes 1966,107; his Phase 1 is roughly equivalent to Nerman's first period, but it continues into the seventh century to include objects preceeding the latest Style C-decorated objects at *Sutton Hoo*).

It is important to establish that fused paste first appears in Scandinavia early in the Vendel period together with garnet shapes and motifs which are associated with the fused paste work from the Continent and Anglo-Saxon England described here. Although certain garnet shapes, such as the half-mushroom, can be re-set several times and may therefore have a long period of use, this is much less likely with complete motifs like the human masks. It is interesting, however, that the human mask is also a typical motif on the slightly later button-on-bow brooches with grooved edges (cf. Arrhenius 1971 fig. 183,185). In this case the motif is coarser and made of garnets cut to the typically rounded e. St-shapes. The human masks on these brooches can only be identified when their prototypes are known. These brooches are dated to Nerman's second period, that is 600–650. There is also evidence that type 3 garnets were used during this period, suggesting that the workshop which produced f- and g-stepped garnets no longer existed. It is from this period that we can trace the production of swords with cloisonné in Uppland, represented by the pommels from grave I at *Vendel* and graves 5 and 7 at *Valsgärde* (fig. 230–232). The garnets are of type 3 and the mounts from Vendel I also has green glass inlay. Fused paste was already found in Vendel XII, but only as an underlay for cabochon-cut garnets or trays with a couple of garnets only (cf. Stolpe-Arne 1927 pl. XXXVII:7).

A complete covering with cloisonné is first found on these pommels; a sword pommel from *Snösbäck* can probably also be referred to this group (Behmer 1939 pl. XXXVII:I). It is difficult, indeed impossible, to be certain where these pommels were produced, but it seems likely to have been Uppland, since, despite the rich material from Gotland, there is no real evidence that sword pommels in cloisonné were made there.

In the course of the seventh century a change takes place in the cloisonné art both on Gotland and in Uppland, and the white fused paste of calcite/wax is replaced by a local paste of quartz-sand and wax. At the same time garnets appear which were not cut but retouched. The garnets are often of type 3, that is Eastern garnets, but sometimes also of type 2.

It is easy to distinguish between the button-on-bow brooches from Gotland and those from mainland Scandinavia, where a remarkable similarity between brooches from Northern Norway and Uppland can be observed, but the actual cloisonné work in the whole area is noticeably uniform. It is almost as if the same goldsmiths travelled between Gotland, the mainland and Norway.

Although this last stage of Scandinavian cloisonné art clearly had a provincial character, there are nonetheless some associations with continental Christian reliquaries. Thus the curving ribbon designs in cloisonné on the *Enger* reliquary, probably made using the fused paste technique, are paralleled in the curving cloisonné design on the button-on-bow brooch from *Ruda* or *Tuna* in *Alsike* (cf. Arrhenius 1971, 192).

## 6:5 Continental fused paste work not clearly associated with workshops

Some continental fused paste work made with wax paste mixed with wood fibre was described in chapter 3: the large disc brooch from grave 150, *Nocera Umbra* (Rom 1) and the large bow-brooch from *Wittislingen* (Münch 1). Both have the coarser e-stepped garnets which we have assumed came from *Constantinople*. It is therefore possible that they came from the same workshop, but there is insufficient material to allow its location to be identified.

Werner (1951,18 ff.) draws attention to several features of the *Wittislingen* brooch which connect it with Langobardic brooches, but the analysis of the inscription in the same publication (Bischoff and Betz in Werner 1951), which indicated a Rhenish origin, made Werner conclude that the brooch came from the Rhineland. The complicated history of this brooch has more recently been discussed by Foltz (1982), and with a new analysis of the inscription (Ellmers, in the course of revision) it now seems advisable to reconsider the origin of this brooch.

In this context, I wish to draw attention to the goldsmith's workshop in the area of *Wittislingen,* described by Christlein (1978,101), which produced bossed disc brooches like those in the *Wittislingen* grave and in grave 598, *Schretzheim.*

In chapter 4 it was maintained that several of the goldsmith's workshops which produced cloisonné in the sand putty technique changed to the manufacture of bossed disc brooches. It is possible that this was also the case for this workshop and that its predecessor was the south German/Danube workshop which produced so many of of the brooches found at *Schretzheim,* for instance (chapter 7). We also know that bossed disc brooches were made with fused paste in some places (cf. the brooch fig. 209 from *Amiens,* BM 16). It is possible that influences of this kind affected the workshop described by Christlein and that the brooch from *Wittislingen* was also made here. This can, however, only be proved by analysis of the pastes in the bossed disc brooches.

Finally, there is a further group of objects with cloisonné in the fused paste technique, whose geographical origins cannot be ascertained, as their pastes have not been analysed. The group consists of a number of ecclesiastical objects like the staff from *Delsberg* (Haseloff 1955), the *Theoderigus* reliquary (cf. Roth 1979, fig. 229) and the *Enger* reliquary (Roth 1979, fig. 233). The staff from *Delsberg* and the *Theoderigus* reliquary both have e-stepped garnets. On the *Enger* reliquary I have visually examined the fused paste, in which wax predominates. It does not seem likely that these objects all come from *one* workshop, but rather that they represent several ecclesiastical cloisonné workshops where fused paste and imported eastern garnets were used.

# Chapter 7. The social implications of the Frankish cloisonné art

## 7:1 Introduction

This study enables the identification of individual cloisonné workshops: those in the Frankish kingdom are fairly well documented. On the basis of geographical and chronological spread, rather than the number of garnets in any particular find, it has been established that type 1 garnets as well as particular shapes are predominantly found in the Frankish area. It is therefore probable that the Germanic cloisonné art was largely of Frankish origin. The material therefore lends itself to a study of the organisation of the goldsmith's craft and an evaluation of cloisonné work among the Franks.

It is likely that this organisational system was also adopted by other Germanic peoples, along with the techniques of cloisonné inlay. However, local circumstances may have brought about changes which lie outside the scope of this study.

## 7:2 The distribution of cloisonné work in the Frankish kingdom

The workshops identified are centred on the River Rhine, with some on the upper Danube and the Moselle (cf. distribution map II). A central workshop supplying raw material—cut garnets—to satellite workshops is assumed to have existed in *Trier* on the Moselle. The production in the central workshop was strikingly different from that in the satellite workshops. The central workshop apparently did not make everyday jewellery, such as the small disc brooches, found in Frankish graves, but concentrated on luxury brooches, buckles and pendants with or without concealed spaces for relics. Jewellery produced in the workshops using sand putty is of a very different character, but even where more than one workshop was involved in production, types look remarkably similar.

A typical example is provided by the disc brooches with cloisonné (cf. fig. 233–241) from the cemetery at *Schretzheim, Ulm* in south Germany (Koch 1977). Disc brooches of this kind were found in twenty-five graves. The pastes from ten of these were analysed; samples could only be obtained from brooches which had been damaged, and the samples can therefore be considered as random. Of the ten, eight were sand putty (from graves nos. 26,233,250,300,464,509,583 and 586) and two fused paste (from graves nos. 23 and 350). The brooches from four graves (nos. 233,464,509 and 586) were made in the local south German sand putty workshop (cf. chapter 5), while the brooches from another four were imported from the Rhenish area. The equal numbers of local and imported brooches do not appear typical of the brooches which were not analysed: of the brooches with sand putty or cement technique found in ten graves, more than half seem to have come from Rhenish workshops. One brooch is lost (grave 146, period 2) and as its cloisonné cannot be identified from the illustration it has not been included in this discussion. The disc brooches from graves 358,387 and 553 are decorated with *pressblech* and belong to a type with brown sand paste, many examples of which are found in the museums of *Bonn, Cologne* and *Worms*; the paste from one of these (*Kottenheim,* Bonn 47) was determined by analysis. I agree with Koch (1977,187) that these brooches were produced in the Rhineland, probably in the *Cologne-Trier* workshop (while rosette-brooches with *pressblech* in the centre appear to have been made in *Mainz,* cf. BM 8, without provenance in Germany). It is also probable that the small rosette-brooch with a pearl in the centre from grave 20 was also imported, as Koch maintains. I know of no other examples from the south German sand paste workshop, but this type is well represented in the production of the *Cologne-Trier* workshop (cf. grave 34, *Rittersdorf,* Trier 3); brooches of this form were, however, probably also produced in the *Mainz* area. The small almandine brooches from graves 197 and 247 are of a type usually associated with the cement technique; typically, they belong to the earliest phase at *Schretzheim,* and are found with brooches of Thuringian type. Koch (1977,188) suggests that these brooches arrived with Thuringian settlers. The remaining four brooches with sand putty technique in graves 206,208,210 and 258 are types which also occur in the south German and Rhenish workshops. They may or may not be imported and are categorised in the diagram (fig. 243) as without identified area of origin. It can be pointed out, however, that the filigree ornament on these brooches is similar to that on

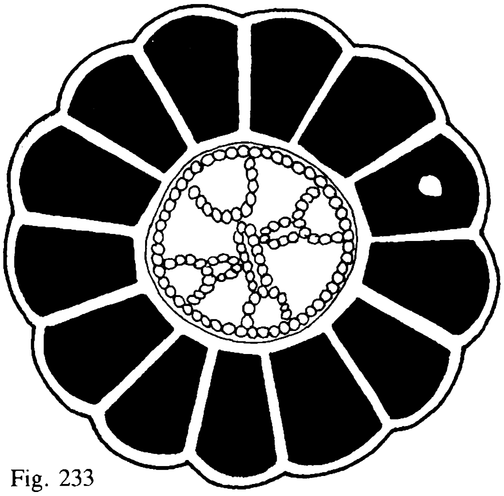


Fig. 233

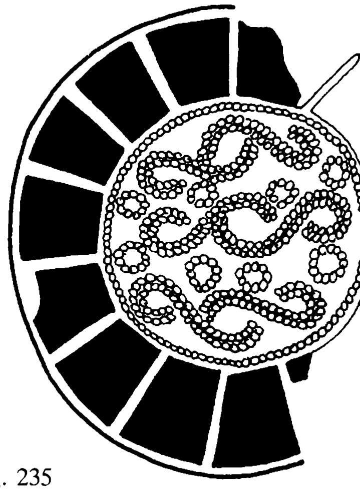


Fig. 235

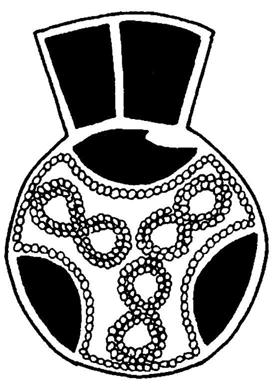


Fig. 234

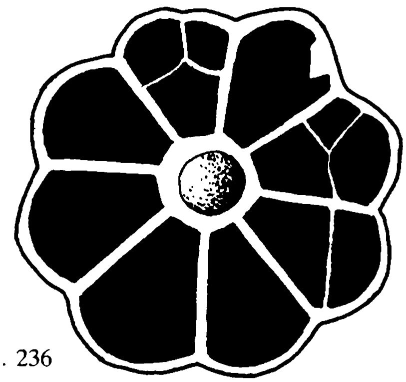


Fig. 236

Fig. 233–236. Garnet cloisonné on disc brooches from Schretzheim.
233) Rosette brooch, Gr 233 (Dill 9). 2:1.
234) Gr 509 (Dill 7). 2:1.
235) Partly damaged brooch, Gr 464 (Dill 6).
236) Rosette brooch grave 20 (Dill 12). In the centre a white bead.

the disc brooches from *Szentendre* (Bud 11 and 14) for instance, which were produced in the Danube workshop.

None of the imported brooches analysed are from the Mainz area, although the products of the workshops there had a wide distribution. As regards sand putty work, the main connection was with *Cologne-Trier* instead, since five of the analysed brooches came from this workshop (they were from four graves as two were found in the same grave, no. 26, cf. fig. 242). This is of particular significance since a considerable number of objects made with fused paste technique were found in the same cemetery, many of which were probably imported from the same area. As well as the fused paste brooches, one of which (from grave 23) has sulphur paste and the other (from grave 350) calcite/wax paste, empty cell work was found in graves 22 and 513. There were also some bronze brooches with glass inlay, probably mounted in fused paste, in grave 529, for instance, and in grave 23, where a small disc brooch of this type was found along with the gold brooch mentioned above (cf. fig. 218). The large gold brooch was discussed in chapter 6 and assigned to the central workshop i *Trier*. The *pressblech* ornament on the small brooch links it to the large three-zoned brooch with fused paste of calcite in grave 350. This brooch had panels of *pressblech* between the garnet cloisonné with a design of human masks, both in profile and full face. Koch (1977,63) compares this design with similar designs on *pressblech* from wooden vessels found, for instance, in grave 106 at *Soest* (cf. Werner 1935, 55). It was suggested in chapter 6 that there was probably a fused paste work-

Fig. 237–241. Garnet cloisonné on disc brooches from Schretzheim.
237) Grave 250 (Dill 8).
238) Gold, grave 26 (Dill 4).
239) Gold rosette, grave 26 (Dill 3).
240) Grave 300 (Dill 11).
241) Grave 350 (Dill 10).

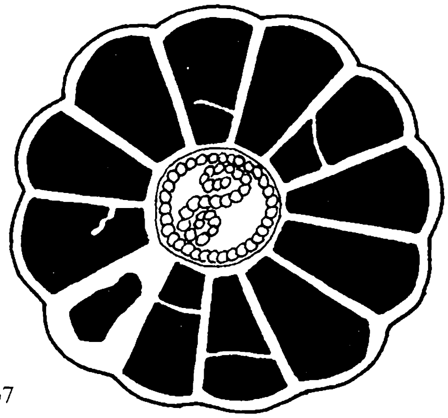


Fig. 237

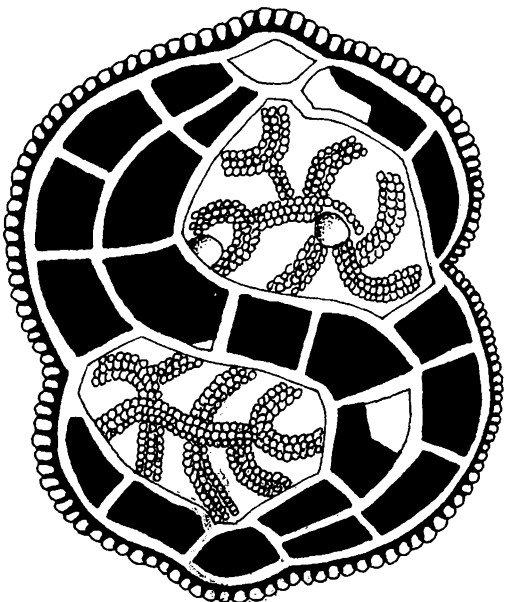


Fig. 238

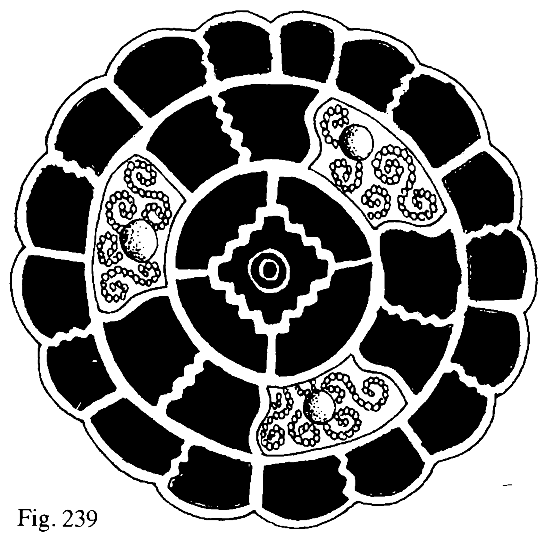


Fig. 239

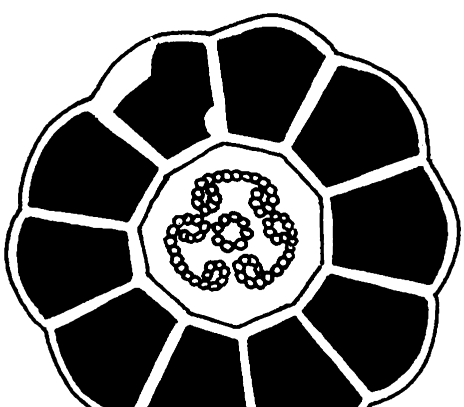


Fig. 240

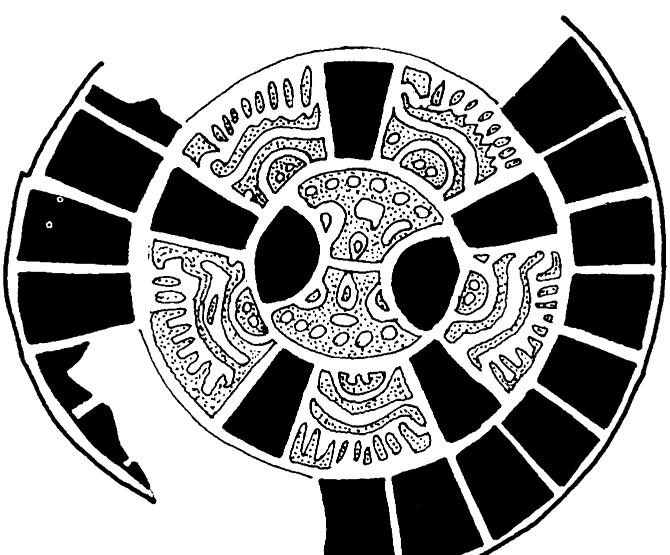


Fig. 241

Fig. 242. The distribution of disc brooches with cloisonné in the cemetery at Schretzheim.

X = determined by chemical analysis; O = determined by visual inspection only.

a. Brooches in sand putty technique without identified area of origin.

| grave no. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 206 | | | O | |
| 208 | | | O | |
| 210 | | | O | |
| 258 | | O | | |

b. Brooches in sand putty technique from the Cologne-Trier workshop.

| grave no. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 20 | | | O | |
| 26 | | | X,X | |
| 250 | | | X | |
| 300 | | X | | |
| 358 | | | | O |
| 387 | | | | O |
| 553 | | | | O |
| 583 | | X | | |

c. Brooches in sand putty technique from the Danube workshop.

| grave no. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 233 | | | | X |
| 464 | | | | X |
| 509 | | | X | |
| 586 | | X | | |

d. Brooches with fused paste.

| grave no. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 22 | | | | O |
| 23 | | | X | |
| 350 | | | | X |
| 513 | | | O | |
| 529 | | | O | |

e. Small one-zoned brooches in (?)cement technique.

| grave no | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 197 | O | | | |
| 247 | O | | | |

shop in the North Sea area, which produced brooches like the one from grave 350, *Schretzheim.* The exact relationship between the brooches with glass inlay from graves 23 and 529 and the brooch from grave 350 is beyond the scope of this study, but it seems likely that these brooches were also produced in the workshop in the North Sea area at a period when garnets were hard to obtain.

The empty gold cloisonné cells in the objects from graves 22 and 513 were discussed in chapter 6, and it was concluded that they probably originally contained inlays. Koch (1977) states that the cells in the brooch from grave 513 contained a yellow powder when it was found, which indicates that it was originally a sulphur paste work like the one from grave 23.

