Ancient Monuments Laboratory
Report 121/91

THE CONSERVATION OF A STONE CAPITAL FROM ST AUGUSTINE'S ABBEY, CANTERBURY.

Derek Brain and P M Welford

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Summary

This report describes the conservation of a carved limestone capital from St Augustine's Abbey, Canterbury. The capital is dated somewhere between the late 6th and mid 11th centuries. Pigments including Egyptian blue and a minute amount of gold leaf were detected on the capital. Other painted stone fragments from the same excavation are described. The significance of Egyptian blue in a post Roman, British context is discussed. The conservation treatment included the consolidation of small areas of powdery limestone using an acrylic silane.

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CONSERVATION OF A STONE CAPITAL FROM ST AUGUSTINE'S ABBEY, CANTERBURY

INTRODUCTION

This report describes the conservation of a stone capital (AML 78203098) from St Augustine's Abbey, selected for the 'Making of England' exhibition which was due to open at the British Museum on 8 November 1991.

St.Augustine's Abbey is situated to the east of the city wall in Canterbury. King Aethelbert of Kent granted land to the papal missionary St.Augustine in AD 597 and a monastery was founded the following year. A series of churches were built in the following years starting with the church of Sts Peter and Paul, dedicated in 613. To the east was built the church of St Mary *c* 620. (Sparks 1988). Abbot Wulfric II (1047-59) linked these churches together with a rotunda of two storeys, which was never completed. Following the Norman conquest, the Anglo-Saxon structures were demolished to make way for the monastic church and claustral buildings, beginning in 1073 with St Mary's church.

The capital was excavated in the summer or autumn of 1914 (Sparks pers.comm.1991). It was found under the eastern bays of the nave of the Romanesque church, presumably in the infill placed in the crypt of the rotunda (*c* 1050) during the demolition and rebuild of Abbot Scotland *c* 1073 (Sparks pers.comm.1991). Thus the date of the capital must lie somewhere between 597 and *c* 1073.

It is tempting to suggest that the capital came from one of the eight columns of the eleventh century rotunda. Peers and Clapham (1927) placed it in the tenth century. Taylor and Taylor 1966 compared the capital with others in the crypt of St Germain Abbey at Auxerre which are dated from 841 to 865. On stylistic grounds the capital is likely to belong to the late sixth or early seventh centuries (Gem 1991 pers.comm.). The quality of the piece and its naive yet accurate interpretation of the Roman composite order argue for this earlier date. It is possible that the capital came from the churches of Sts Peter and Paul or St Mary. Although St Mary's church was an aisleless building the capital may have come from something like a small scale chancel arch. Another possibility is that the capital was a early piece re-used in the rotunda.

DESCRIPTION

Stone type

The stone, from which the capital (and the other two fragments) has been carved, has been identified as Calcaire Grossier (Worssam and Tatton-Brown 1990). Calcaire Grossier is a fine grained grey-yellow limestone containing *Ditrupa* worm and foraminifera fossils and has uniformly good weathering resistance. It is found in the Paris Basin (Worssam and Tatton Brown 1990).

Morphology of the capital

The capital is 47 cm square and 30 cm high. The diameter of the capital at the base is 32 cm. It is likely that the column on which the capital rested was of a similar diameter. It is carved on all four faces. The capital is illustrated in fig 1.

The style of the capital is Roman composite because it incorporates the pronounced volutes of the Ionic order and the acanthus leaves of the Corinthian order. The large acanthus leaves are at the corners below each volute. Each face has three upright acanthus leaves. The central one of each face is slightly raised compared to those on either side. The tips of the three upright leaves are truncated by an astragal.

The astragal is a recessed slot the back wall of which is curved so that it is 1 cm deep at the middle deepening to 2 cm at each corner. The back wall of each is decorated with 8 diagonal stripes in a zig zag pattern.

Bands of the volutes are continued across above the astragal. They are depressed in the middle as they curve around beneath a central round feature near the top on each face. This round feature is assumed to be a petalled rosette but the surface is so poorly preserved that no petals are visible.

The abacus is represented by a carved ledge in the top 4 cm of the capital. A ledge 2.0-1.5 cm from the top of the capital becomes more recessed towards the middle where there is a central horizontal semicircular feature directly above each rosette. These recesses would have been used to key the capital in to the masonry above (fig 6). There are slots in the corner acanthus leaves near the base which were probably used to key in to the masonry below (fig 1).