In conclusion, it can be established that objects using the fused paste technique were found in five graves from *Schretzheim*: analyses from two of the graves showed that both sulphur and calcite/wax paste were present.

The dating of the groups identified in this manner may therefore be of interest. The diagram (cf. fig. 242) shows that brooches from the local sand putty workshop occur in the middle and later part of the sixth century and early seventh century, eg. AMII, III and JMI (cf. Ament 1977), which correspond to Koch's periods 2, 3 and 4; imported brooches with sand putty cover the same period, although the small disc brooches, which were perhaps made with the cement technique, are earlier, representing the earliest decades of the sixth century or Koch's period 1, e.g. AMI (cf. Ament 1977). The fused paste works belong to Koch's periods 3 and 4, but particularly period 3, that is the latest part of the sixth and early seventh century, e.g. AMIII and JMI (cf. Ament 1977). The brooches whose place of origin has not been determined occur in Koch's periods 2 and 3: the paucity of finds from these periods at the Danube workshop (cf. diagram) may be explained if some of these brooches would be referred to this group.

The diagrams show no significant chronological distinction between brooches from the *Danube* and from the *Cologne-Trier* workshops, proving that there was no competition between the local sand putty workshop and the more distant workshop. The situation is a little different when considering fused paste brooches: they occur only in Koch's periods 3 and 4, and the proportion of imported objects made from gold is 60% as against 29% of the analysed sand putty brooches. This may explain why there are no brooches with fused paste from period 2, since the more valuable gold brooches would have circulated for a longer period than the simpler silver brooches. It was pointed out in chapters 5 and 6 that the production of brooches with garnet inlay ceases towards the end of the sixth century, and where they occur in graves from period 4 (590–620/30) they would probably have been made late in period 3 and only deposited in period 4 (for this retardation cf. Almgren 1955,74).

The fact that there was no particular rivalry between workshops provides an insight into the character of the trade in these brooches.

A situation with apparently no competition between brooches produced locally and at a distance suggests that the distribution of these objects was not based on the kind of economy where exchange of goods is directly linked with capital investment. Another indication that the distribution pattern did not reflect traditional trade relations is the fact that brooches were often brought from workshops at a great distance, while others which were nearer, and more or less directly along the same route—like *Mainz*—were ignored.

The distribution of brooches in the cemetery also supports this hypothesis. Koch's distribution map, supplemented by the geographical origins worked out here (fig. 243), demonstrates that cloisonné brooches from differ-

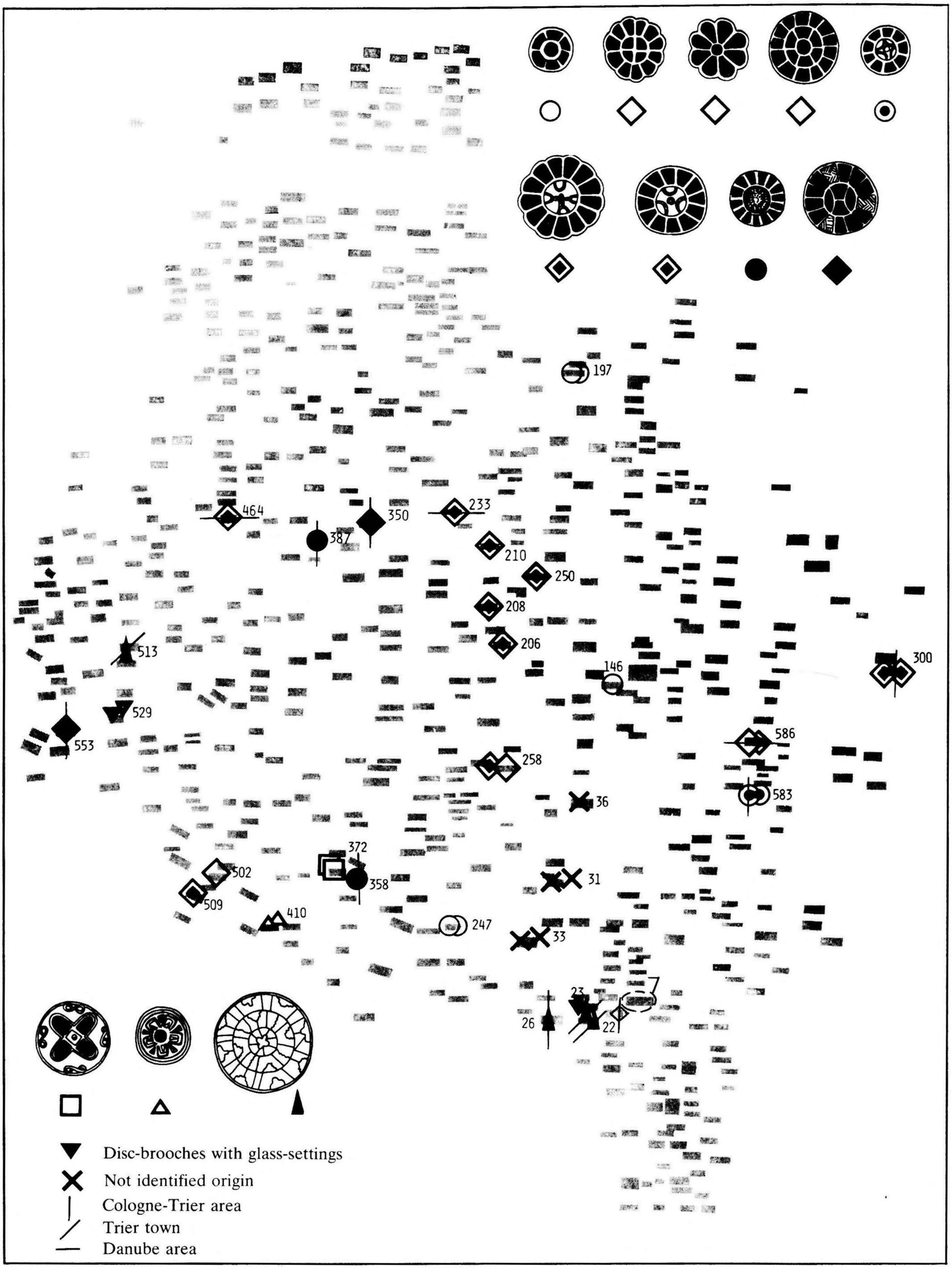



Fig. 243. Distribution of disc brooches from Schretzheim (After Koch 1977, pl. 226 with additions by the author).

ent workshops tend to occur in the same row or group of graves. These rows or groups probably represent family burials (Koch 1977,16 ff.): for instance, Koch (1977,20) has identified a row of graves from periods 2 and 3 at the eastern end of the cemetery (graves 583–590/91) (cf. fig. 242). Grave 583 contained cloisonné brooches from the *Cologne-Trier* area while the brooches in grave 586 were from the Danube workshop. Another group consists of four women's graves, 20,22,23 and 26, and a man's grave, no. 7. All are characterised by very expensive grave goods from period 3: in three women's graves the cloisonné brooches are of gold and in the fourth of silver. Two disc brooches are fused paste work from the central workshop in *Trier,* while the two gold brooches in the third grave and the silver brooch in the fourth are sand putty work from the *Cologne-Trier* area. Other objects in the graves are also associated with the Rhineland, including the amulet box (grave 26, cf. Koch 1977, 86) and a pottery vessel (grave 23, Koch 1977,145). The links with this area are further emphasized by the man's grave, an equestrian burial, where the belt had silver mounts of Frankish/Rhenish origin (cf. Koch 1977,124).

Koch (1977,190) postulates that the *Schretzheim* cemetery was established by Thuringian settlers under Frankish supremacy. The Frankish element is seen, for instance, in the equestrian burials, which are usually the richest graves in the cemetery.

We may therefore hypothecate that this grave group consists of the equestrian burial of a Frankish nobleman from the Rhineland who settled here, the four graves with cloisonné brooches belonging to his women, who also came from the Rhineland. If this is the case, then the presence of the cloisonné brooches is not indicative of trade with the Rhineland, but rather of exogamy, the Frankish nobles' custom of marrying partners from some distance away outside their own clan or group. Werner (1970,78) has emphasised the importance of exogamy in the distribution of certain objects in the Merovingian period, with the following reservation:

> Der Nachweis von Exogamie mit Hilfe von einfachen, gewissermassen wertlosen Trachtzubehörs überzeugt metodisch eher als Schmuckstücke als Edelmetall auch wenn diese eine Trachtfunktion besassen (Werner 1970,77).

The disc brooches with cloisonné inlay discussed here are, however, examples of valuable jewellery which clearly indicate exogamy. It is important to note that this type of distribution of cloisonné jewellery from different workshops does not only occur in the *Schretzheim* cemetery. The same phenomenon has been observed in other cemeteries, as illustrated by the analyses of the cloisonné brooches from the *Szentendre* cemetery in Hungary, where the brooches came from the *Danube* workshop as well as from *Mainz,* and the cemetery from *Nocera Umbra,* where the same combination was found. In the cemetery from *Köln-Müngersdorf,* finally, there were brooches from *Cologne-Trier* as well as the *North Sea* area. Werner (1970,78) has pointed out that exogamy is well documented in the written sources from the Merovingian period, and was practised by the Germanic dynasties and the Frankish nobility.

A more detailed discussion of the importance of exogamy among the Langobards in Hungary, where several Frankish cloisonné brooches were found, is beyond the scope of this study. Werner (1962,134), however, has examined the relationships between the Frankish and Langobardic royal house which began when Theodobert, son of a Frankish king, became engaged to Wisigarda, the eldest daughter of Wacho, king of the Langobards.

A consideration of the distribution of cloisonné jewellery as a result of exogamy may also provide an indication of the significance of these jewels as status and group symbols. It is of particular interest that jewellery from different workshops may occur in one grave, such as the *Cologne* Cathedral grave where pendants from the necklace were made with the fused paste technique, while other cloisonné objects were made with the sand putty technique in the *North Sea* workshop. It may be possible to interpret the jewellery in this grave in terms of the exchange of gifts, perhaps in the context of bride barter. The exchange of gifts was apparently not limited to marriage arrangements, as cloisonné work from different workshops also occurs in men's graves, particularly those of people of high rank. In Childeric's grave, for instance, some objects came from the central workshop in *Constantinople,* while others—like the guards of the sword grip—were mounted in the Rhineland. Similarly in *Uppsala Västhög,* there were cloisonné objects from both fused paste and sand putty workshops; even in the rich *Sutton Hoo* grave, objects came from several different workshops.

The phenomenon described here, with cloisonné jewellery of very similar types produced at the same time in different workshops and found in the same cemeteries, and even in the same graves, suggests that such objects were mainly distributed through the exchange of gifts. The character of these exchanges will be discussed further below (7:4).

## 7:3 The organisation of cloisonné production in the Frankish kingdom

In chapter 4:1 the circumstances of cloisonné production were described. The double value of this jewellery was emphasized, both the precious metal and the garnet inlays having a high second-hand value. The combined cost of the cloisonné jewellery suggests that it must as a rule have been made to commission. A system whereby the goldsmith was associated with a distributor who supplied the raw materials was suggested. It was pointed out that the distributor could himself be the customer, but that he could also be an intermediary.

It was further established that the more specialised aspects of the production, such as gem-cutting, were limited to certain areas, and thus concentrated in central workshops. The distribution of local pastes also suggested that other aspects of the production were also limited to certain places.

In this context it was observed that there was a difference between the central workshops, where all aspects of cloisonné jewellery production were carried out, and the satellite workshops, which only undertook the mounting of already completed cloisonné panels. Although local pastes were used, the great similarity between the forms of the jewellery suggested that some movement of craftsmen between the different workshops did take place.

The cloisonné craft is therefore relevant to the debate over the organization of the goldsmith's work in the late Iron Age which was reanimated by Werner's paper *Zur Verbreitung frühgeschichtlicher Metallarbeiten* (1970), in which he maintains that itinerant craftsmen played an important role in the Germanic goldsmith's art on the Continent. Roth raised some objections to this thesis in 1971, and in 1972 Driehaus produced a number of arguments against its relevance to the Merovingian kingdom. Driehaus demonstrates that the so-called goldsmiths' graves—mainly found to the east of the Rhine—show that the goldsmiths' craft was specialized: the tools in these graves were used for casting and working in silver and bronze, while the term *Aurifex* in Merovingian sources applied to highly specialized goldsmiths, whose techniques included soldering, niello-ornament, cloisonné inlay etc. The *Aurifex* appears generally not to have been a free man and did not have the mobility of itinerant craftsmen. Claude (1981,244), who has most recently contributed to this discussion on the basis of the historical sources, objects that in several cases the sources mention mobile craftsmen, including *Aurifex,* but adds that this group of craftsmen did not apparently have the permanent mobility of the itinerant craftsmen. Claude also points out that the sources mention both free and unfree goldsmiths. I do not consider the discussion of the status of more specialized goldsmiths to be particularly relevant, as the *Aurifex,* by virtue of the cost of his materials, was tied to his clients in a way which can be considered as comparable to an unfree status. I agree with Driehaus that the Merovingian finds would uphold the idea of a distinction between the *Aurifex* and other metalworkers, but in northern Europe, for instance, no such specialization can be observed to any extent. In chapter 5 it was shown that the production of cloisonné is a specialized craft linked to certain localities, and also indicated by the use of local pastes, although there seems to have been some movement of craftsmen between individual workshops. With certain cloisonné techniques, such as the fused paste technique used in the North Sea group, we have seen that craftsmen would travel long distances—from the North Sea coast to England and Scandinavia, for instance—bringing all the necessary materials including pastes.

In cloisonné art it can also be observed that each workshop group exists for a limited time, and production tends to change and develop within a period which I estimate at about two and a half or three generations. We can trace the cement technique on objects mounted in the Rhineland from the death of Childeric to about 520, that is fifty years. The workshops using the sand putty technique were active on the Continent from the 520s to the 580s, that is about sixty years (then possibly moving to England, where the technique was practised until the 620s, that is 570–620 or fifty years). The workshops using fused pastes exist from the 540s to about 620, while the central workshop using sulphur paste only lasted until about 590, that is fifty years. After this time, fused paste was used in England until some unknown date in the seventh century.

The fused paste technique was used in Scandinavia from about 550, but changed towards the seventh century when a new type of garnet was introduced. On Gotland and in Central Sweden cloisonné work developed independently, continuing until a further change took place in the 670s, when the paste was replaced by a fused paste with sand and wax. Jewellery of this type occurs in north Norway, Uppland and on Gotland. This production continued until about the 720s, and had certainly ended when the trading posts at *Birka* and *Paviken* were established.

Contemporary with the Scandinavian cloisonné work was the ecclesiastical cloisonné art on the Continent which is typified by Eligius' work. As glass and older, re-mounted garnet plates are used here, its location cannot be identified in the same way as with other work, but a very wax-rich fused paste was apparently typical.

In the North Sea area secular cloisonné production closely paralleled that of the ecclesiastical workshop, and is exemplified by the bossed disc brooch from *Dorestadt* (Van Es 1976, 249). This secular cloisonné art appears to belong to a later phase than Eligius' work and may have been contemporary with the later cloisonné art of Scandinavia in the period 620–720.

The cloisonné workshops probably derived their typical life-span—most precisely exemplified by the Frankish workshops in the Rhineland where the period was the shortest, lasting barely two and a half generations—from their need for a patron or distributor, who provided the raw material in the form of garnets. It is likely that only the royal houses, the nobility and the church could guarantee a supply of this kind, and it is among these classes that the distributors must therefore be sought.

It may be of interest to estimate the size of the production studied here, although only approximations are possible. In the Schretzheim cemetery cloisonné brooches occurred most frequently in Koch's periods 2 and 3 (530–590); and here 8% of the graves contained such brooches. This figure agrees well with those from more centrally situated cemeteries in the Frankish kingdom, such as *Junkersdorf,* where 9% of the graves contained cloisonné brooches (La Baume 1967; the figure relates to graves from Böhner's period III (1958)), and *Lavoye* where the equivalent figure is 8% (cf. Joffroy 1974; this figure refers to the sixth century, if we accept that half the graves without grave goods belong to this period). The brooches usually occur in pairs in graves of this period. If 8% is taken to apply to the whole population of 530 000 in Germany at this time, which is probably an exaggeration, since not everybody—and particularly not the Latin population—wore brooches of this kind or was buried in *Reihengräber* cemeteries (cf. van Houtte 1980,16), we arrive at a figure of 84 800 brooches produced during sixty years (520–580), that is 1 413 brooches per year. If this number is divided between the six workshops which have been identified, 236 brooches were produced in each workshop in a year, that is assuming fifty working weeks, four or five brooches each week. This is not an unreasonable rate of production considering that the inlay material was provided, and the actual mounting of a cloisonné brooch would hardly have taken more than one day. It must, however, be taken into account that objects other than brooches were also produced in cloisonné. These figures demonstrate that the realtively small number of workshops which have been identified is not entirely unrealistic, since there cannot have been very many more even if, as here, the largest possible production is envisaged. It must be presumed that there was work in each workshop for at least one or two *Aurifex* and a number of assistants (two *Aurifex* is a likely number—an older master and his apprentice; cf. *Vita Eligii,* for instance, or the two goldsmiths, Undino and Ello, mentioned in the inscription on the *Theoderigus* reliquary (Claude 1981,289)).

In chapters 2 and 4:1 it was pointed out that the mounting of the cloisonné work took very little time; the time-consuming part was the production of the inlay material. We have seen that garnets of type 1 probably came from Bohemia (cf. chapter 1), and it was suggested that garnets of type 1, which were used in cloisonné work in western and northern Europe, were mainly cut and polished in *Trier* (cf. chapter 5). At their source garnets were probably detached with larger pieces of rock in which they were contained in clusters, 'garnet roses', and transported to *Trier* as ballast as part of the regular river traffic. The garnets were knocked out of the rock and cleaved by heating. One such cluster or 'rose' can in my experience produce as many as twenty or twenty-five plates. Cutting and polishing was very time-consuming: Bruce-Mitford (1978,601) asked a number of gem-cutters to study garnets from *Sutton Hoo,* and they agreed that one garnet would have taken at least a day to complete, while some of the more complicated forms would have required the work of several days.

Gem-cutters in Sweden have made similar estimates, but pointed out that much of the time would have been spent on the actual cutting and shaping, such as the step-patterning, while the polishing could be rationalised. Garnets with straight edges probably therefore took less time, and it seems reasonable that four sector-shaped stones cut out of one polished disc, shapes which are typical of Frankish disc brooches, could have been made in a day. We have estimated that 1 413 brooches could have been produced in the Rhineland each year, and if there is an average of twelve garnets per brooch, the time needed to produce these represents 4 239 days' work for a gem-cutter, or a year's work for at least twelve men. If we consider that garnets were produced in the *Trier* workshop for many objects other than brooches, as many as twenty or thirty men could have been employed in this workshop. This figure may perhaps be compared with a weaving-mill employing forty girls which was donated by Count Eberhard to the monastery of Murbach in Elsass in 735–7 (cf. Claude 1981,219). But these figures also lead us to consider the implications if all the cut garnets from *Sutton Hoo,* for instance, were imported from *Trier.* The garnet shapes and the analyses (cf. Chapter 1:6) indicate that some of the garnets used in the objects from

*Sutton Hoo* were of type 1 and were cut in *Trier,* while other garnets were eastern. Bruce-Mitford (1978,602) states that there are about 4000 garnets in this find; all have such complicated shapes that an estimate of one day's work per garnet is too low, and one and a half days would be more realistic. These garnets represent, therefore, 6000 days' work and it follows that seventeen men could have produced them in a year. With a total of thirty men in the workshop, this would not leave a great deal of time for the production of simple *plates* for the Frankish disc brooches. It is, however, unlikely that an order of the magnitude indicated by the *Sutton Hoo* find was executed in a single year; it would presumably have been made in several instalments and, as was pointed out above, some of the garnets appear to have come from *Constantinople.* These figures merely serve to show that the *Trier* workshop could have supplied a larger area on the basis of a reasonable estimate of its size.

The designs of the cloisonné patterns are another factor in estimating the time taken for the production: in chapter 5 it was emphasized that this required a geometrical division of the panels of a kind similar to that used in manuscript illuminations. It has been suggested that such illuminations were based on collections of patterns (cf. U. Roth 1979, and literature referred to there), and designs in some manuscripts, such as the Book of Durrow, are strongly reminiscent of cloisonné patterns (cf. U. Roth 1979, 157). This similarity would tend to support the association between ecclesiastical and cloisonné art which has been assumed in this study.

These calculations demonstrate that production of the Frankish disc brooches involved many time-consuming work-processes distributed among many people.

The fact that this kind of activitity required a smoothly functioning society in order to develop was probably one of the reasons why cloisonné art flourished for only a short while among the Germanic people. The disruption of just one of the many factors which combined to produce cloisonné jewellery could have been enough to bring about the elimination of the whole art form.

## 7:4 The significance of cloisonné jewellery as status symbols

Precious stones were highly regarded in the Roman Empire and were believed to have supernatural properties which could confer considerable advantages on the bearer. Objects with precious stones were used as gifts to curry favour or in return for services rendered. This is illustrated by Pliny's tale of the tyrant Polycrates of *Samos* who, in order to win happiness and prosperity, sacrificed a ring with a sardonyx stone in the sea, only to have the ring returned to him in the belly of a fish which was served at his table (Pliny, *Historia Naturalis,* Book 37:1, Eichholz 1962, 165 ff).

Of the precious stones Pliny rates highest the carbuncle (Greek *anthrax*), which generally refers to garnet (cf. chapter 1); the stone was given the name *carbunculus* (glowing coal) because it glows like fire but cannot be affected by fire. Pliny maintains further that some of these stones possess an inner heat which enables them to melt sealing wax and which shines in the dark with a purple glow, (*Historia Naturalis,* Book 37:XXV, Eichholz 1962, 241). The story of the luminous carbuncle was one of the antique myths which became very important in the Christian Church. It is first mentioned in Epiphanius' lapidary (cf. Arrhenius 1969,52). The purple colour made it a natural symbol of sovereignty and in the Christian religion the carbuncle was one of the twelve stones which, according to Exodus XXVIII,17 Vulgate text, decorated the large breast plate of the high priest of the Jews, (cf. Kunz 1913,275 ff). The carbuncle was the fourth stone, symbolizing the tribe of Judah. It gained a particular significance in the Christian Church, being compared to Christ, who came to lighten man's darkness. Garnets therefore played a part in the Christian cult from an early period, or at least from the fourth century (cf. Lipinsky 1978).

In Germanic art it appears that garnets first occur as decoration on objects which definitely suggest status, such as neck rings, arm rings and brooches for men and on drinking vessels, and it is only at a later stage that garnets were also used in cloisonné on weapons, buckles, saddle mounts and women's jewellery.

The brooches referred to here are the large so-called Imperial brooches which are portrayed on Roman coins and medallions and are represented in finds from *Szilágy Somlyó, Osztropataka* and *Nagymihaly* (Rebrény) (cf. Riegl 1927,345 ff. and pl. II, III and IV).

In the find from *Szilágy Somlyó* the large Imperial brooches occur in two versions: one is represented by the large cross-bow brooch (cf. Fettich 1932. Pl.IX:I) where the bow takes the form of a central oval panel inlaid with an enormous sardonyx surrounded by a border of rectangular garnets in simple clasped cloisonné. Berloques were probably also attached to this brooch.

The other version is a round brooch, with a raised central panel inlaid with garnets in clasped cloisonné surrounding a rock crystal. Round the central panel is a border with animal ornament. Two rings on the rim of the brooch indicate where berloques were attached.

The fine quality of the cross-bow brooch has made it the most discussed of the Imperial brooches (cf. Delbrüeck 1929,40) and the large sardonyx links this brooch directly with the Imperial house, since such stones were reserved for the Emperor and his family alone. The brooch has therefore been interpreted as a gift from the Emperor. It is however also a possibility that it was manufactured in Pannonia on the order of the Emperor considering the rather simple way in which the crossbow is made e.g. the raw material, that is the onyx and the gold was sent to Pannonia by the Emperor. It is somewhat similar to the cross-bow brooches of gold which the Emperor gave his officers and which were found in Childeric's grave, for instance.

The round brooch probably served the same purpose, although it may have represented a different status. It appears that round brooches were more common than cross-bow brooches, as they have been preserved in larger numbers (cf. Heurgon *Le Trésor de Tenes*, 1958). The round brooches (fig. 6) from *Szilágy Somlyó* had garnets from the Black Sea area and were therefore probably made in the *Crimea* or *Georgia.* The appearance of the round brooch suggests that it was rather a barbaric copy of an Imperial brooch, and this is also the case with the brooches covered in garnets from *Petroassa* (suggested by Brown 1972). Brown's suggestion, based on the curvature of the underside, that the large eagle brooch rested on the shoulder with the bird's head facing outwards is very convincing. The other brooches were worn in pairs (one brooch of one pair has been lost in recent time) (cf. fig. 34) and I agree with Brown that they represent barbaric copies of the brooches worn by female members of the Imperial family.

It is interesting to note the frequent occurrence of garnet jewellery symbolising status in Germanic hoards, which must probably be regarded as *hoards belonging to Germanic kings*. These kings copied both the brooches and the custom of presenting them as gifts.

This would explain the very large number of brooches of Germanic types, like those covered in garnets from *Szilágy Somlyó,* as probably intended as gifts and honours for especially favoured men and their women. The analyses show that such brooches were most probably made in Hungary, perhaps as royal commissions.

The reasons why the mounts on swords and horse trappings inlaid with garnets were based on models from Byzantine art were discussed in chapter 4, along with how the parallels in Sassanian art resulted mainly from the strong mutual influences at this time between Byzantine and Sassanian art. In both areas jewelled swords were apparently important status symbols, as seen on representations on both Byzantine diptychs and Sassanian silver bowls. It is therefore not surprising that the Germanic kings also acquired such swords; it has been pointed out that these were initially imported directly from *Byzantium,* a local production being recorded only during and after the time of Childeric (cf. chapter 4). The jewelled swords were less frequently used in Germanic areas and never became as important as the brooches with garnet inlay.

In an interesting study, *Die Alamannen,* Christlein (1978, 86 f.) divides archaeological finds into groups representing social strata. Groups C and D both represent finds of the highest quality while group D includes finds of particularly high value and of a character which would not have occurred in normal trade. The finds from *Rüdern* and *Gültingen,* richly equipped men's graves with objects in cement cloisonné (cf. Stutt 8 and 11), are assigned to group D and supposedly represent a rank which the Allemanni called princes. Christlein's divisions therefore support the opinion expressed here that weapons and bridle mounts with cloisonné were a mark of status conferred on the king's trusted liegemen.

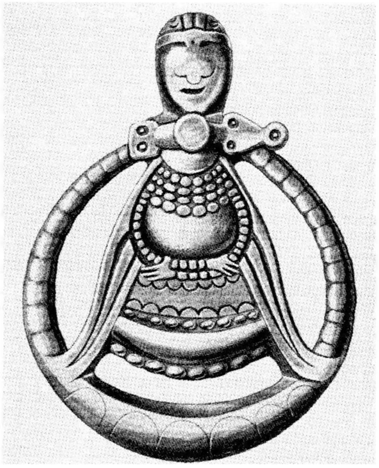
The significance of Frankish sword pommels in Swedish finds, for instance (cf. chapter 5), is interesting in this context. In the light of the present discussion these finds must be regarded as indications of contacts and diplomacy between the Franks and the Svear *at a royal level,* rather than of trading links. This thesis is further supported by the fact that the local goldsmiths' production in sixth-century Central Sweden adopted all the status symbols of the Franks, including the weapons and horse trappings, whose rich decorations included garnet cloisonné, such as those found in the earliest boat graves from *Vendel* and *Valsgärde* (Arrhenius 1983).

The distribution of weapons and female jewellery is strikingly different. Like weapons, pieces of women's jewellery were probably gifts with the character of status symbols, but it appears that they were distributed through somewhat different channels. The Frankish disc brooches, for example, spread from the central Frankish area to south Germany, Hungary and Italy and to Anglo-Saxon England, while there is only one late example of a brooch of this kind in Sweden (Swed 63). There are, however, relatively more Frankish pommels, buckels etc. in Sweden than in the equivalent continental areas. The reason for this distribution may be that exogamy, used as a means of diplomacy, never involved Scandinavia.

Otherwise the distribution of female jewellery may reflect missionary activity by the Catholic church. It has already been established that some of the Frankish cloisonné production was probably in the charge of the church. Some of the finer pieces of female jewellery could have been gifts exchanged, for instance, during Christian marriage ceremonies (Gregory of Tours mentions marriage gifts of considerable size, cf. Weidemann 1982, I, 314).

The appreciation of jewellery with garnet cloisonné as status symbols in Scandinavia can be deduced from the development of the button-on-bow brooches. There are Swedish finds from the eighth century of such brooches more than 30 cm long, which could never have been worn as brooches but must have been intended as idols or cult objects. Contemporary amulets portray women wearing these grotesque brooches.

These brooches have been identified with Brisingamen, the goddess Freya's jewel (the flaming jewel) (Arrhenius 1969). If this identification is correct, it further supports the opinion expressed here that garnet jewels represented status and symbolised royal power.



# Chapter 8. Tables I, X and XI

Table I. Analyses of Garnets by Mellis 1963.

| Find no. | Provenance | d | n | Absorption maxima 576 μm | 505 μm | 527 μm | Colour |
|---|---|---|---|---|---|---|---|
| a) Mineralogical properties of garnets with d>4.16 | | | | | | | |
| Swed 2/D | NP Germany | >4.16 | >1.810 | x | | | light reddish violet |
| Swed 21/Sw | Hög Edsten | >4.16[1] | >1.810 | xx | xx | x | reddish violet |
| Swed 15/Bu | Åshusby | 4.16 | – | | | | |
| Swed 90/B-bt | Sanda | 4.16 | >1,810 | xx | xx | x | light reddish violet |
| Swed 25/M | Östervarv | >4.16[1] | >1.810 | xx | xx | x | reddisch violet |
| Swed 70/B-bt | Hejnum | >4.16 | 1.810 | | | | reddish violet |
| Swed 50/M | Kylver, Gr. 6 | 4.16 | >1.810 | | | | |
| Swed 22/Sw | Tibble | >4.16[1] | >1.810 | xx | x | | brownish red |
| Swed 17c/G | Helgö | >4.16 | 1.810 | | | | |
| b) Mineralogical properties of garnets with 4.16>d>4.12 | | | | | | | |
| Swed 18/B-bt | Hällan | 4.16>d>4.12 | 1.801 | xx | x | x | reddish violet |
| Swed 14/Bu | Sjörup | 4.12 | 1.798 | xx | xx | x | reddish violet |
| Swed 276/Bu | Uppsala Västhög | 4.16>d>4.12 | – | | | | |
| Swed 74/b-Bt | Tofta | 4.12 | 1.799 | xx | xx | | |
| Swed 51/B-bt | Björkome, Gr 4. | 4.12 | 1.803 | xx | xx | x | reddish violet |
| Swed 71/B-bt | Kylver, Gr 5. | 4.16>d>4.12 | 1.800 | | | | light reddish violet |
| Swed 23/M | Lejde | 4.12 | 1.798 | xx | x | x | light reddish violet |
| | | | $n_6$=1,800 | | | | |
| c) Mineralogical properties of garnets with 4,12>d>4,03 | | | | | | | |
| Swed 52/B-bt | När | 4.12>d>4.03 | 1.798 | | | | brownish red |
| Swed 117/Sw | NP | 4.03 | 1.785 | x | | | brownish red |
| Swed 31/Sw | Vendel, Gr I. | 4.12>d>4.03 | 1,798 | | | | brownish red |
| Swed 93/B-bt | Grötlingbo | 4.12>d>4.03 | 1.790 | | | | |
| Swed 105/B-bt | NP Go. | 4.03 | 1.790 | xx | xx | x | light reddish violet |
| Swed 53/B-bt | Bjärs Gr 103 | 4.12>d>4.03 | 1.792 | xx | xx | x | reddish violet |
| Swed 39/B-bt | Tuna, Alsike | 4.12>d>4.03 | 1.790 | x | | | brownish red |
| Swed 39/B-bt | Tuna, Alsike | 4.12>d>4.03 | 1.789 | x | | | brownish red |
| Swed 39/B-bt | Tuna, Alsike | 4.12>d>4.03 | 1.791 | x | | | brownish red |
| Swed 848/B-bt | Anga | 4.12>d>4.03 | 1.797 | xx | xx | x | light reddish violet |
| Swed 848/B-bt | Anga | 4.12>d>4.03 | 1.790 | x | | | light reddish violet |
| Swed 848/B-bt | Anga | 4.12>d>4.03 | | | | | |
| Swed 54/B-bt | Västkinde, Gr 2. | 4.12>d>4.03 | 1.788 | x | | | brownish red |
| Swed 113/B-bt | Othem | 4.03 | 1.785 | x | | | brownish red |
| Swed 102/B-bt | Rikvide När | 4.12>d>4,03 | 1.791 | | | | |
| Swed 40/B-bt | Ruda | 4.03 | 1.790 | | | | brownish red |
| Swed 44/M | Kunsta | 4.03 | 1.789 | | | | |
| Swed 56/B-bt | Fardhem | 4.03 | 1.789 | | | | |
| Swed 26a/Sw | Skrävsta | 4.12>d>4.03 | | | | | |
| | | | $n_{17}$=1,791 | | | | |
| d) Mineralogical properties of garnets with 4,03>d≥3.84 | | | | | | | |
| Swed 1/M | Crimea | 4.03>d>3.84 | 1,77 | xx | xx | x | brownish red |
| Swed 26b/G | Skrävsta | 4.03>d>3.84 | 1.775 | xx | xx | x | light reddish violet |
| Swed 45/B-bt | Ringarum | 4.03>d>3.84 | 1.789 | x | | | |
| e) Mineralogical properties of garnets with 3,74>d≥3,69 | | | | | | | |
| Swed 42/P | Edsberg | 3.74>d>3.69 | 1.748 | x | | | brownish red |
| Swed 55/B-bt | Endre | 3.74>d>3.69 | 1.748 | | | | |
| | | | $n_2$=1,748 | | | | |

[1]The density of this garnet is only around >4.16.

Table X. Occurrence of different substances recognized by diffraction analyses in the cements and fillings.

| Name | Formula | Number | Per cent |
|---|---|---|---|
| *Elements* | | | |
| Carbon | C | 16+(1?) | 9 |
| Sulphur | S | 9 | 5 |
| Silver- and golddust | Au+Ag | 25 | 14 |
| *Sulfides* | | | |
| Argentite | $Ag_2S$ | 6 | 3 |
| *Oxides and chlorides* | | | |
| Corundum | $Al_2O_3$ | 1 | |
| Calciumoxide | CaO | 1 | |
| Zinkite | ZnO | 2 | |
| Goethite | FeO(OH) | 1 | |
| Laurionite | Pb(OH)Cl | (1?) | |
| Cerargyrite | AgCl | 2 | |
| *Carbonates* | | | |
| Calcite | $CaCO_3$ | 99 | 50 |
| Aragonite | $CaCO_3$ | 7 | 4 |
| Dolomite | $CaMg(CO_3)_2$ | 11 | 6 |
| Malachite | $Cu_2(CO_3)(OH)_2$ | 4 | 2 |
| Cerussite | $PbCO_3$ | 2 | 1 |
| Smithonite | $4ZnO \cdot CO_2 \cdot 4H_2O$ | 1(?) | |
| Basic Zn-carbonate | $4ZnO \cdot CO_2 \cdot 4H_2O$ | 4 | 2 |

| Name | Formula | Number | Per cent |
|---|---|---|---|
| *Silicates* | | | |
| Quartz | $SiO_2$ | 119 | 65 |
| Cristobalite | $SiO_2$ | (2) | |
| Microcline | $KAlSi_3O_8$ | (1) | |
| Oligoklase | $(Na,Ca, Al)Si_3O_8$ | 2+(1?) | |
| Muskovite | $(KAl_3Si_3O_{10}(OH)_2$ | 1+(1?) | |
| Kaoline | $(Al_2Si_2O_5(OH)_4$ | 10 | 6 |
| Glauconite | (variable formula) | 3+(1?) | |
| Heulandite | $CaAl_2Si_2O_{18} \cdot 6H_2O$ | 2 | |
| MS | | 65 | 36 |
| *Sulphates and phosphates* | | | |
| Gypsum | $CaSO_4 \cdot 2H_2O$ | 11 | 6 |
| Burnt Gypsum | $CaSO_4 \cdot 1/2\ H_2O$ | 2 | |
| Anhydrite | $CaSO_4$ | 1 | |
| Barite | $BaSO_4$ | 3 | |
| Chalcantite | $CuSO_4 \cdot 5H_2O$ | 1 | |
| Jarosite | $KFe_3(SO_4)_2(OH)_6$ | 2 | |
| Brochantite | $CuSO_4(OH)_6$ | 2 | |
| Mimetite | $Pb_5(A,S,P)O_4)_3Cl$ | 1 | |
| *Organic material* | | | |
| Wedellite | $CaC_2O_4 \cdot 2H_2O$ | 3 | |
| Wax | | 46+(1?) | 25 |
| Plant fragm. | | 7+(1?) | 4 |
| Shellack | | (1?) | |
| Wood splinter | | 4 | 2 |
| *Unidentified* | | | |
| UID | | 23 | 13 |

Table XI. Diffraction analyses of paste samples.
The table lists the consecutive numbers given to the analysed samples and the results of the analyses.

Where samples contain several constituents, the substances are arranged according to roughly-estimated diminishing proportions. Uncertain identifications are marked (?) and unidentified substances (UID), while substances considered to be contaminations are placed in brackets. HPH in the column indicates that the sample is hydrophobic.

Where there is no other information, calcite is very fine-grained with grain sizes <10 μm, usually 1–5 μm, and quartz grains are rounded and of various sizes between 20 and 250μm, usually 50–70 μm.