CONDITION

Previous repair

The capital had been broken into two halves but the two halves have been bonded together using cement and iron dogs, probably by the excavators. This was done before 1917 as the joined capital is illustrated in St.John Hope (1917) op. p 24. It is also pictured in Peers and Clapham (1927) plate XXVIII which also shows two other fragments of similar capitals (AML 78203656 and 78203093). The cement has been packed in with pieces of tile to bulk out the fill. The capital balances on a large plug of cement which has a flat bottom. The iron dogs appear to have copper rods inserted in them for an unknown reason.

A small rod of iron is set into the top edge of the capital in the horizontal semicircular feature on one of the faces (fig 2). There is a flat surface below the rod which has three diagonal lines scored in it. These may be marking out lines associated

with work to attach the round feature which is missing from this face: alternatively they may be to do with the incorporation of the capital into another structure. The fact that the surface is obscured in places by a mortar supports the idea that the capital was re-used in another structure.

For the purposes of this report the faces of the capital have been numbered. The face with the iron rod mentioned above is face 1. The other faces are numbered anticlockwise 2-4 (figs 3-5).

Losses

The weathered surface of the stone has suffered losses especially in vulnerable places such as corners. These reveal a white/cream coloured stone which contrasts starkly with the dull grey/beige colour of the rest of the stones surface. Some of these losses have been caused by abrasion, but others may have been caused by the movement of soluble salts. The surface revealed by some of the losses is loose and powdery e.g on the rosette on face 2 (fig 3).

The top corner between face 1 and 2 is missing above the volute. Only the stump of the volute remains on this side. The corner between face 1 and 4 is also missing including the whole volute and the upper half of the corner acanthus leaf.

The lower corner between face 2 and 3 has been lost including the lower part of the corner acanthus leaf. The tip of this acanthus is also lost.

On faces 2 and 4, which are traversed by the fracture plane, large triangular wedges of stone have been lost from the lower portion of the capital.

SURFACE DEPOSITS

Disfiguring white substance

On the surface there is a white substance which obscures detail in the carving, especially on the central acanthus leaf of face 1. It is also noticeable elsewhere on the capital. This was identified as $CaCO_3$. It is likely that the carbonate is from a lime mortar applied to incorporate the capital into another structure. In places it overlays the Egyptian blue pigment (fig 7).

Pigments and gold leaf

Traces of pigment were found on the capital as indicated on figs 2-5. Small samples of the pigments ,(one or two grains), were taken, using a scalpel, from face 1 and 2 as marked on figs 1 and 2. They were examined by optical microscopy in cross-section , dispersion and unmounted. With each of the colours, there is only evidence of one layer of pigment on the stone.

There are traces of a yellow pigment, pale cream/orange in colour, on the third volute band from the bottom, to the left of the rosette on face 2 (fig 3 and 8). There are also traces of the yellow pigment on face 3. No traces of yellow pigment have been found on faces 1 or 4. The yellow was identified as yellow ochre. A fragment of gold leaf, recovered in sample 2 taken from face 2, suggests that the yellow ochre served as a bole for gold leaf.

Traces of red pigment were found on the band above the yellow band on face 2 and these were identified as red ochre.

There are traces of blue pigment remaining on faces 1 - 3. On face 1, these occur above the central acanthus leaf (fig 9) and on the leaf to the left.

Under the microscope the blue pigment particles are seen to be mixed with colourless particles of roughly the same size (fig 10). Chemical tests and examination of the dispersed sample under a polarising microscope ruled out the possibility that the pigment was ultramarine. A suggestion that the pigment might be Egyptian Blue ($Ca\ Cu\ Si_4O_{10}$) (Howard 1991 pers. comm.) was shown to be correct using SEM and EDX analysis. The results are shown in fig 11.

A suggested reconstruction of the colour scheme of the capital is shown in fig 12.