## I. THE CARBONATE GROUP

### 1:1 Calcite with wax

*I:1 a. Calcite with wax less than 50%*

| | | | | |
|---|---|---|---|---|
| 2. | Swed 89/B-bt | Kylver | calcite+wax | |
| 3. | Swed 103/B-bt | Rikvide | calcite+wax | |
| 4. | Swed 88/B-bt | Endre | calcite+wax+quartz (traces) | HPH |
| 5. | Swed 31/Sw | Vendel, Gr I | calcite+wax+gypsum (traces) | |
| 15. | Swed 35/B-bt | Birka | calcite+wax+quartz+clay (small quantity) some foraminifera | HPH |
| 16. | Swed 66/B-bt | Stånga | calcite+wax+(malachite) | HPH |
| 29. | BM 16/Bd | Continent | calcite+wax+quartz (traces) | HPH |
| 30. | BM 2/L | Torino | calcite+wax+rounded calcite grains c. 60 μm | HPH |
| 31. | BM 4/Ed | Italy | calcite+wax+angular calcite grains 50–200 μm | HPH |
| 55. | Swed 29/Sw | Valsgärde 5. | calcite+wax (small quantity) + quartz (small quantity) | HPH |
| 97. | Liv 3/D | Kingston, Gr 5 | calcite+wax+quartz (traces) | HPH |
| 99. | Swed 52/B-bt | När | calcite+wax+UID | HPH |
| 104. | Swed 101/B-bt | Endre | calcite+wax | HPH |
| 201. | Dill 10/D | Schretz, Gr 350 | calcite+wax (traces) | HPH |

*I:1 b. Calcite with wax as a secondary constitutent*

(The wax is not mixed with the calcite but forms a separate layer on top of the calcite.)

| | | | |
|---|---|---|---|
| 1. | Paris $1^b$/Sw | Childeric | calcite (hard) + barite + kaolin + quartz + wax (traces) |
| 68. | Köln 1/Bu | N P France | calcite (hard) + UID (small quantity) + wax (traces) |
| 73. | Stut 21/Bu | Stammheim | calcite (hard) + wax (traces) |
| 177. | Wien 2/D | Baumgarten | calcite (hard)+calcium-oxalate dihydrate + wax (traces) |

**I:2. Pure calcite without wax**

*I:2a. Pure calcite (sometimes with small traces of other substances)*

| | | | |
|---|---|---|---|
| 17. | Swed 115/D | Barshaldershed | calcite |
| 18. | Swed 116/D | N P Go. | calcite+UID(traces)+ [malachite (traces]+plant fragments |
| 35. | BM 11/D | Dover | calcite+(Au) |
| 114. | Oslo 1/M | Åker | calcite+[malachite] |
| 185. | Köln 5/Se | Cathedral grave | calcite+UID (small quantity) |

*I:2b. Pure calcite, vesicular (e.g. wax melted away)*

| | | | |
|---|---|---|---|
| 22. | Swed 26/Sw | Skrävsta | calcite+calcium oxide (small quantity)+[Au(abundant)+shellac?] |
| 23. | Swed $27^a$/Sw | Uppsala, W mound | calcite+aragonite (traces) |
| 46. | Swed 74/B-bt | Tofta | calcite+[zink oxide (abundant)]+some foraminifera |
| 105. | Swed 57/B-bt | Broa | calcite+[zinc oxide] |
| 191. | Münster 5/Bt | Enger | calcite+[Au] |

*I:2c. Calcite as I:2a., but hardened*

| | | | |
|---|---|---|---|
| 118. | Paris $1^b$/Sw | Childeric | calcite (hard) |
| 140. | Rom 5/Sw | Nocera Umbra | calcite (hard)+UID |

**1:3. Calcite with little quartz**

*I:3a. Calcite with little quartz*

| | | | |
|---|---|---|---|
| 13. | Swed 22/Bt | Tibble | calcite+quartz (small quantity)+corundum |
| 24. | Swed 65/Sw | Vallstenarum | calcite+quartz (small quantity) |
| 28. | Swed 15/Bu | Åshusby | calcite+quartz (small quantity) |
| 32. | BM 13/Bu | Taplow | calcite+quartz (small quantity) |
| 69. | Köln 10/D | Müngersdorf, Gr 91b. | calcite+quartz |
| 94. | Swed 24/M | Spelvik | calcite+quartz (small quantity) |
| 183. | Köln 8/B | Cathedral grave | calcite+quartz+UID |

*I:3b. As I:3a but sample vesicular (e.g. wax melted away)*

| | | | |
|---|---|---|---|
| 25. | Swed 63/D | Alva | calcite+quartz+carbon+UID sample vesicular |
| 98=108 | Swed 58/B-bt | N P Gotland | calcite+quartz (small quantity) sample vesicular |
| 106. | Swed 106/B-bt | Vallstena Gotland | calcite+quartz+(basic zinc carbonate) sample vesicular |
| 108=98 | Swed 58/B-bt | N P Gotland | calcite+quartz (small quantity) sample vesicular |

*I:3c. As I:3a, but hardened*

| | | | |
|---|---|---|---|
| 33. | BM/D | Bone, N. Africa | calcite (hard)+quartz (small quantity)+[Ag] |
| 145. | Paris $1^c$/Sw | Childeric | calcite (hard)+quartz (small quantity) |

**I:4. Calcite with larger amounts of quartz**

*I:4a. As above but quartz + MS*

| | | | |
|---|---|---|---|
| 36. | BM 10/Bd | N P | calcite+quartz+MS |
| 38. | BM 8/R | N P France(?) | calcite (small quantity)+quartz+MS |
| 64=93. | Worms 32/D | Sprendlingen | calcite+quartz+MS+brochantite |
| 74. | Mainz 5/R | Hahnheim | calcite+quartz+MS |
| 77. | Mainz 9/R | Dalsheim | calcite+quartz+MS |
| 78. | Mainz 7/Sb | Dalsheim | calcite+quartz+MS |
| 93=64. | Worms 32/D | Sprendlingen | calcite+quartz+MS+brochantite+basic zinc carbonate |
| 133. | Bud 38/Sa | Németkér | calcite+quartz+MS |
| 135. | Bud 1/Bu | N P Hungary | calcite+quartz+MS |
| 137. | Bud 2/R | Szent, Gr 54. | calcite+quartz+MS |
| 138. | Bud 3/D | Szent, Gr 2. | calcite+quartz+MS |
| 139. | Rom 6/D | Nocera, Gr 87. | calcite+quartz+MS+[argentite] |
| 150. | Bud 4/R | Szent, Gr 29. | calcite (small quantity)+quartz+MS |
| 152. | Bud 2/R | Szent, Gr 54. | calcite+quartz+MS |
| 153. | Bud 6/R | Szent, Gr 14. | calcite (small quantity)+quartz+MS |
| 187. | Maid 1/D | Bifrons, Gr 42. | calcite (small quantity)+quartz+MS |
| 210. | Bud 30/Bu | N P Hungary | calcite+quartz+MS |
| 211=135. | Bud 1/Bu | N P Hungary | calcite+quartz+MS |

*I:4b. As above but quartz + mica (?)*

| | | | |
|---|---|---|---|
| 50=51. | Rom 3/D | Castel Tro, Gr 168. | calcite+quartz+glauconite ? + mica |
| 51=50. | Rom 3/D | Castel Tro, Gr 168. | calcite+quartz+oligoclase?+muscovite(?)(small quantity) |
| 54. | Rom 2/Bd | Castel Tro, Gr 115. | calcite+quartz+oligoclase+mica(?)+[Au or Ag] |

*I:4c. As above but with quartz+MS+dolomite*

| | | | |
|---|---|---|---|
| 151. | Bud 5/D | Scent, Gr 29. | calcite+quartz+MS+dolomite (small quantity) |
| 154. | Bud 7/R | Tatab, Gr 24. | calcite+quartz+MS+dolomite |
| 161. | Westp/D | Varpalota, Gr 5. | calcite+quartz+oligoclase+mica+dolomite |
| 179. | Mainz 13/D | Schwarzrheindorf | calcite (coarse crystalline)+quartz+MS+dolomite |
| 180. | Mainz 14/Sb | N P Germany | calcite (coarse crystalline)+quartz+MS+dolomite |
| 193. | Dill 2/D | Schretz, Gr 586. | calcite+quartz+MS+dolomite |
| 197. | Dill 6/D | Schretz, Gr 464 | calcite+quartz+MS+argentite+dolomite |
| 198. | Dill 7/D | Schretz, Gr 509. | calcite+quartz+MS+dolomite |
| 200. | Dill 9/R | Schretz, Gr 233. | calcite+quartz+MS+dolomite+[Ag] |

*I:4d. As above but with quartz +UID (possibly clay mineral)*

| | | | |
|---|---|---|---|
| 75. | Mainz 6/R | Mörstadt | calcite+quartz (c. 50%) UID (traces) |
| 76. | Mainz 8/R | Abenheim | calcite+quartz+UID |
| 129. | Swed 16/Sw | Sturkö | calcite+quartz+UID (clay mineral) |
| 143. | Turin 1/B | Desana | calcite+quartz+UID |
| 204. | Nürnb. 1/Eb | Domagnano | calcite+quartz+UID+MS |

**I:5. Other carbonates**

*I:5a. Aragonite with wax as a secondary constituent (the wax is not mixed with the aragonite but forms a separate layer on the top of the aragonite)*

| | | | |
|---|---|---|---|
| 88. | Mainz 2/Sw | Planig | aragonite+wax+calcite (small quantity) |
| 89. | Mainz 2/Sw | Planig | aragonite+wax+calcite (small quantity) |

*I:5b. Aragonite without wax*

| | | | |
|---|---|---|---|
| 60. | Mainz 2/Sw | Planig | aragonite (vesicular) |
| 62. | Worms 33/Sw | Eich | aragonite+calcium oxalate dihydrate |
| 90. | Karl. 1/Sw | Altlussheim | aragonite+calcite(traces) |
| 91. | Karl. 1/Sw | Altlussheim | aragonite+calcite(traces) |

*I:5c. Cerussite and dolomite*

| | | | |
|---|---|---|---|
| 136. | Bud 27/Ea | Tiszalök | cerussite($PbCo_3$) (probably corrosion products) +quartz (traces)+carbon |
| 162. | Westp. 2/Sb | Varp. 17. | dolomite |

II. THE SILICATE GROUP

**II:1. Quartz with wax less than 50%**

| | | | |
|---|---|---|---|
| 8.(102) | S 108/B-bt | Ihre | quartz+wax+kaolin |
| 101. | S 39/B-bt | Tuna | quartz+wax+kaolin (small quantity) |
| 102.(8) | S 108/B-bt | Ihre | quartz+wax+kaolin (small quantity) |
| 103. | S 110/B-bt | Endre | quartz+wax+kaolin |

*II:2.* **Quartz without wax**

*II:2a. Quartz with mixed silicates (MS)*

| | | | |
|---|---|---|---|
| 9. | Swed 2/D | N P. Germany | quartz+MS+Au (traces) |
| 10. | Swed 21/Sw | Hög Edsten | quartz+MS+plant fragments+Au (small quantity) |
| 19. | Swed 13/Sw | Väsby | quartz+MS+silicious algae+Au |
| 56. | Br 1/Sb | Lede | quartz+MS |
| 66=85. | Bonn 48/D | Kottenheim, Gr 36 | quartz+MS |
| 72. | Stutt 5/D | Horkheim | quartz+MS |
| 80. | Worms 6/D | N P Worms | quartz+MS |
| 81. | Worms 7/D | N P Worms | quartz+MS |
| 82. | Trier 2/D | Rittersdorf, Gr 15. | quartz+mimetite+Ag or Au |
| 83. | Trier 3/R | Rittersdorf, Gr 34. | quartz+MS |
| 84. | Trier 11/D | Ritterdorf, Gr 107 | quartz+MS |

| | | | |
|---|---|---|---|
| 85=66 | Bonn 47/D | Kottenheim, Gr 36 | quartz+MS |
| 86. | Köln 22/R | Junkersdorf, Gr 41 | quartz+MS |
| 87. | Krefeld 5/R | Gellep, Gr 2597. | quartz+MS+plant fragments |
| 155. | Szek 2/R | Kajdacs Gr 2 | quartz+MS+Au |
| 169. | Bud 8/B | Hegykö, Gr 18. | quartz+MS+UID (small quantity) |
| 178. | Mainz 16/R | Dalsheim | quartz+MS+Au |
| 181. | Mainz 15/D | Abenheim | quartz+UID |
| 189. | Maid 7/P | Milton | quartz+MS |
| 192. | Dill 1/D | Schretz, Gr 583. | quartz+MS |
| 194. | Dill 3/R | Schretz, Gr 26. | quartz+MS+[argentite+chalcontite+brochantite+Au] |
| 195. | Dill 4/Sb | Schretz, Gr 26. | quartz+MS |
| 199. | Dill 8/R | Schretz, Gr 250 | quartz+MS |
| 202. | Dill 11/R | Schretz, Gr 300. | quartz+MS |
| 207. | Bud 26/B | Szilagy | quartz (large grains>0.5 mm)+MS |

*II:2b. Quartz with clay minerals*

| | | | |
|---|---|---|---|
| 20. | Swed 23/M | Lejde | quartz (small quantity)+plant fragments carbon+clay mineral |
| 37. | BM 9/D | Germany | quartz+glauconite+plant fragments |
| 39, 40. | BM 12/D | Faversham | quartz+kaolin+carbon+brochantite (only on the surface) |
| 57. | Civi 1/Sb | Cividale | quartz+microline |
| 67. | Bonn 33/D | Hürth-Kalscheuren | quartz+kaolin+glauconite |
| 71. | Stutt 3/D | Heidenheim | quartz+kaolin+glauconite+plant fragments |

*II:2c. Cristobalite*

| | | | |
|---|---|---|---|
| 12. | Swed 27[b]/Bu | Uppsala W. mound | cristobalite+UID (small quantity) |
| 21. | Swed 27[b]/Bu | Uppsala W. mound | cristobalite+UID (small quantity) |

*II:2d. Heulandite*

| | | | |
|---|---|---|---|
| 176. | Bud 34/Eb | Bereg. | heulandite ($CaAl_2Si_7O_{18}\cdot 6H_2O$) |
| 205. | Szeg 3/Bu | Nagysz. | heulandite ($CaAl_2Si_7O_{18}\cdot 6H_2O$) |

## III. THE SULPHATE GROUP

**III:1. Gypsum with wax on the surface (in a separate layer)**

| | | | |
|---|---|---|---|
| 41. | BM 1/M | Reastan | gypsum+burnt gypsum (small quantity)+wax (small quantity) |
| 49. | BM 7/Bu | N P Continent | gypsum+wax+quartz |
| 116. | Paris 1[a]/Sw | Childeric | gypsum+quartz+wax+anhydrite |

**III:2. Gypsum without wax**

| | | | |
|---|---|---|---|
| 42. | BM 7/Bu | N P Continent | gypsum |
| 96. | Liver 1/M | Gilton | gypsum+burnt gypsum (small quantity) |
| 115. | Paris 1[d]/Sw | Childeric | gypsum+quartz+(small fragment goethite) |
| 117. | Paris 2[b]/Sa | Childeric | gypsum+quartz+muscovite |
| 121. | Cluj 1/M | Apahida II | gypsum (ca. 0.5 mm lentoid gympsum monocrystals)+quartz+MS |
| 122. | Cluj 2/M | Apahida II | gypsum (ca. 0.3 mm lentoid gypsum monocrystals)+quartz+MS |
| 144. | Paris 2[d]/Sa | Childeric | gypsum |

**III:3. Other sulphates**

| | | | |
|---|---|---|---|
| 148. | Paris 3/M | Childeric | jarosite ($KFe_3(SO_4)_2(OH)_6$) |
| 149. | Paris 3/M | Childeric | jarosite ($KFe_3(SO_4)_2(OH)_6$) |

**III:4. Other sulphates with wax as a secondary constituent (in a separate layer on the top of the sulphate)**

| | | | |
|---|---|---|---|
| 146. | Paris 4/M | Childeric | wax+barite ($BaSO_4$)+quartz(traces) |

## IV. THE SULPHUR GROUP

| | | | |
|---|---|---|---|
| 58. | Cop 3/D | Reinstrup | sulphur+wood splinter+quartz (small quantity) +MS(traces)+talc and kaolin (traces) |
| 59. | Cop 3/D | Reinstrup | sulphur+talc and kaolin (traces) |
| 65. | Wiesb. 2/D | Eltville | sulphur |
| 70. | Münst 2/P | Soest, Gr 106. | sulphur |
| 134. | Bud 33/R | Bereg. | sulphur |

| | | | |
|---|---|---|---|
| 175. | Bud 32/Ea | Szeksard | sulphur |
| 182. | Köln 7/P | Cathedral grave | sulphur (sublimated sulphur)+UID+carbon |
| 186. | Köln 6/P | Cahtedral grave | sulphur |
| 196. | Dill 5/D | Schretz, Gr 23. | sulphur |

## V. THE ORGANIC GROUP

### V:1. Wax as main constituent

| | | | |
|---|---|---|---|
| 11. | S 8/Bu | Crimea | wax+calcite |
| 43. | BM 5/Bu | Milton | wax+calcite |
| 95. | Liver 2/D | Gilton, Gr 42 | wax+quartz (small quantity)+(malachite+$Ag_2S$+Au) |
| 107. | Swed 113/B-bt | Othem | wax+calcite (some calcite grains≈100$\mu$m)+quartz |
| 109. | Swed 85/B-bt | Grötlingbo | wax+calcite+quartz(traces) |
| 113. | Trond 1/B-bt | Melhus | wax+quartz (small quantity)+UID(small quantity) |
| 119. | Paris 10/Bo | Chosroe | wax+quartz (small quantity)+clay mineral |
| 127. | Bud 20/B | Szilagy | wax+quartz (small quantity)+MS (small quantity) |
| 142. | Rom 4/Eb | Capitol. | wax+UID |
| 156. | Szek 1/Bu | Nagyd. | wax+calcite (small quantity)+quartz+MS+carbone |
| 159. | Fe 1/Bu | Ta'cro 1 | wax+calcite+UID (small quantity) |
| 160. | Fe 2/D | Ŗaca'lma's | wax(?)+quartz+UID+MS |
| 163. | Bud 11/Bu | N P | wax+quartz (small quantity)+UID+MS (small quantity) |
| 171. | Bud 12/M | N P | wax+quartz (small quantity)+UID+basic zinc carbonate |
| 172. | Bud 12/M | N P | wax+zinc carbonate(?)+basic zinc carbonate |
| 174. | Bud 13/B | Szarvas | wax+calcite (small quantity) |
| 203. | Swed 112/B-bt | Gotland | wax+calcite (small quantity)+(Au or Ag) |

### V:2. Carbon as main constituent

| | | | |
|---|---|---|---|
| 14. | S 1/M | Crimea | carbon+calcite+dolomite |
| 120. | Buka 1/B | Petroassa | charcoal+quartz (small quantity)+MS(traces) |
| 125. | Cluj 3/Bu | Apahida II | carbon+quartz(grains ca. 0,4 mm)+MS |
| 128. | Bud 15/B | Schilagy | charcoal+quartz (small quantity)+UID+(Au) |
| 130. | Bud 16/B | Szilagy | charcoal+(Au) |
| 131. | Bud 17/B | Szilagy | charcoal+quartz(large quantity)+UID |
| 132. | Bud 18/Bo | Szilagy | carbon+(Au) |
| 164. | Bud 10/B | N P | carbon+quartz+MS |
| 170. | Bud 9/B | N P | carbon+quartz UID+MS+Au |
| 206. | Bud 19/D | Szilagy | carbon+quartz (small quantity)+MS |
| 208. | Bud 18/Bo | Szilagy | carbon+quartz (small quantity)+MS |
| 209. | Bud 25/B | Szilagy | carbon+quartz+argentite(?) |

### V:3. Plant material as main constituent

| | | | |
|---|---|---|---|
| 52=53. | Rom 1/D | Nocera, Gr 150. | wood splinter+UID (traces) |
| 53=52. | Rom 1/D | Nocera, Gr 150. | wood splinter+quartz(traces)+calcite (small quantity) cerussite |
| 111. | Münch 1/B | Wittis. | wood splinter+quartz |
| 157. | Szek 3/Bu | Regöly | vegetable mat.+quartz+calcite+MS+carbon+wax (traces) |
| 158. | Szek 3/Bu | Regöly | vegetable mat.(?)+quartz+calcite+MS+carbon(?)+wax(traces) |

### V:4. Calcium oxalate as main constituent

| | | | |
|---|---|---|---|
| 61. | Worms 33/Sw (cf. 1:5b, nr. 62) | Eich | calcium oxalate dihydrate+quartz (traces) |

# Appendix

## An excerpt from: Report on the scientific examination of several garnets from the Sutton Hoo jewellery together with comments on the possible presence of 'backing pastes'.

(Only the text from the report is reproduced below; for figures and table cf. British museum Research laboratory, R. L. Files 2467, 2468, 2562, 2563, 2710.)

### 1. *Introduction*

The gold and garnet jewellery from Sutton Hoo is characterised by the high quality of the cutting of the garnets and the skill with which they have been fitted into their respective cloisons. In all cases the garnets are much thinner than the depth of the cloison, and this has led to the suggestion that they must have been supported in position by a 'backing paste', as in the comparative continental jewellery (see: Birgit Arrhenius, *Granatschmuck und Gemmen aus Nordischen Funden des Frühen Mittelalters*, Stockholm, 1971).

However in the cases where Sutton Hoo garnets are broken or missing no unequivocal evidence of backing paste remains in the cells. In some instances existing garnets have sunk to the bottom of their cells, and this suggests that backing paste is absent. It has been postulated that paste was originally present but that it has dissolved away from the cells in the cases where the garnets have sunk; if this was so it must have dissolved away from most, if not all, of the other cells as well and it seems likely that many more garnets would have sunk or been lost when their support was removed.

Recent work has shown that backing pastes are present behind the garnets on the boar's head escutcheons on the large hanging bowl and on the shield, but it is the opinion of the Research Laboratory that no backing pastes were present in most, if not all, of the jewellery and that the garnets were wedged in position by the upturned edges of the gold foil and the sideways pressure of the cell walls. The following investigation has been carried out to test this hypothesis. As some garnets were removed from their settings as part of the project, the opportunity was taken of measuring some of their physical constants, which are also reported.

### 2. *Removal of a garnet from one of the hemispherical bosses on the sword (SH. 26)*

Examination of boss (SH. 26) showed that one of the garnets adjacent to the lower edge was loose. This is illustrated in Figs. 1 and 2. The garnet was remowed, together with its gold foil backing, by gently rocking in its cloison, and it is illustrated in the boss because of incomplete soldering of the cell walls with the result that some soil could have washed in during burial.

### 3. *Removal of a garnet from belt plaque (SH. 6)*

Belt plaque 1939.10–10.5a was chosen for the first attempt to remove a tightly fitting garnet. The garnet selected is indicated by 'A' on Fig. 5. When it was removed the cell was found to be empty except for two small areas of a dark brown deposit on the underside of the gold foil (Fig. 6) and traces of a similar deposit in the bottom of the cell (Fig. 7). X-ray diffraction analysis of a sample from the underside of the gold foil indicated the presence of quartz and gold. If any other material was present it must have been amorphous, and possibly organic.

### 4. *Removal of a replacement 'stone' from belt plaque (SH. 6)*

The cell indicated by 'B' on Fig. 5 contained a 'stone' which was a different colour from the other garnets. This 'stone' was soft and a small sample was removed from the back. It dissolved readily in acetone and analysis by infra-red spectrometry gave a spectrum which was essentially identical with that of cellulose nitrate. We know that one (unspecified) cell was restored in the late 1940's and hence it is concluded that this 'stone' is a restoration which was put in position at that period.

Underneath the 'stone' was a gold foil resting on a soft green backing paste which retained the pattern of the identations on the foil when this was removed. An x-ray diffraction analysis of a sample of this green material indicated the presence of calcite with a relatively large crystal size and a very small amount of $\alpha$-quartz which is probably of a similar crystal size.

No beeswax was detected by x-ray diffraction analysis but, as the consistency of the green paste suggests that an organic binder must be mixed with the calcite, a further analysis was carried out by infra-red spectrometry. This method of analysis confirmed the presence of calcite but failed to positively identify the organic component. However it is possible to say that it is probably a long chain aliphatic compound which does not contain carbonyl groups. Hence it is not beeswax, paraffin wax, carnauba wax, lanolin or tallow, but the spectrum did bear some resemblance to that of petroleum jelley (i.e. Vaseline), though this cannot be regarded as a positive identification.

### 5. *Removal of a garnet from strap end (SH. 14)*

Strap end (SH. 14) was selected for the removal of the second garnet. The position of the garnet is indicated on Fig. 8. When it was removed the cell was again found to be empty except for a small amount of a dark brown deposit covering parts of the cloison walls and base as well as the underside of the foil. This is illustrated in Fig. 9 which shows the empty cell and the underside of the foil. X-ray diffraction analysis again revealed only quartz and gold.

In an attempt to identify any other component of the dark brown deposit a sample was examined by infra-red spectrometry. The only identifiable peak suggested that some silicate type of material may be present. No wax or resin was identified.

Once again this cloison did not form a sealed cavity but was connected with the other cells by incompletely soldered joints at the corners.

### 6. *Removal of a garnet from strap-end (SH. 18)*

The last garnet to be investigated was on strap end (SH. 18) and its position is indicated on Fig. 8. This cell contained more debris than the two previous ones and among the dark brown deposits some large grains of sand were visible. The debris in the bottom of the cell is illustrated in Fig. 10. X-ray diffraction analysis of a sample of this deposit indicated the presence of quartz and gold and some clay-like material.

### 7. *Analysis of samples from empty cells on buckle (SH. 11)*

Traces of deposit are to be seen in some of the empty cells on buckle (SH. 11). These were examined by Dr Arrhenius in May 1977 and at her suggestion x-ray diffraction analysis was carried out on the two marked 'C' and 'D' on Fig. 5. The sample from 'C' was green and soft and was shown to contain calcite. No beeswax was detected and although an organic binder must be mixed in with the calcite its nature was not established. This backing material is very similar, if not identical, to that behind the restored garnet on belt plaque (SH. 6) (see section 4 above). Sample 'D' was dark brown and only quartz and gold were detected.

### 8. *Discussion on "backing pastes"*

Of the six samples examined, four contained quartz and gold as the main crystalline phases which were identified. Two of these four samples contained no other phases, but the other two possibly some clay-like material. The fifth and sixth samples contained calcite and presumably some type of organic binder, although this was not positively identified.

It seems highly unlikely that the quartz (and ? clay) represent the remains of a backing paste. If this were so the cells would be expected to have remained full as neither substance is soluble in percolating rain water, and it is therefore postulated that these materials have migrated into the cells from the surrounding soil.

The calcite, however, cannot be regarded as natural contamination from the mound at Sutton Hoo because of the acid nature of the soil. The backing paste containing calcite is, in both cases, soft and green in appearance but on the belt plaque (SH. 6) it was found underneath a 'stone' which we know to be a modern restoration. However, when an *original* garnet was removed from the same piece of jewellery (section 3 above) no such backing paste was found beneath it.

Unfortunately the laboratory records which mention the replacement of the 'stone' in (SH. 6) do not mention the presence (or absence) of a backing paste and so do not provide any dating evidence for this paste. However it is clear that the soft green calcite paste cannot be an original feature of the belt plaque (because of its absence in cell A), but it is not clear whether it represents a repair of Anglo-Saxon date or whether it is associated with the modern replacement of the missing garnet. Further evidence on this point is discussed below, but since it is contradictory, no firm decision is possible in the light of present knowledge.

As sample 'C' from buckle (SH. 11) came from an open cell, rather than from behind a garnet in its original position, no firm conclusions about the date of the calcite backing paste can be based on this sample.

*Evidence for a Saxon date for the soft green paste containing calcite*

(a) Calcite has been found as a packing material in several positions on the shield boss, and there is no reason to think that these are not original.
(b) One of the garnets on the eyebrow of the bird plaque from the front of the shield, for which there are no records of any restoration, was removed and beneath it was a soft green backing paste which contained calcite, but not beeswax.

*Evidence that the soft green paste containing calcite may be modern restoration*

A soft green backing paste containing calcite is present beneath the garnets on the central disc of the shield boss. This garnet setting was completely rebuilt in the post-war period and it is now impossible to know whith certainty whether the backing paste is original, but this would seem unlikely. This paste and the soft green pastes in the jewellery appear to be identical. (In the appendix on the scientific examination of the Shield in Sutton Hoo: Vol. II, this backing paste was reported as possibly containing a little wax. A re-examination of the diffraction film suggests that the wax identification is rather optimistic and should be disregarded.)

*Other backing pastes*

Soft green paste has been found behind the garnets on the boars head escutcheons on the large hanging bowl and x-ray diffraction analysis has shown that the backing pastes behind the two garnets on boar's head escutcheon No. 1 are apparently different, one containing beeswax (without calcite) and the other containing calcite (possibly with a very small amount of wax). Both contained a trace of $\alpha$-quartz which must be regarded as contamination.

The eye socket without the garnet on boar's head escutcheon No. 2 was found to contain calcium sulphate hemi-hydrate. The presence of this is difficult to explain but the same material was also detected behind one of the garnets in the eyebrow of the helmet. It must be assumed that this is the result of restoration in the late 1940's as the hemi-hydrate would not be expected to survive wet burial conditions for 1500 years without being converted to gypsum ($CaSO_4$. $2H_2O$).

Records indicate that when the two boar's head escutcheons, which were excavated in 1939, were examined in 1946 the 4 eye sockets (two on each escutcheon) contained between them 3 garnets and 4 backing foils, but that only 2 backing pastes were present. The recent examination has identified 3 (different) backing pastes in 3 of the eyes and the fourth was not investigated. Unfortunately there is no way of knowing, from the 1946 records, which are the two backing pastes present then, and it must be presumed that at least one of the three, which have been investigated recently, is a modern replacement.

## 9. *Conclusions*

The situation regarding the backing pastes behind the garnets in the finds from Sutton Hoo has still not been fully clarified. Backing materials of various types have been found *in situ* behind garnets on the shield, helmet and hanging bowl, and behind a restored garnet on belt plaque (SH. 6) and in an open cell on buckle (SH. 11). In some cases these are positions where there is evidence for restoration having been carried out 30 years ago, although it is not clear whether this extended to the backing pastes.

However, since no backing pastes were found behind the three perfect garnets which were purposely removed from the jewellery it is concluded that backing pastes were not an original feature of the Sutton Hoo jewellery.

## 10. *The garnet*

The opportunity was taken of measuring some physical constants and of taking samples for x-ray diffraction analysis from the unpolished edges of those garnets which had been removed for an examination of the backing paste.

Garnet is extremely widespread in nature and there is little hope that analysis will lead to an identification of the source of the mineral deposit for two reasons:

First, the abundant possible geographic locations of garnet have not all been examined and the deposits characterized.

Second, even if all the different geographic garnet deposits were examined, the geological conditions under which garnet is formed would be expected to produce a wide variation in composition within any one source.

In the light of these comments the lattice spacings of eight garnets were measured from the x-ray diffraction patterns and the refractive indices (RI) of four of the stones were measured with a Rayner refractometer. It proved impossible to measure the RI's of the other stones on account of their very small size. The results are contained in the table.