The significance of the Egyptian blue

Egyptian blue was widely used in ancient and classical painting at least since the Fourth Dynasty in Egypt. It was believed that the method for its manufacture was lost some time in the late Roman period. However, Egyptian blue has now been identified from several post Roman contexts. In Italy examples come from Castel Seprio (Leveto 1985), San Vincenzo (Howard forthcoming) and the church of San Clemente, Rome (AD 847 and 857) (Lazzarini 1982). In Switzerland there is an example in Carolingian paintings at the Mustair Convent (Mairinger and Schreiner 1986).

The intensity of colour of Egyptian blue depends on the copper content of the pigment while the degree of crystallinity is a function of the time of calcination during preparation. Poor quality Egyptian blue is pale, because of the high proportion of unreacted quartz and the degree of crystallinity is low. There was no trace of tin in the pigment (fig 11) which suggests that the source of copper was malachite rather than scrap bronze, in other words, this is a high quality pigment.

The existence of Egyptian blue on the St Augustine's Abbey Capital strengthens the argument that the technology to produce the pigment was not lost at the end of the Roman period. Other evidence for this argument may come from Winchester and St Albans where lumps of blue pigment have been found in post Roman contexts (Biddle 1991 pers.comm.).

One unresolved point is the fact that only one layer of paint was found. If the capital were an early 7th century piece in Wulfric's rotunda repainting layers would be expected but earlier traces of paint may have been removed by recarving. If the capital was part of Wulfric's rotunda c 1050 and was painted with Egyptian blue at this time, it is the latest documented occurrence of the pigment.

The paint traces on the capital and the pieces in appendix A, raises the number of documented, British, pre-conquest sculptures bearing original paint from 12 (Tweddle 1990) to 17.

Black surface crust

There is an area of blackened surface which covers the top edges of the capital. On face 4 the black surface only affects the left hand fragment of the capital, however, the black surface does extend over the fracture on the opposite side so this is not necessarily a weathering phenomenon which formed while the capital was in two pieces. The layer was identified as a sulphate.

It is not clear when the sulphate layer built up. It is localised around the top edges and there is no evidence to suggest that other areas have been cleaned. This could be because when buried only the top was exposed or perhaps because the top took the brunt of the weathering when the whole capital was exposed. It is also possible that the sulphate layer formed while the capital was on site after being excavated, or while it was displayed in the open. The capital was kept indoors at St. Augustine's College except for some years when the stonework was displayed in a roofed porch and stairway which was open to the atmosphere (Sparks 1991 pers.comm.). From 1969 the stonework was displayed in a hut on the site and since 1981 they have been at what is now English Heritage's Dover store (Sparks 1991 pers. comm.). Wulfric's rotunda was never completed so it is possible that weathering took place while the capital was part of the building.

Modern surface deposits

Dribbles of cement occur on the surface of face 3. They show that the capital was inverted to apply the cement.

There is a loose layer of dirt and dust especially on the top surface of the stone.

A turquoise blue coloured marking ink was used to mark on the inventory number on the top surface of the capital. Black ink was used to mark on the site museum number.

There are three kinds of modern paint:

a)One is a turquoise blue which has been transferred to the

capital by abrasion against a painted surface. This may have happened during transport in the back of a vehicle (Moore 1991 pers.comm.)

b) A slightly deeper blue, remarkably similar to the Egyptian Blue, occurs as blobs on faces 2,3 and 4 (figs 7 and 8).

c) Spots of white paint occur on face 4.

A maroon/brown coloured wax occurs in small blobs around the lower part of the capital on faces 1,2,3 and 4.

TREATMENT

The objective of the treatment was to prepare the capital for exhibition, to clean away recent dust and dirt, to treat any instabilities and to minimise the visual impact of the surface losses.

X-Radiography

X-radiography was attempted to gain information about the condition of the iron dogs which, together with the cement, hold the stone together. Exposures of 250 KV for 20 minutes did produce an image but because of the thickness of the capital, the image was diffuse and poorly defined. This was despite the inversion of the capital to place the iron nearer to the x-ray film. There is no reason to suppose that the iron and cement are not sound from the external appearance.

Cleaning

The capital was brushed with a dry paint brush to remove dust. The dust was collected on a sheet of paper and retained. Care was taken not to brush the areas identified as bearing ancient pigment traces. It was decided not to try to clean away the disfiguring white deposit as this may result in further damage to the stone surface. This deposit constitutes evidence for the capitals re-use.