M. S. Tite W. A. Oddy M. Bimson

# List of Examined Finds with Bibiographical References

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Ba 1/Er | Hatra | Hellström 1977 here fig. 8 | Go |
| BM 1/Bu | Reastan, Syria, R. Browns' coll. 1926, 10–14, 1–11 | not publ. here fig. 105 | Br |
| BM 2/L | Turin, Italy Castellani coll. 72/6, Nr. 718. | not publ. here fig. 208 | Go |
| BM 3/D | Bone, Alger | de Baye 1888 | Si |
| BM 4/Ed | Italy?, Castellani coll. | cf. Rosenberg, 1922, fig. 2 | Go |
| BM 5/Bu | Milton, Suffolk, No. 1856, 6–27, 146. | Åberg 1926, Tab. V. No. 83 | Go and Si |
| BM 6/Sb | Langobardian Gr. Italy No. 87/1–8/6 | Fuchs-Werner 1950, pl. 36, B70 | Si |
| BM 7/Bu | NP Continent(?) | cf. Werner, 1958, 57 | Go and Br |
| BM 8/R | prob. Champagne, France, Movel coll. No. 3573. | not publ. | Si |
| BM 9/D | NP Lord Londesborough's coll. | Rupp 1937, pl. XXVI:I, | Go |
| BM 10/Bd | prob. Castellani coll. No. 766. | not publ. | Go and Br |
| BM 11/D | Dover, Priory hill? Gr | Avent 1975, No. 174 | Go and Si |
| BM 12/D | Faversham | Avent 1975, No. 180 | Go |
| BM 13/Bu | Taplow | Kendrick 1933, p. 435, pl. 5. | Go |
| BM 14/D | Belluno North Italy | Fuchs-Werner 1950, C3 | Go |
| BM 15/D | Domagnano, Italy | cf. Bierbrauer 1975, No.8 here fig. 187 | Go |
| BM 16/Bd | Amiens? 91,10–19,20 | not publ. here fig. 209 | Go |
| BM 17/D | NP (possibly Rheinland), Zschille coll. | Smith 1923, plate XV:3 | Go |
| BM 18/p | Stupa, Ahin Posh, Jalalabad, Afghanistan | W. Zwalf in Tait 1976, no. 378 here fig. 44 | Go |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Bonn 1/D | NP coll. Lückger No. 35, 755. | not publ. | Si |
| Bonn 2/D | Rübenach, Gr 152/2 | Neuffer-Müller and Ament 1973 pl. 9 | Si |
| Bonn 3/R | Rodenkirchen No. 44, 168. | Niessen 1911, 4642. | Go |
| Bonn 4/D | Gönnersdorf No. 35,38. | Stoll 1939, No. 2. | Si |
| Bonn 5/D | Rübenach, Gr 163. | Neuffer-Müller and Ament 1973 pl. 10. | Si |
| Bonn 6/R | Dattenberg, No. 44,13 | not publ. | Si |
| Bonn 7/R | Niederbresig, No. 3539 | not publ. | Si |
| Bonn 8/R | Engers, No. 36,18 | Stoll 1939, II. No. 28. | Si |
| Bonn 9/D | Kärlich No. 2545. | Stoll 1939, II, No. 46. | Si with incrustation |
| Bonn 10/D | Engers, No. 36,19 | Stoll 1939, II, No. 28. | Si |
| Bonn 11/D | Andernach, 38,627. | Stoll 1939, II, No. 109. | Si with incrustation |
| Bonn 12/D | Andernach, 38,326. | Stoll 1939, II, No. 109. | Si |
| Bonn 13/Bu | NP;No. 15,89. | Nees 1935, No II:3 | Si and Br |
| Bonn 14/Bu | Andernach, Kirchberg, No. 14.92 | Nees 1935, No. II:1 | Si and Br |
| Bonn 15/Bu | Andernach, No. 35.47 | Stoll 1939, II, No. 136. | Si and Br |
| Bonn 16/Eb | Bornheim, Gr 13. | Stoll 1939, I, No. 18. | Si |
| Bonn 17/D | Andernach, No. 15.90 | Stoll 1939, II, No. 136. | Si |
| Bonn 18/D | Niederbresig, No 35,46. | Niessen 1911, No. 4631 | Br |
| Bonn 19/D | coll. Wied, No. 32.290. | not publ. | Si |
| Bonn 20/D | NP; No. 3593 | not publ. | Si |
| Bonn 21/D | NP, coll. Lückger-Sürth, No. 26.60 | not publ. | Si |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Bonn 22/D | coll. Lückger-Sürth, No. 35.95 | not publ. | Br |
| Bonn 23/D | Neuwieder, Becken, No. 44.11. | not publ. | Si |
| Bonn 24/R | Niederbresig. No. 35.40 | not publ. | Si |
| Bonn 25/R | Sterkrade, No. 38.427 | not publ. | Si |
| Bonn 26/D | NP; No. 14.034. | not publ. | Si |
| Bonn 27/D | Niederbresig, No. 35,42. | not publ. | Si |
| Bonn 29/D | Andernach, No. 24.17. | Stoll 1939, II, No. 108. | Br |
| Bonn 30/D | Niederbresig, No. 35.44 | not publ. | Go and Br |
| Bonn 31/D | Andernach, Gr 7. | Stoll 1939, II, No. 106. | Si |
| Bonn 32/D | Engers, No. 36.20 | not publ. | Si |
| Bonn 33/D | Hürth-Kalscheuren | Rupp 1937, 14. | Go |
| Bonn 34/Eb | Kärlich, No. 26.63 | not publ. | Go |
| Bonn 35/D | Orsoy, Gr 5. | Böhner 1949, 177. | Si |
| Bonn 36/D | Andernach, No. 39.1009. | Stoll 1939, II, No. 106. | Si |
| Bonn 37/D | N.P. No. 18.37 | not publ. | Br with incrustation |
| Bonn 38/D | Rübenach, Gr 175. | Neuffer-Müller and Ament 1973, pl. 11 | Si |
| Bonn 39/D | Rödingen, Gr 12. | Bonner Jahrbücher 1951, 206. | Si |
| Bonn 40/Bu | Rübenach, Gr 458. | Neuffer-Müller, and Ament 1973, pl. 32 | Si |
| Bonn 41/D | Rübenach, Gr 435. | Neuffer-Müller and Ament 1973, pl.30 | Si |
| Bonn 42/D | Niederbresig | Niessen, 1911, No. 4630. | Si |
| Bonn 43/Eb | Gondorf, No. 48.45. | not publ. | Si |
| Bonn 44/D | Siersdorf, Gr 2. | Bonner Jahrbücher 1939, 40 and pl. 58. | Si |
| Bonn 45/R | Nettersheim, Gr 36, cf. Bonn 46. | not publ. | Si |
| Bonn 46/D | Nettersheim, Gr 36, cf. Bonn 45 | not publ. | Si |
| Bonn 47/D | Kottenheim, Gr 36. | Stoll 1939, II, No. 91. | Si |
| Bonn 48/D | Kottenheim, Gr 36. | Stoll 1939, II, No. 91. | Si |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Bonn 49/R | Gondorf, No. 48.49. | not publ. | Si |
| Bonn 50/D | Kärlich, No. 44.12. | Stoll 1939, II, No. 46. | Br |
| Brno 1/Bu | Blûcina, Moravia, Gr | Werner 1956,83 here fig. 131 | Go |
| Brno 2/Sa | Blûcina, Moravia, Gr | Werner 1956 pl 22,6, here fig. 131 | Go |
| Brno 3/Se | Blûcina, Moravia, Gr | Werner 1956 pl. 22,5, here fig. 131 | Go |
| Brno 4/Se | Blûcina, Moravia, Gr | Werner, 1956, 83 f, here fig. 131 (2 of the same kind) | Go |
| Br 1/Sb | Lede, Flanders | De Loe, 4 1939, 126. | Si |
| Br 2/D | Marilles. | Arrhenius 1970, here fig. 160 | Go |
| Br 3/B | Maroeuil, Pas de Calais, France | De Loe, 4, 1939, 163 here fig. 140 | Br |
| Bud1/Bu | NP | Alföldi 1932 pl. XXXIV:8 here fig. 148 | Go |
| Bud 2/R | Szentendre Gr 54 | Bona 1976 pl. 50 | Si |
| Bud 3/R | Szentendre Gr 2 | Bona 1976, pl. 61 | Si |
| Bud 4/R | Szentendre GR 5 | Bona 1974 pl. VII | Si |
| Bud 5/D | Szentendre Gr 29 | Bona 1974, pl. 7 and Bona 1971,48 fig. 14 | Si |
| Bud 6/R | Szentendre Gr 14 | Bona 1971 48 | Si |
| Bud 7/R | Tatabánya Gr 24 | Bona 1976, pl. 61 | Si |
| Bud 8/R | Hegykö Gr 18 | Bona 1971a and here fig. 149 | Si |
| Bud 9/B | NP | Hampel 1905, pl. 154:2 | Si |
| Bud 10/B | NP | Bona 1976 pl. 1 | Si |
| Bud 11/Bu | NP | Bona 1976 pl. 139–40 | Si |
| Bud 12/M | NP | Fettich 1953 pl. XXXIX | Br |
| Bud 13/B | Szarvas 94/1903 | Bona 1976 pl. 277 | Br |
| Bud 14/Ea | Tiszalök | Bierbrauer 1975 list 5, no. 53 | Go |
| Bud 15/B | Szilágy Somlyó | Fettich 1932 pl. XX | Go and Sz |
| Bud 16/B | Szilágy Somlyó | Fettich 1932 pl. XXII | Go and Si |
| Bud 17 B | Szilágy Somlyó | Fettich 1932 pl. XVIII | Go and Si |
| Bud 18/Bo | Szilágy Somlyó | Fettich 1932 pl. XXXX | Go |
| Bud 19/D | Szilágy Somlyó | Fettich 1932 pl. V | Go |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Bud 20/B | Szilágy Somlyó | Fettich 1932 pl. XXIII | Go and Si |
| Bud 21/B | Szilágy Somlyó | Fettich 1932 pl. XII | Go and Si |
| Bud 22/B | Szilágy Somlyó | Fettich 1932 pl. XIV | Go and Si |
| Bud 23/B | Szilágy Somlyó | Fettich 1932 pl. II | Go |
| Bud 24/B | Szilágy Somlyó | Fettich 1932 pl. XI | Go and Si |
| Bud 25/B | Szilágy Somlyó | Fettich 1932 pl. XXV | Go and Si |
| Bud 26/B | Szilágy Somlyó | Fettich 1932 pl. VII | Go |
| Bud 28/Md | Szorna | Alföldi 1932 pl. VIII here figs. 19,20 | Go |
| Bud 30/Bu | N P | Alföldi 1932,61 pl. XXXIV here fig. 148 | Go |
| Bud 31/D | Szentendre Gr 48 | Not publ. see however Bona 1971 | Si |
| Bud 32/Ea | Szekszard | Bierbrauer 1975, 247, list 5, no. 64 | Go |
| Bud 33/Ri | Beregszász | Csallány 1961, here fig. 199 | Go |
| Bud 34/Eb | Beregszász | Csallány 1961, here fig. 199 and 127 | Go |
| Bud 35/B | Rábapordány | Alföldi 1932,72 pl. X | Go and Br(?) |
| Bud 36/Sb | Tamasi Gr 18 | Not publ. see however Bona 1976 pl. 47 | Br |
| Bud 37/Sw | Batazek | Bona 1982, pl. 18 | Go |
| Bud 38/Sa | Németkér | Kovrig 1959,211 here fig. 146 | Go |
| Buka 1/Bo | Petroassa (Pietroasa) | Odobesco 1900, here figs. 30 (detail) and 35 | Go |
| Buka 2/Eb | Petroassa (Pietroasa) | Odobesco 1900. Brown 1972, pl. XXI:a | Go |
| Buka 3/Eb | Petroassa (Pietroasa) | Odobesco 1900 here fig. 34 | Go |
| Buka 4/B | Petroassa (Pietroasa) | Odobesco 1900. Brown 1972, pl. XXII:b | Go |
| Buka 5/L | Petroassa (Pietroasa) | Odobesco 1900, here fig. 91 | Go |
| Civi 1/Sb | Cividale, No. 733. | Fuchs-Werner 1950, pl. 35, B49 | Go and Si |
| Civi 2/Sb | Cividale, No. 735 | Fuchs-Werner 1950, pl. 34, B 43. | Si |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Cluj 1/M | Apahida II | Horedt 1972, pl. 51–52, here figs 129 and 188 | Go, bridle mounts |
| Cluj 2/M | Apahida II | Horedt 1972, pl. 49–50, here fig. 133 | Go, saddle-mounts |
| Cluj 3/M | Apahida II | Horedt 1972, pl 43. 1–3 | Go, small M:s from a horse-bit |
| Cluj 4/M | Apahida II | Horedt 1972, pl. 53–56, here fig. 124 | Go, bridle mounts |
| Cluj 5/M | Apahida II | Horedt 1972 pl. 48:3–5, here fig. 123 | Go, bridle mounts |
| Cluj 6/M | Apahida II | Horedt 1972 pl. 48:6–9 | Go, rectangular bridle-mounts |
| Cluj 7/M | Apahida II | Horedt 1972 pl. 47:6–9 | Go, small ornamental mounts |
| Cluj 8/M | Apahida II | Horedt 1972 pl. 47:16–17 | Go, ornamental mounts |
| Cluj 9/M | Apahida II | Horedt 1972 pl. 47:12–15 | Go, ornamental mounts |
| Cluj 10/M | Apahida II | Horedt 1972, pl. 47:1–5 | Go, small ornamental mounts |
| Cluj 11/M | Aahida II | Horedt 1972, pl. 47 10–11 | Go, ornamental mounts |
| Cluj 12/M | Apahida II | Horedt 1972, pl. 46:1 | Go, bridle mounts |
| Cluj 13/M | Apahida II | Horedt 1972, pl. 46:2 | Go, bridle mounts |
| Cluj 14/M | Apahida II | Horedt 1972, pl 43:4–5 | Go, mounts to a horse-bit |
| Cluj 15/P | Apahida II | Horedt 1972, pl. 47: 20–26 | Go, beads |
| Cluj 16/Pm | Apahida II | Horedt 1972, pl. 34:3 | Go, purse mount |
| Cluj 17/Bu | Apahida II | Horedt 1972, pl. 39:3 | Go, heavy buckle |
| Cluj 18/Bu | Apahida II | Horedt 1972, pl. 40:8 | Go, buckle frame |
| Cluj 19/Bu | Apahida II | Horedt 1972, pl. 39:1–2 | Go, small buckles |
| Cluj 20/Pm | Apahida II | Horedt 1972, pl. 33:1–2 and 32:1 here fig. 186 | Go, buckles and mounts to the large purse |
| Cluj 21/Sw | Apahida II | Horedt 1972 pl. 34:1, here fig. 122 | Go, suspension loop |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Cluj 22/Sa | Apahida II | Horedt 1972 pl. 34:2 here fig. 125 | Go, seax pommel (?) |
| Cluj 23/Pm | Apahida II | Horedt 1972, pl. 33:5–5 | Go, buckles and mounts to a small purse |
| Cluj 24/Bu | Apahida I | Riegl 1927, pl. I:7 | Go, heavy buckle |
| Cluj 25/M | Apahida I | Riegl. 1927, pl. I:2 | Go, pendant mount |
| Cluj 26/Bu | Cluj-Someseni | Horedt 1970, pl. 22:3 | Go, buckle with rectangular plate |
| Cluj 27/Bu | Cluj-Someseni | Horedt 1970, pl. 22:4 | Go, buckle with semi-oval plate |
| Cluj 28/P | Cluj-Someseni | Horedt 1970, pl. 23:1–24 | Go, beads and pendants |
| Cluj 29/Ri | Cluj-Someseni | Horedt 1970, pl. 24:1–3 | Go |
| Cop 1/B | Stjernede, Gundslev, Falster | Holmqvist 1939,286 | Si |
| Cop 2/B | Årslev, Fyn. | Mackeprang, 1940, here fig. 24 | Go |
| Cop 3/D | Reinstrup, Seeland. | Ørsnes 1966, 297. | Go |
| Cop 4/B-bt | Lousgård, Gr 35, Bornholm | Ørsnes 1966, fig. 84. | Br, E4 |
| Cop 5/B-bt | Skodborg, Haderslev A. | Mackeprang, 1952, pl. 23:8 | Go and Si |
| Cop 6/B-bt | Elsehoved, Oure, Svendborg A. | Mackeprang, 1952, pl. 23:17 | Go and Si |
| Cop 7/B-bt | Morild, Hjörring A. | Ørsnes 1966, fig. 82 | Br, E6 |
| Cop 8/B-bt | Bäkkegård, Gr 90, Bornholm. | Ørsnes 1966, fig. 66 | Ba,E5 |
| Cop 9/B-bt | Kobbeå, Gr 2, Bornholm | Ørsnes 1966, fig. 60 | Br, E1 |
| Cop 10/Bd | Varde, Jutland | Holmqvist 1939 pl. LXV:3 | Go |
| Cop 11/B-bt | Örby mark, Seeland | Ørsnes 1966, fig. 63 | Br, E2 |
| Cop 12/P | Hesselager, Fyn. | Voss 1951 | Go |
| Dill 1/D | Schretzheim Gr. 583 | Koch 1977 | Si |
| Dill 2/D | Schretzheim Gr 586 | Koch 1977 | Si |
| Dill 3/R | Schretzheim Gr 26 | Koch 1977, here fig. 239 | Go |
| Dill 4/Sf | Schretzheim Gr 26 | Koch 1977, here fig. 238 | Go |
| Dill 5/D | Schretzheim Gr 23 | Koch 1977 | Go |
| Dill 6/D | Schretzheim Gr 464 | Koch 1977, here fig. 235 | Si |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Dill 7/D | Schretzheim Gr 509 | Koch 1977, here fig. 234 | Si |
| Dill 8/R | Schretzheim Gr 250 | Koch 1977, here fig. 237 | Si |
| Dill 9/R | Schretzheim Gr 233 | Koch 1977, here fig. 233 | Si |
| Dill 10/D | Schretzheim Gr 350 | Koch 1977, here fig. 241 | Si |
| Dill 11/R | Schretzheim Gr 300 | Koch 1977, here fig. 240 | Si |
| Dill 12/R | Schretzheim Gr 20 | Koch 1977, here fig. 236 | Si |
| Eri 1/Se | Kerch, Crimea | Fettich 1951, pl. XLVI:5, here fig. 217a | Go |
| Eri 2/M | Kerch, Crimea | Fettich 1951, pl. XLVI:1 | Go |
| Eri 3/Se | Kerch, Crimea | Fettich 1951, pl. XLVI:2–3, here fig. 217b | Go |
| Eri 4/M | Kerch, Crimea | Fettich 1951, pl. XLVI:6 | Go |
| Eri 5/M | Kerch, Crimea | Fettich 1951, pl. XLVI:7 | Go |
| Eri 6/Se | Kerch, Crimea | Fettich 1951, pl. XLVI:4 | Go |
| Eri 7/Sa | Borovoje, Kasakstan | Werner 1956, pl. 14, here fig. 26 | Go |
| Eri 8/Sw | Kerch 1904, Crimea | Behmer 1939, pl. 11 | Go |
| Eri 9/M | Kerch 1904, Crimea | Zaseckaja 1975, fig. 6 | Go |
| Eri 10/Eb | Concesti, Moldau | Werner 1956, pl. 29:6 | Go |
| Eri 11/Md | Verche-Jablochno | Werner 1956 pl. 34 | Go |
| Fe 1/Bu | Diszesat Tácról | Bona 1971b, 290 | Go and Br |
| Fe 2/D | Racalons Racálmás | Bona 1971b, 278 | Si |
| Karl 1/Sw | Altlussheim | Garcha 1936, here fig. 107 | Go |
| Karl 2/Sb | Klepsau Gr 7 | Koch 1980, pl. 12:2–3, here fig. 57–58 | Go |
| Karl 3/D | Klepsau Gr 50 | Koch 1980, pl. 11:6 | Go |
| Kre 1/Sw | Krefeld-Gellep Gr 1782 | Pirling 1974, pl. 127 here fig. 177 | Go and Si |
| Kre 2/M | Krefeld-Gellep Gr 1782 | Pirling 1974 pl. 131, here fig. 190 | Go and Si, bridle mounts |
| Kre 3/Pm | Krefeld-Gellep. Gr 1782 | Pirling 1974, pl. 131 | Si |
| Kre 4/M | Krefeld-Gellep, Gr 1782 | Pirling 1974, pl. 130 | Go, saddle mounts |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Kre 5/R | Krefeld-Gellep, II, Gr 2597. | not publ. cf. Pirling 1966, 32. | Si |
| Kre 6/R | Krefeld-Stratum, Gr. 80. | cf. Steeger 1937. | Si |
| Kre 7/R | Krefeld-Stratum, Gr 122 | Steeger 1937. | Si |
| Kre 8/D | Krefeld-Gellep II, Gr 1818. | not publ. cf. Pirling 1966, 32. | Si |
| Kre 9/D | Krefeld-Gellep II, Gr 189. | cf. Pirling, 1966,32 | Si |
| Köln 1/Bu | NP France, coll. Diergardt, No. 406. | Götze 1907, pl. XV:2 | Bu |
| Köln 2/Eb | NP, coll. Diergardt, No. 1016. | Werner 1961, No. 204. | Br |
| Köln 3/Bu | Leuc, Dep. Aude. | Götze 1907, pl. XIV. | Br |
| Köln 4/D | Cathedral Gr | Doppelfeld, 1960a | Go |
| Köln 5/Se | Cathedral Gr | Doppelfeld, 1960a, Werner 1963, here fig. 139 | Go and Si |
| Köln 6/P | Cathedral Gr | Doppelfeld 1960a. | Go |
| Köln 7/P | Cathedral Gr | Doppelfeld 1960a, here fig. 201 | Go |
| Köln 8/B | Cathedral Gr | Doppelfeld 1960a, here fig. 123 | Go and Si |
| Köln 9/Pm | Müngersdorf, Gr 70. | Fremersdorf 1955, pl. 92:3. | Si(?) |
| Köln 10/D | Müngersdorf Gr 91 b. | Fremersdorf 1955, pl. 90:9 | Si |
| Köln 11/D | Müngersdorf Gr 91 b. | Fremersdorf 1955, pl. 90:10. | Si |
| Köln 12/D | Müngersdorf Gr 47. | Fremersdorf 1955, pl. 90:15. | Si |
| Köln 13/D | Müngersdorf Gr 84. | Fremersdorf 1955, pl. 90:12. | Si |
| Köln 14/D | Müngersdorf Gr 90. | Fremersdorf 1955, pl. 93:4. | Si |
| Köln 15/D | Müngersdorf Gr 131. | Fremersdorf 1955, pl. 90:11. | Si |
| Köln 16/R | Müngersdorf Gr 59. | Fremersdorf 1955, pl. 90:16. | Si |
| Köln 17/D | Müngersdorf Gr 73. | Fremersdorf 1955, pl. 90:22. | Si |
| Köln 18/D | Müngersdorf Gr 89. | Fremersdorf 1955, pl. 90:10. | Si |
| Köln 19/D | Müngersdorf Gr 95. | Fremersdorf Gr 1955, pl. 90:6. | Si |
| Köln 20/R | Müngersdorf Gr 95. | Fremersdorf 1955, pl. 90:17. | Si |
| Köln 21/D | Junkersdorf Gr. 78. | La Baume 1967, pl. 40:20. | Si |
| Köln 22/R. | Junkersdorf Gr 41. | La Baume 1967, pl. 40:18. | Si |
| Köln 23/D | Junkersdorf Gr 37. | La Baume 1967, pl. 40:16. | Si and Br |
| Köln 24/D | Junkersdorf Gr 36. | La Baume 1967, pl. 40:12. | Si and Br with incrustation |
| Köln 25/D | Junkersdorf Gr 57. | La Baume 1967, pl. 40:13. | Si |
| Köln 26/D | Junkersdorf Gr 336. | La Baume 1967, pl. 40:14. | Si |
| Köln 27/D | Junkersdorf Gr 1. | La Baume 1970, plate 40:20. | Si |
| Köln 28/Se | South Russia, coll. Diergardt, Nr. 331 c. | Fremersdorf, 1954 Arrhenius 1971, fig. 3 | Go |
| Köln 29/M | South Russia, coll. Diergardt. | cf. Fremersdorf, 1954. | Go, to a sword(?) |
| Köln 30/M | South Russia coll. Diergardt. | cf. Fremersdorf, 1954. | Go, bridle mount(?) |
| Köln 31/Bu | South Russia, coll. Diergardt. | cf. Fremersdorf, 1954, here fig. 41. | Go |
| Köln 32/M | South Russia, coll. Diergardt. | cf. Fremersdorf, 1954, here fig. 42. | Go |
| Köln 33/Bu | South Russia, coll. Diergardt. | Fremersdorf, 1954, pl. 7. | Go |
| Köln 34/M | South Russia, coll. Diergardt | Fremersdorf 1954, pl. 2. | Go, a belt mount (?) |
| Köln 35/Sa | South Russia, coll. Diergardt. | Fremersdorf 1954, pl. 4. | Go, loop to a scabbard |
| Köln 36/P | Hellmitzheim, Scheinfeld, Gr 17, coll. Diergardt. | Dannheimer 1962. | Go |
| Köln 37/P | Hellmitzheim, Scheinfeld, Gr 17, coll. Diergardt. | Dannheimer 1962. | Go |
| Köln 38/Bu | NP, coll. Diergardt. | cf. Fremersdorf 1954. | Go |
| Köln 39/Bu | NP, coll. Diergardt. | cf. Fremersdorf 1954. | Go and Br |
| Köln 40/Bu | Monceau le Neuf, dep. Aisne, France. | Götze 1907, pl. XI:1. | Si |
| Köln 41/Bu | Severinstrasse | Werner 1958, fig. 96 here fig. 108 | Go |
| Liver 1/M | Gilton, Kent. | Fausset 1856, XXXIX, here fig. 75 | Go and Si, rectangular |
| Liver 2/D | Gilton, Kent Gr 15 | Avent 1975, No. 175, here fig. 56 | Go and Si |
| Liver 3/D | Kingston, Kent Gr 18. | Avent 1975, No 120 | Si |
| Leu 1/Bu | Wynaldum | Bruce-Mitford, 1954, here fig. 195 | Go |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Maid 1/D | Bifrons Gr 42 | Åberg 1926, 82 ff | Si with G and green enamel. |
| Maid 2/D | Bifrons Gr 42 | Åberg 1926, 82 ff. | Si |
| Maid 3/B | Bifrons Gr 42 | Åberg 1926, 82 ff | Si |
| Maid 4/Ri | Bifrons Gr 42 | Åberg 1926, 82 ff | Si |
| Maid 5/P | Bifrons Gr 42 | Åberg 1926.82 | Si, spoon with G-cloisonné |
| Maid 6/B | Lymminge Gr. 44 | Leeds 1952 17 and pl. 14:A | Si and Go-settings |
| Maid 7/P | Milton | Chadwick-Hawkes 1963 | Go |
| Maid 8/D | Aylesford | Avent 1975, No 173 | Go |
| Mainz 1/D | Niederselters No. 5729, L.M. | Ament, 1967. | Si |
| Mainz 2/Sw | Planig, Rheinhessen L.M. | Kessler 1940 | Go and Si |
| Mainz 3/Pm | Planig, L.M | Kessler 1940 | Si |
| Mainz 4/M | Rommersheim, Rheinhessen, L.M. | Thiry 1939, pl. 6:52 | Go |
| Mainz 5/R | Hahnheim, Nr. 4376, L.M. | not publ. | Si |
| Mainz 6/R | Mörstadt, O 15370, R.G.M. | Behrens 1947, fig. 99. | Si |
| Mainz 7/Sb | Dalsheim O 15384, R.G.M. | Behrens 1947, fig. 99. | Si |
| Mainz 8/D | Abenheim, O 15380, R.G.M. | Behrens 1947, fig. 98 | Si |
| Mainz 9/R | Dalsheim, O 15368, R.G.M. | Behrens, 1947, fig. 99 | Si |
| Mainz 10/D | Dalsheim, O 15371, R.G.M. | Behrens, 1947, fig. 99. | Si |
| Mainz 11/R | NP, O 17352, R.G.M. | not publ. | Si |
| Mainz 12/D | NP, Rheinland O 24814, R.G.M. | Behrens, 1947, fig. 80. | Si |
| Mainz 13/D | Schwarzrheindorf O 2929, R.G.M. | Behrens 1947, fig. 75:6 | Si |
| Mainz 14/Sb | NP, O 24815, R.G.M. | Not publ. | Si |
| Mainz 15/D | Abenheim O. 15382, R.G.M. | Behrens 1947, fig. 98 | Si |
| Mainz 16/R | Dalsheim O 15638, R.G.M. | Behrens 1947, fig. 99 | Si |
| Mainz 17/D | Hahnheim O 4347, R.G.M. | Not publ. | Si |
| Mainz 18/R | NP, O 17351, R.G.M. | Not. publ. | |
| Mainz 19/Bu | Schwarzrheindorf, O 11904, R.G.M. | Behrens 1947, fig. 75:11 | Si |
| Monza 1 | Monza | Lipinsky 1960. | Go |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Münch 1/B | Wittislingen. | Werner 1950a, pl 1. | Si and Go |
| Münch 2/Bu | München-Aubing | Werner 1958, No. 12. | Go and Br |
| Münster 1/D | Soest, Westphalen, Gr 106. | Werner 1935, pl. 17. | Go |
| Münster 2/P | Soest, Westphalen, Gr 106. | Werner 1935, pl 17. | Go |
| Münster 3/D | Soest, Westphalen, Gr 105 | Rupp 1937, XXV:15. | Br |
| Münster 4/Bd | Soest, Westphalen, Gr 18. | Thieme 1978 No. 169 | Go |
| Münster 5/Bt | Enger Cathedral | Vierck 1980 | Go |
| Nürn 1/Eb | Cesena, Domagnano | Bierbrauer 1975, XIX:1 | Go |
| Nürn 2/L | Cesena, Domagnano | Bierbrauer 1975 pl. XX:1–9. | Go |
| Nürn 3/Ib | Cesena, Domagnano | Bierbrauer 1975 pl. XVIII:2. | Go |
| Nürn 4/Ea | Cesena, Domagnano | Bierbrauer 1975 pl. XIX | Go |
| Nürn 5/D | Herbrechtingen | Veeck 1930. | Si |
| O 1/Bu | Åker, Vang | Gjessing 1934, 12. | Si |
| O 2/M | Åker, Vang | Gjessing 1934, 12. | Br, to the belt. |
| O 3/P | Hon | Grieg 1929. | Go |
| Paris 1/Sw | Childeric Gr (B.N.) | Böhner 1981, here fig. 106. | Go, a, b, e, d, single parts cf. fig. 106. |
| Paris 2/Sa | Childeric Gr (B.N.) | Böhner 1981, here fig. 11 and 114. | Go, a, b, c, d, single parts cf. fig. 116. |
| Paris 3/M | Childeric Gr (B. N.) | Böhner 1981, pl. 31:5c | Go, semiround. |
| Paris 4/M | Childeric Gr (B.N.) | Böhner, 1981, pl. 32:f | Go, to the sword scabbard? |
| Paris 5/Bu | Childeric Gr (B.N.) | Böhner 1981, pl. 31:4 | Go, only the tongue |
| Paris 6/M | Childeric Gr (B.N.) | Böhner 1981, pl. 31:5a | Go, probably mount to the horse bridles |
| Paris 7/M | Childeric Gr (B.N.) | Böhner 1981, pl. 31:5b. | Go, probably mount to the horse bridles. |
| Paris 8/M | Childeric Gr. (B.N.) | Böhner 1981, pl. 31:5d | Go, round |
| Paris 9/B | Aurès (M.H.) | Camps-Fabrier 1970, 153, here fig. 12 | Br and Go with incrustations |
| Paris 10/Bo | Chosroeplate (B.N.) | Akerman 1938a pl. 771, here fig. 30. | Go |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Paris 11/Bo | Gourdon (B.N.) | Lafaurie 1958, here fig. 65. | Go |
| Paris 12/Bo | Tressan, Herault (Cl.) | Arbman 1948, here fig. 40 | Go and Br with incrustation |
| Paris 13/M | St Denis (B.N.) | Vierck 1974, here fig. 74 | Go |
| Paris 14/D | St Denis (Cl.) | France-Lanord 1962 | Go |
| Paris 15/D | NP (B.N.) | Rupp 1937 pl. I,1 | Si |
| Paris 16/Sw | Lavoye gr 319 (M.G.) | Joffroy 1974 | Go |
| Paris 17/Bu | Lavoye gr 319 (M.G.) | Joffroy 1974 | Go |
| Paris 18/Pm | Lavoye gr 319 (M.G.) | Joffroy 1974 | Si |
| Parma 1/D | Parma | Monaco 1955 | Go |
| Rom 1/D | Nocera Umbra, Gr 150 (M.A.) | Fuchs-Werner, 1950 No. C 5. | Go |
| Rom 2/Bd | Castel Trosino Gr 115 (M.A.) | Fuchs-Werner, 1950, No. C 35. | Go |
| Rom 3/D | Castel Trosino, Gr 168 (M.A.) | Fuchs-Werner, 1950, No. C 6. | Go |
| Rom 4/Eb | Via Flaminia. (M.A.) | Åberg 1923a, 48, here fig. 60 | Go |
| Rom 5/Sw | Nocera Umbra Gr 1. (M.A.) | Åberg 1923a 99, fig. 157 | Go |
| Rom 6/D | Nocera Umbra Gr 87. (M.A.) | Ament 1967. | Go |
| Stutt 1/Eb | Schwenningen | Veeck 1939, Werner 1958, No. 10. | Go |
| Stutt 2/D | Schwenningen | Veeck 1939, Werner 1958, No. 10. | Go |
| Stutt 3/D | Heidenheim (?) | Veeck 1931, 173, pl. 26A:1 | Go |
| Stutt 4/D | Pfullingen? | Veeck 1931, 263, pl. 26A:2. | Go |
| Stutt 5/D | Horkheim | Veeck 1931, 218. | Si |
| Stutt 6/D | Oberstötzingen | Veeck 1931, 283, pl. 26A:6. | Si |
| Stutt 7/Sb | Deisslingen, Gr 6. | Veeck 1931, 283, pl II:6. | Go |
| Stutt 8/B | Gültingen | Veeck 1931, pl. 21A:1. | Si and Go |
| Stutt 9/Bu | Rüdern | Veeck 1931, 215, pl. 48B:6. | Go |
| Stutt 10/D | Pfullingen 21/1700 | Veeck 1931 pl. 26A:10 | Si |
| Stutt 11/Bu | Gültingen | Veeck 1931 259, pl. 31:7. | Br and Si |
| Stutt 12/D | Fützen, Baden 1961. | not publ. | Si |
| Stutt 13/M | Altenstadt No. 631:3 | Veeck 1931, 318, pl. 62A:12. | Si |
| Stutt 14/Sw | Möglingen, A 20. | Veeck 1931 227, pl. 319. | Go |
| Stutt 15/Sb | Nusplingen Gr 28. | Fundberichte Schwaben, N.F. 8, 1933–1935. | Si |
| Stutt 16/D | Nusplingen, Gr 28. | Fundberichte Schwaben, N.F. 8, 1933–1935. | Go |
| Stutt 17/D | Pfullingen, No. 1702. | Veeck 1931, 267, pl. 26A:13. | Br(?) |
| Stutt 18/D | Sindelfingen No. 2. | Veeck 1931 206, pl. 26A:3. | Si |
| Stutt 19/R | Murr Nr. A 520. | Veeck 1931, 229, pl. 26A:5. | Si |
| Stutt 20/Bd | Kirchheim Gr 85 | Thieme 1978, No. 87 | Go |
| Stutt 21/Bu | Stammheim | Christlein 1978, pl. 45 | Si and Br with incrustation |
| Stutt 22/D | Pfullingen, No. 1696. | Veeck 1931, 267, pl. 26A:12. | Si |
| Stutt 23/D | NP | not publ. | Si |
| Stutt 24/D | Erpfingen Gr A, Inv. No. 12297 | Veeck 1931, 265, pl. 26A:7. | Si |
| Stutt 25/D | Ehningen, (Wurtzemberg) Gr 12. | Veeck 1931, 190, pl. 26A:15. | Si |
| Stutt 26/D | Ulm | Veeck 1931, 343, pl. 26A:18 | Si |
| Stutt 27/R | Sindelfingen 2. | Veeck 1931, 206, pl. 26A:4. | Si |
| Stutt 28/D | Nusplingen Gr 222 | Germania, 1954. pl. 23:5 | Si |
| Stutt 29/D | Pfullingen? 1699. | Veeck 1931, 267, pl. 26A:19 | Si |
| Stutt 30/D | Deisslingen, Gr 31. | Veeck 1931, 284, pl. 117 | Si |
| Stutt 31/Sw | Niederstotzingen, Gr 9 | Paulsen 1967. | Go |
| Stutt 32/Bu | Gültingen, No. 11539. | Veeck 1931, 259, pl. 31:3. | Go |
| Stutt 33/M | Gültingen, No. 11614. | Veeck 1931, 259, pl. 59A:6 | Si |
| Stutt 34/Pm | Ulm | Veeck 1931, 343, pl. 46B:4. | Go |
| Stutt 35/Sb | Sontheim, Gr 178. | Neuffer-Müller, 1966, 70. | Si |
| Stutt 36/D | Mössingen, 12 47. | Veeck 1931, 280, pl. 26A:9 | Si |
| Stutt 37/R | Nusplingen, Gr 35. | Fundberichte Schwaben N.F. 8, 1933–1935 | Si |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Stutt 38/D | Sontheim, Gr 174. | Neuffer-Müller, 1966, 68, pl. 37:4. | Si |
| Stutt 39/R | Sontheim, Gr 125. | Neuffer-Müller, 1966, 33, pl. 38:8. | Si |
| Stutt 40/D | Sontheim Gr 78. | Neuffer-Müller, 1966, 57, pl. 38:7. | Si(?) |
| Stutt 41/D | Täbingen | Veeck 1932. | Go |
| Swed 1/M | Kerch Crimea, S.H.M, 10038. | Martin 1896, here fig. 37 | Go, rectangular |
| Swed 2/D | Germany, the Rheinland, S.H.M, 2683. | Arne 1925, here fig. 94 | Si |
| Swed 3/B | Kabbarp, Skåne, S.H.M. 11392 | Stjernquist 1955, 131. | Si and glass |
| Swed 4/M | Brostorp, Öland, S.H.M. 18964 | Stenberger 1933, 17. | Br and glass beads |
| Swed 5/Ri | Berga Vrå, Södermanland, S.H.M, 21259. | Beckman 1969, No. 299, here fig. 25. | Go |
| Swed 6/L | Burahus, No. 2, Ravlunda, Skåne S.H.M. 21582 | Strömberg 1963, 35, here fig. 59 and 89. | Go |
| Swed 7/M | Lilla Harg, Vikingstad, Östergötland S.H.M. 14460 | Oxenstierna 1958,57 | Si |
| Swed 8/Bu | N.P. Constantinople, S.H.M. 12077 | Martin 1896, T. J. Arne, 1925, here figs 87–88 | Br |
| Swed 9/L | Eksjö, Småland, S.H.M. 16199. | Arrhenius 1971, fig. 31 | Br |
| Swed 10/Bt | Ekeby, Uppland museum Gustavianum, Uppsala. | Arrhenius 1975 | Br |
| Swed 11/Sw | Djurgårdsäng, Västergötland, S.H.M. 6563 | Janse 1922, 189. | Si |
| Swed 12/Sw | Övede, Eskelhem, Gotland, S.H.M., 2747 | Nerman 1935, No. 20. | Si,probably to a sword pommel. |
| Swed 13/Sw | Väsby, Hammarby, Uppland, S.H.M., 10348. | Arbman, 1950, 138, here fig. 176 | Go |
| Swed 14/Bu | Sjörup, Skåne S.H.M., 2437 | Salin 1894, Arrhenius 1971, fig. 86a | Si |
| Swed 15/Bu | Åshusby, Norrsunda, Uppland, S.H.M. 3560, Gr | Arrhenius 1971, fig. 121–122 | Si |
| Swed 16/Sw | Sturkö, Blekinge, S.H.M.11317 | Arbman 1950 138, here fig. 166 | Go |
| Swed 17/G | Helgö Ekerö. a) No. 10298, building group 3 b) No. 1947, building group 2 | Arrhenius 1971, 48 ff. and figs. 53–54. | |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| | c) No. 8817, building group 2 d) Gr at building group 1 | | |
| Swed 18/B-bt | Hällan, Hälsingland, S. H. M. 981 | Åberg 1924, No. 119 | Si |
| Swed 19/Bu | Tuna, Alsike, Uppland, S.H.M. 9818, Grave XIV. | Arne 1934, 47, Arrhenius, 1980. | Si and Go |
| Swed 20/Sw | Glafsfjorden, Värmland, S.H.M., 1067 | Arbman, 1950, 142., Arrhenius 1971 figs. 176–177 | Si and Go |
| Swed 21/Sw | Hög Edsten, Kville, Bohuslän, S.H.M. 3163. | Arbman, 1950, 138, here fig. 169–172 | Go |
| Swed 22/Sw | Tibble, Badelunda, Västmanland Gr, S.H.M. 20251 | Åberg 1953, Arrhenius 1971, figs. 143–144 | Go and Si |
| Swed 23/M | Lejde, Skultuna, Västmanland, Gr S.H.M. 19225. | Floderus, 1931, Arrhenius 1971, fig. 117 a–b. | Go |
| Swed 24/M | Spelvik, Södermanland, Gr S.H.M., 23243 | Lamm 1962, | Go only a fragment |
| Swed 25/M | Östervarv, Varv, Östergötland, S.H.M. 8656 | Arbman 1939, Arrhenius 1971, fig. 113 | Go only a small fragment |
| Swed 26/Sw | Skrävsta, Botkyrka, Södermanland, Gr, S.H.M. 22586 | Åberg 1953, 112, here fig. 213 | Go |
| Swed 26b/Bu | The same Gr as Swed 26/Sw | Here fig. 50 | Only a G probably from a buckle |
| Swed 27a/Sw | Uppsala Västhög, G. Uppsala, Uppland, Gr, S.H.M. 5308 | Lindqvist 1936, Arrhenius 1971, fig. 141 d. | Go |
| Swed 27b/Bu | Uppsala Västhög, G. Uppsala, Uppland, Gr S.H.M. 5308 | Lindqvist 1936, here figs. 214–215 | Go, only fragments |
| Swed 27c/Sw? | Uppsala Västhög, G. Uppsala, Gr, S.H.M. 5308 | Lindqvist 1936, here fig. 216 | Go |
| Swed 28/M | Uppsala Östhög, G. Uppsala, Uppland, Gr S.H.M. 5308 | Lindqvist 1936, fig. 87 | Go |
| Swed 29/Sw | Valsgärde, G. Uppsala, Uppland, Gr 5, M. Gustavianum | Lindqvist 1932, here fig. 232. | Br and Go |
| Swed 30/Sw | Valsgärde, G. Uppsala, Uppland, Gr 7, M. Gustavianum. | Arwidsson, 1977, 2, here fig. 231. | Br and Si |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Swed 31/Sw | Vendel, Gr I, S.H.M. 7250 | Stolpe-Arne, 1927, here fig. 230. | Br and Si |
| Swed 32/M | Vendel, Gr XII, S.H.M. 7250 | Stolpe-Arne 1927, pl. XXXVIII, 7. | Br and Si – only small cloisonné panels. |
| Swed 33/M | Vendel, west of the church, Gr 8, S.H.M, 10038:8 | Arrhenius 1971, fig. 147 | Br and Si – only small cloisonné panels. |
| Swed 34/Sw | Snösbäck, Karleby, Västergötland, S.H.M., 2561. | Behmer 1939, pl. XXXVII:1. | |
| Swed 35/B-bt | Birka, Adelsö, Gr 1079, Uppland, S.H.M., 5208 | Arbman 1940, pl. 84:6 | Br, Eo |
| Swed 36/B-bt | Stockholms Näs, Uppland, S.H.M., 15481. | Åberg 1953 fig. 131 | Br, E1 |
| Swed 37/B-bt | Hade, Hedesunda, Gästrikland, S.H.M. 1209 | Åberg 1953 fig. 32. | Si, Eo |
| Swed 38/B-bt | Hyby, Skåne, private owner. | Strömberg, 1961, pl 62,1. | Br, E5 |
| Swed 39/B-bt | Tuna, Alsike, Uppland, Gr S.H.M., 9404:1. | Arne 1934, 20. | Br, E6 |
| Swed 39/G | Tuna, Alsike Uppland, Gr., S.H.M., 9404:1 | | Only loose G to the B-bt |
| Swed 40/B-bt | Ruda, Östergötland, S. H.M., 17906 | Arwidsson, 1942,51. | Br, E6 |
| Swed 41/G | Klinta, Köpingsvik, Öland, S.H.M. 27877. | cf. Arrhenius 1971 | Only G probably for a B-bt |
| Swed 42/P | Edsberg, Kvisserud, Eketorp, Örebro M. 22461 | Ekelund 1956 | Go |
| Swed 43/D | Birka, Adelsö, S.H.M. 5208, Gr 526, and 549. | Arbman 1940, pl. 100, 12 cf. 13. | Si |
| Swed 44/M | Kunsta, Östergötland, S.H.M. | Arwidsson, 1942, pl. 48. | Br |
| Swed 45/B-bt | Rullerum, Ringarum, Östergötland, S.H.M. 23391 | Hellman 1970, 96. | Br, E5 (?) |
| Swed 46/B-bt | Gröndal, Köping, Öland, S.H.M. 11761. | Åberg 1923b | Br, E1 |
| Swed 47/D | Bolmsö, Häringe, Småland, S.H.M. 14535. | Arrhenius 1971, fig. 115. | Go |
| Swed 48/P | Lyrestad, Västergötland, S.H.M. 24447. | not publ. | Br |
| Swed 49/B-bt | N P, Löddeköping Skåne L.H.M 3610 | Strömberg 1961 pl. 62,3 | Br, E4 |
| *No. 50–117 all finds from Gotland* | | | |
| Swed 50/Bt | Kylver, Stånga, S.H.M. 13436 Gr 6. | cf Nerman 1955 | Go, probably to a sword |
| Swed 51/B-bt | Björkome, Västkinde, S.H.M. 11757, Gr 4. | not publ. | Br, E3 |
| Swed 52/B-bt | När, S.H.M. 2579 | not publ. | Br, E3 |
| Swed 53/B-bt | Bjärs, Hejnum, S.H.M. 8767, Gr 103. | not publ. | Br, E2 |
| Swed 54/B-bt | Björkome, Västkinde, S.H.M. 11752 Gr 2. | not publ. | Br, E3 |
| Swed 55/B-bt | Allekvia, Endre, S.H.M. 14547. | not publ. | Br, E2 |
| Swed 56/B-bt | Fardhem S.H.M. 21586 | not publ. | Br, E2 |
| Swed 57/B-bt | Broa, Halla 113, new find: 66 | not publ. | Br, E2 |
| Swed 58/B-bt | N P, S.H.M. 9836 | not publ. | Br, E3 |
| Swed 59/B-bt | N P, S.H.M. 7571:346 | not publ. | Br, no G. E7 |
| Swed 60/B-bt | Uddvie, Grötlingbo, New find: 31/61 | Arrhenius 1971 fig. 166 | Br, E2 |
| Swed 61/B-bt | Vallstena, S.H.M. 5368 | not publ. | Br, E2 |
| Swed 62/G | Paviken, Västergarn, | Lundström 1973, Löfgren 1973 | Only G |
| Swed 63/D | Gudings, Alva, S.H.M. 8735 | Nerman 1969 fig. 101 | Br. |
| Swed 64/Bu | Endre, S.H.M. 484:35 | Nerman 1969 fig. 269 | Br and Go |
| Swed 65/Sw | Vallstenarum, Vallstena, S.H.M. 6295 | Nerman 1969 fig. 523, here fig. 173 | Go |
| Swed 66/B-bt | Stånga, S.H.M. 12173 | Nerman 1969, fig. 39 | Br, Eo |
| Swed 67/B-bt | Roma, S.H.M. 13566:1 | Nerman 1969, fig. 43 | Br, E4 |
| Swed 68/B-bt | Ringome, Alva, S.H.M. 5035 e. | Nerman 1969, fig. 44 | Br, E4 |
| Swed 69/B-bt | Trullhalsar, Anga, S.H.M. 8555, Gr 33. | Nerman 1969, fig. 45 | Si, E2 |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Swed 70/B-bt | Hejnum, S.H.M. 10725:8 | Nerman 1969, fig. 46 | Br, E2 |
| Swed 71/B-bt | Lilla Bjärges, Lau, S.H.M. 18703, Gr 28. | Nerman 1969, fig. 47 | Br, E2 |
| Swed 72/B-bt | Lilla Ihre, Hellvi, S.H.M. 20826, Gr 35. | Nerman 1969, fig. 48 | Br, E2 |
| Swed 73/B-bt | Bjärs, Hejnum S.H.M. 8767, Gr 109 | Nerman 1969, fig. 50 | Br, E2 |
| Swed 74/B-bt | Nasume, Tofta, S.H.M. 7557 | Nerman 1969, fig. 52 | Br, E2 |
| Swed 75/B-bt | Alands, Hogrän, S.H.M. 6048 (unf.) | Nerman 1969, fig. 53 | Br, E2 |
| Swed 76/B-bt | Vallstenarum, Vallstena, S.H.M. 5275 | Nerman 1969, fig. 54 | Br, E2 |
| Swed 77/B-bt | Träkumla, S.H.M. 7912 | Nerman 1969, fig. 55 | Br, E2 |
| Swed 78/B-bt | Endre, S.H.M. 1306 | Nerman 1969, fig. 56 | Br, E3 |
| Swed 79/B-bt | Barshaldershed, Grötlingbo, S.H.M. 8204 | Nerman 1969, fig. 58 | Br, E2 |
| Swed 80/B-bt | Trullhalsar, Anga, S.H.M. 8555, Gr 18. | Nerman 1969 fig. 59 | Br, E2 (button E3) |
| Swed 81/B-bt | Bjärs, Hejnum, Go. S.H.M. 10298, Gr 139. | Nerman 1969, fig. 60 | Br, E2 |
| Swed 82/B-bt | Burggrind, Allekvia backar, Endre, Go. S.H.M. 14547, Gr 8. | Nerman 1969, fig. 61 | Br, E3 |
| Swed 83/B-bt | St. and Lilla Ihre, Hellvi, S.H.M. 20826, Gr 265 | Nerman 1969, fig. 62 | Br, E3 |
| Swed 84/B-bt | N P, S.H.M. 10739:2 | Nerman 1969, fig. 63 | Br, E3 |
| Swed 85/B-bt | Grötlingbo, S.H.M. 10482:3 | Nerman 1969, fig. 64 | Br, E3 |
| Swed 86/B-bt | Sandegårda, Sanda, Go. S.H.M. 2502 | Nerman 1969, fig. 65 | Br, E5 |
| Swed 87/B-bt | Ringome, Alva, S.H.M. 5035 e | Nerman 1969 fig. 66 | Br, E5 |
| Swed 88/B-bt | Endre backe between the church and Endregårda, Endre, S.H.M. 4233 | Nerman 1969, fig. 69 | Br, E3 |
| Swed 89/B-bt | Kylver, Stånga, Go. S.H.M. 13436, Gr 5. | Nerman 1969, fig. 71 | Br, E3 |
| Swed 90/B-bt | Sandegårda, Sanda, S.H.M. 7480 | Nerman 1969, fig 73, here fig. 229 | Br, E1 |
| Swed 91/B-bt | Sandegårda, Sanda, S.H.M. 7480 b. | Nerman 1969, fig. 74 | Br, E1 |
| Swed 92/B-bt | Vallstenarum, Vallstena, S.H.M. 6294 | Nerman 1969, fig. 75 | Br, E1 |
| Swed 93/B-bt | St. and Lilla Ihre, Hellvi, S.H.M. 20826, Gr 280 d. | Nerman 1969, fig. 76 | Br, E1 |
| Swed 94/B-bt | Bjärs, Hejnum, S.H.M. 8062, Gr 10 a. | Nerman 1969, fig. 77 | Br, E1 |
| Swed 95/B-bt | Allekvia, Endre, Go, S.H.M. 24277, Gr 3. | Nerman 1969, fig. 78 | Br, E1 |
| Swed 96/B-bt | Roes, Grötlingbo S.H.M. 7563 | Nerman 1969, fig. 842 | Br, E0 |
| Swed 97/B-bt | Bjärs, Hejnum, S.H.M. 8767, Gr 120. | Nerman 1969, fig. 845 | Br, E3 |
| Swed 98/B-bt | Bjärs, Hejnum, S.H.M. 8767, Gr 103. | Nerman 1969 fig. 846 | Br, E3 |
| Swed 99/B-bt | Anga, S.H.M. 10498:4 | Nerman 1969, fig 848 | Br, E3 |
| Swed 100/ B-bt | N P, S.H.M. 10546:19 | Nerman 1969, fig. 849 | Br, E3 |
| Swed 101 /B-bt | Endre, S.H.M. 484:5 | Nerman 1969, fig. 850 | Br,E3 |
| Swed 102/ B-bt | Näs, S.H.M. 13555:25 | Nerman 1969, fig. 851 | Br, E3 |
| Swed 103/ B-bt | Rikvide, När, S.H.M. 2394 a. | Nerman 1969, fig. 852 | Br, E3 |
| Swed 104/ B-bt | N P, S.H.M. 11006 | Nerman 1969, fig. 853 | Br, E2 |
| Swed 105/ B-bt | N P, S.H.M. 7571:339 | Nerman 1969 fig. 855 | Br, E3 |
| Swed 106/ B-bt | Stenstugu, Vesterhejde S.H.M. 5495 | Nerman 1969, fig. 860 | Br, E3 |
| Swed 107/ B-bt | Rikvide, När, S.H.M. 2394 | Nerman 1969, fig. 1363 | Br, E7 |
| Swed 108/ B-bt | St. and Lilla Ihre, Hellvi, S.H.M. 20550 Gr 159. | Nerman 1969, fig. 1364 | Br, E7 |
| Swed 109/ B-bt | Långgutes, Misterby, Go. S.H.M. 16070:1 | Nerman 1969, fig. 1369 | Br, E7 |
| Swed 110/ B-bt | Endre Backe, between Endregårda and the Church S.H.M. 4648 c | Nerman 1969, fig. 1374 | Br, E3 |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Swed 111/ B-bt | NP, S.H.M. 10610:8 | Nerman 1969, fig. 1377 | Br, E3 |
| Swed 112 /B-bt | NP S.H.M. 4442 b. | Nerman 1969 fig. 1378 | Br, E3 |
| Swed 113 /B-bt | Othem, Gr 11887:1 | Nerman 1969 fig. 1799 | Br, E7 |
| Swed 114 /B-bt | Havdhem, S.H.M. 10415 | Nerman 1969 fig. 2149 | Br, E8 |
| Swed 115/D | Barshaldershed, Gr 26, Grötlingbo, S.H.M. 10939 | Nerman 1969, fig. 92 | Br, "pressbleck" and no G. |
| Swed 116/D | NP S.H.M. 11348:2 | Nerman 1969, fig. 90 | Br, "pressbleck" and no G |
| Swed 117/Sw | N P, S.H.M. 2976 | Nerman 1969 fig. 1181 | Br. |
| Szeg 1/Se | Szeged-Nagyszéksós | Fettich 1953, pl. I: 23–25 here fig. 110 | Go, small rhomboids |
| Szeg 2/G | Szeged-Nagyszéksós | Fettich 1953 pl. I: 19, 21 | Loose G probably to strapends of type Szeg 7. |
| Szeg 3/Bu | Szeged-Nagyszéksós | Fettich 1953, pl. I: 5 here fig. 111 | Go, small buckle |
| Szeg 4/Bt | Szeged-Nagyszéksós | Fettich 1953, pl. II; 7–8 | Go small button |
| Szeg 5/M | Szeged-Nagyszéksós | Fettich 1953, pl. II: 4 | Go, a disc-shaped M |
| Szeg 6/Md | Szeged-Nagyszéksós | Fettich 1953, pl. II:19 | Go |
| Szeg 7/Se | Szeged-Nagyszéksós | Fettich 1953, pl. I:21 | Go, triangular strapend |
| Szeg 8/M | Szeged-Nagyszéksós | Fettich 1953, pl. I:22 | Go, a bird's head shape |
| Szeg 9/M | Szeged-Nagyszéksós | Fettich 1953, pl. II: 16–17 | Go, 4 cabochons |
| Szeg 10/M | Szeged-Nagyszéksós | Fettich 1953, pl. II:11–15 | Go, 3 small cabochons |
| Szek 1/Bu | Nágydorog Tolna | Kovrig in Roth 1979, 130 and pl. 33A | Go, rectangular plate |
| Szek 2/D | Kajdâcs Gr. 2 | Bona 1974 pl. I:2 | Si |
| Szek 3/Bu | Regöli | Gyula 1972, pl. II:9 | Go and Si |
| Szek 4/B | Regöli | Gyula 1972, pl. II:7 | Go and Si |
| Szek 5/B | Regöli | Gyula 1972 pl. II:11 | Go and Si |
| Szek 6/M | Regöli | Gyula 1972, pl. II:3 | Go, small M with cabochons |
| Tong 1/M | The Cathedral of Tongeren | Arbman 1950 fig. 17 here figs. 206–207 | Go |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Turin 1/B | Desana | Bierbrauer 1975 Pl. 204, here fig. 194 | Go and Si |
| Trier 1/D | Trier Egbert-Shrein in Trier Cathedral | Rademacher, 1936, here figs 204–205 | Go |
| Trier 2/R | Rittersdorf Gr 15. | Böhner, 1958, 116. | Si |
| Trier 2/D | Rittersdorf, Gr 15. | Böhner 1958, 116. | Si |
| Trier 3/R | Rittersdorf, Gr 34 | Böhner, 1958, 119. | Si |
| Trier 3/D | Rittersdorf, Gr 34. | Böhner, 1958, 119. | Si |
| Trier 4/D | Rittersdorf, Gr 11. | Böhner, 1958, 116. | Si |
| Trier 5/R | Rittersdorf, Gr 50. | Böhner, 1958, 122. | Si |
| Trier 6/D | Rittersdorf, Gr 89. | Böhner, 1958, 126. | Si, star shaped |
| Trier 7/R | Rittersdorf, Gr 90 | Böhner, 1958, 121. | Si |
| Trier 8/D | Rittersdorf, Gr 101. | Böhner, 1958, 128. | Si |
| Trier 9/R | Rittersdorf Gr 140. | Böhner, 1958, 130. | Si |
| Trier 10/D | Rittersdorf, Gr 75 | Böhner, 1958, 124. | Si |
| Trier 11/D | Rittersdorf, Gr 107. | Böhner, 1958,10, 129. | Si |
| Trier 11/Eb | Rittersdorf Gr 107. | Böhner, 1958, 129. | Si |
| Trond 1/B-bt | Melhus, Overhalla. | Gjessing 1934, pl. XXXV | Br, E6 |
| Wash 1/Ea | Olbia | Rupp 1937, Ross 1965, No. 166, here fig. 63 | Go |
| Wash 2/p | Olbia | Rupp 1937, Ross 1965, No. 166, here fig. 64 | |
| West 1/D | Várpalota Gr 5 | Bona 1956, 28 and pl. 187 | Si |
| West 2/Sb | Várpalota Gr 17 | Bona 1956, 35 and pl. 187 | Br. |
| Wien 1/M | NP Austria K.H. | Noll 1958, No. C 11. here fig. 54 | Go, rectangular |
| Wien 2/D | Baumgarten an der Marsch, N.H. | Werner 1962 | Si |
| Wien 3/Ea | Laa an der Thaya N.H. | Werner 1956, pl. 9:4 | Go |
| Wiesb. 1/D | Eltville | Schoppa, 1955. | Si |
| Wiesb. 2/D | Eltville | Schoppa, 1955. | Go |
| Wiesb. 3/P | Wolfsheim | Ebert 1914 | Go |