No attempt was made to remove the sulphate layer because of the danger that the surface underneath might be powdery and would have to be consolidated. Aqueous treatments were ruled out because of the presence of the pigments and the possibility of mobilising soluble salts. Although the blackened sulphate layer is unsightly, it does record a part of the stones history when it was exposed to weathering.

Consolidation of powdery stone

The abraded areas were tested to decide which needed consolidation by brushing with a soft paint brush: the area needed consolidation if powder was seen to be brushed off. The consolidant chosen was *Racanello* 55 050 acrylic silane as this has been used successfully to treat fine powdery limestone

surfaces (Hanna 1984). The product was first diluted to half its concentration with acetone, it was placed on the powdery surfaces one drop at a time, each drop being allowed to soak in before the next was added. When consolidant began to pool on the surface, consolidation was ceased. The areas treated are marked on figs 2 - 5. Any excess consolidant on the surface of the stone was removed with acetone on a swab of cotton wool.

The consolidant did bring out the yellow colour of the stone to some extent and so it helped to tone in the whiteness, thus these areas did not need further toning in (see below).

Reducing the visual impact of the surface losses

A trial was carried out, on a small area of loss, to tone down the whiteness using the dust removed from the capital. This method was tried as it was thought most acceptable to put back only those deposits that were already on the stone. The dust was sieved to remove fluff and then ground with a pestle and mortar. The dust was mixed with a little distilled water and painted on to the white surface. This method proved unsatisfactory as the dust when dry was too loosely attached to provide adequate toning in for the required period of the exhibition.

Earth pigments were inappropriate because, given the original pigmentation found on the stone, such a method would provide confusion for future investigation. It was decided to tone down the whitest surfaces using Lamp black and Vandyke Brown *Winsor and Newton* dry ground artist pigments. These were chosen because they contrast starkly with the original pigments. Lamp black pigment is mainly carbon while Vandyke brown is a bituminous substance. XRF analysis revealed no inorganic elements (see appendix B). These pigments have a greasy quality which meant that they stick to the stone surface unlike the dust or earth pigments. The powder was dabbed on in small quantities and smeared with a soft brush. The areas toned down in this way are marked on figs 2, 3 and 5.

Face 4 of the capital, after treatment, is shown in fig 13.

Packaging of the capital

The capital had arrived in the laboratory in a wooden crate 53 cm square on the inside. The capital is 47 cm square at the top which leaves a three centimetre gap around the capital for packing material. The crate was held together by nails.

It was not possible to remove the capital without when it arrived without dismantling the crate, so one side of the crate was removed by forcing the joins apart using a crow bar. Care was taken not to damage the stone during this process. It was decided to modify the crate by removing the nails holding the sides to one another and to the base, replacing them with screws. This means that all three sides can now be removed with a screwdriver to allow the stone to be placed on or removed from the base board with as little danger of damage to the stone as

possible.

The spaces between the stone and the sides of the crate have been packed with expanded polystyrene and polythene. The screws that can be undone were clearly marked with arrows.

Health and Safety

The consolidant *Racanello* 55 050 was used with the use of local fume extraction trunks and an organic vapour mask. (Health and safety data for *Racanello* 55 050 have been requested from the supplier).

DISPLAY OF THE CAPITAL

Conservators from the British Museum, where the stone is to be displayed, inspected the capital to make recommendations for the mounting method. The favoured method was to bore two holes into the modern cement plinth, approximately 12mm in diameter and 60 mm in depth which would receive stainless steel dowels set into the upper surface of the display plinth. A packing material would be placed underneath the capital, as required, so that it appears level.

Due to the fragile nature of some of the surface and the presence of original paint, the capital should be exhibited out of reach of the public, behind glass or on a tall plinth. If it is exhibited on a plinth, this must be robust enough to support the capital's weight (approximately 114 kg). The plinth should be fixed to the wall and floor to prevent movement.

While on display the temperature and humidity should be kept as stable as possible as fluctuations in humidity could cause problems with mobility of salts in the stone. This is especially important given that there are pigment traces preserved on the stone. There must be no appreciable heating effect by the display lighting. A hot lamp shining on the stone surface would cause cyclic, localised heating and cooling as the lights are switched on and off, which could cause increased evaporation of water and salt efflorescence. Heating and cooling could also cause the iron to expand and contract which would make the capital unstable.