| Find No. | Provenance | Reference | Description |
|---|---|---|---|
| Wiesb. 4/Bu | Wolfsheim | Werner, 1956, pl. 4, here fig. 62. | Go, a heavy buckle |
| Wiesb. 5/Bu | Wolfsheim | Werner, 1956, pl. 4 | Go, a small buckle |
| Worms 1/D | Gundersheim, Rhein-Hessen, Gr 5. | Rupp 1937, 120. | Si |
| Worms 2/R | Gundersheim, Gr 9. | Rupp 1937, 129 | Si |
| Worms 3/D | Rüdesheim, Rhein-Hessen, Gr 39. | Rupp 1937, 120. | Si |
| Worms 4/D | Rüdesheim, F 143. | not publ. | Si |
| Worms 5/D | Rüdesheim, F 147. | Rupp 1937, 128. | Si |
| Worms 6/D | N.P. F 152. | Rupp 1937, 124. | Si |
| Worms 7/R | N.P. No. 155 | Rupp 1937, 123 | Si |
| Worms 8/D | Rüdesheim, F 158. | Rupp 1937, 128. | Si |
| Worms 9/D | Gundersheim, Rhein-Hessen, F 159. | Rupp 1937, 120. | Si |
| Worms 10/D | Mörstadt, Rhein-Hessen. | Rupp 1937, 112. | Si |
| Worms 11/D | Horseheim, Gr 6. | not publ. | Si |
| Worms 12/D | N.P. F 165. | Rupp 1937, 121 | Si |
| Worms 13/D | N.P. F 166. | Rupp 1937, 114 | Si with incrustation |
| Worms 14/D | N.P. F 167. | Rupp 1937, 114. | Si with incrustation |
| Worms 15/D | Flomborn, Rhein-Hessen, F 168. | Rupp 1937, 111 | Si |
| Worms 16/D | Gundersheim, Gr 32, F 169. | Not publ. | Si |
| Worms 17/D | Gundersheim, Gr 24, F 170. | not publ | Si |
| Worms 18/D | Flomborn, Gr.143, F 173. | Rupp 1937, 111. | Si |
| Worms 19/D | N.P. F 176. | not publ. | Si |
| Worms 20/R | N.P. F 177. | Rupp 1937, 116. | Si |
| Worms 21/D | Wiesen-Oppenheim, Rhein-Hessen, F 483. | Rupp 1937, pl. 24:5 | Si |
| Worms 22/D | Wiesen-Oppenheim, Rhein-Hessen, F 484. | not publ. | Si |
| Worms 23/R | Wiesen-Oppenheim, F 485. | Rupp 1937, 131. | Si |
| Worms 24/R | Monsheim, Gr 13 | Rupp 1937, 121. | Si |
| Worms 25/D | Pfeddersheim 1905, Gr 10, F 581. | Rupp 1937, 120. | Si |
| Worms 26/D | Monsheim, Gr 15, F 583. | Rupp 1937, 112. | Si |
| Worms 27/D | Worms-Offstein, Rhein-Hessen, F 1139. | Rupp 1937, 120. | Si |
| Worms 28/R | Worms-Schillerstr. F 1141. | not publ. | Si |
| Worms 29/D | Wiesen-Oppenheim, F 1170. | not publ. | Si |
| Worms 30/D | N.P. Worms | Rupp 1937, pl. XXIII:8. | Si (?) only examined from pictures |
| Worms 31/Sb | N.P. Worms, F 168. | not publ. | Si |
| Worms 32/D | Sprendlingen, 1897. | not publ. | Br. |
| Worms 33/Sw | Eich | Werner, 1958, pl. 11:12 | Go |
| Worms 34/Sw | Flonheim, Gr 5. | Ament 1970. | Si and Go, scabbard-mounts |
| Worms 34/Sw | Flonheim, Gr 5. | Ament 1970 | Si and Go, loop |
| Worms 34/Bu | Flonheim. GR 5. | Ament 1970, pl. | Go |

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