The humidity should not be to high to prevent iron corrosion in the cramps holding the stone together. A figure of 50% relative humidity is recommended. Temperature should be close to 20^{0}C and stable. Light levels do not need to be low as Egyptian Blue and ochres are not particularly light sensitive. A maximum of 300 lux should be used.

APPENDIX A

OTHER ANGLO-SAXON STONEWORK FROM ST AUGUSTINE'S ABBEY

After the discovery of the pigments on the capital, other stone work from the site was examined.

A quarter capital fragment (fig 17, AML 78203093) and a half capital fragment (fig 18, AML 78203656) are virtually identical in style to the subject of this report but no mention of them is found in the correspondence between Potts and St.John Hope (Sparks 1990, pers. comm.). They are slightly smaller than the "complete" capital of this report. The half capital has an astragal 21 cm long while those of the `complete' capital are 24-25 cm long. The side of the half capital is 44 cm while that of the `complete' capital is 47 cm.

These fragments were found to bear traces of pigments that looked identical to those on the capital of this report. The half capital had blue and yellow while on the quarter fragment there more abundant traces of blue and red (figs 14 and 15).

A baluster shaft (fig 19, AML 78203095) was found to have red pigment while another shaft (AML 78203096) was decorated with a green pigment in annular bands. A column base with plinth (AML 78203652) was also examined but no paint was found. The surface of this object was poorly preserved.

The fact that these Anglo-Saxon pieces do not have secure archaeological contexts limits the amount of information that can be gained.

Later material from the same site was examined to note the contrast between the types of pigments found. A late eleventh to early twelfth century piece of carved stone was examined but no paint was found (AML 782031). Medieval painted and gilded plaster and stonework excavated in the 1970's had already been examined. A section of vaulting (AML 775760) was found to bear carbon black, minium (orange lead), red ochre and red lead. Painted plaster was found to bear white cerussite ($PbCO_3$) and blue (Azurite, $2CuCO_3.Cu(OH)_2$), red lead and calcite (unpublished Ancient Monument Laboratory conservation report and Ancient Monument Laboratory Report No.2379.

APPENDIX B

One point that arose from this project was that pigments added to the stone would constitute contamination which may confuse future analysts. *Winsor and Newton* powder pigments e.g. burnt umber, yellow ochre are assumed to be just iron oxides. Likewise the *Rowney* Cryla acrylic colours (earth colours) are thought to be iron oxides in an acrylic medium. To be more definite these colours were analysed by energy dispersive XRF spectroscopy. It should be noted that no elements lighter than boron will be detected by this method. The results are summarised below.

Rowney Cryla acrylic colours

Raw Sienna	Fe	Ba	Sr	Ca (trace)	
Burnt Sienna	Fe	Ba	Sr	Ca (trace)	As
yellow ochre	Fe	Ba	Sr (trace)		
yellow ochre (flow)	Fe	Ba	Sr (trace)		
Burnt Umber	Fe	Ba	Sr (trace)	Ca (trace)	Mn
Raw Umber	Fe	Ba	Sr	Ca (trace)	Mn
Ivory Black	Fe	Ba	Sr	Ca	Mn (trace)

Winsor and Newton dry ground artists' pigments

Yellow ochre	Fe		Ca (trace)	
Raw Sienna	Fe	As (trace)		
Burnt Umber	Fe			
Raw Umber	Fe	Mn	Ca (trace)	
Ivory Black			Ca (trace)	

The *Rowney* acrylic colours all had large iron peaks indicating that the pigments are iron oxides. The barium peaks seen in all the acrylic colours are probably due to $BaSO_4$ used as a white filler material. The calcium and strontium probably occur as ions substituted for barium in the $BaSO_4$. The manganese peaks are likely to be due to MnO_2 used as a pigment in burnt umber, raw umber and ivory black. The manganese and iron peaks in ivory black are small. The main black pigment in ivory black is probably carbon. Burnt sienna had a small arsenic peak probably due to orpiment (As_2S_3).

The *Winsor and Newton* dry ground artist's pigments are much purer than the acrylic colours. The main ingredients are iron oxides. There were very small calcium peaks for yellow ochre, raw umber and ivory black and this may be due to $CaCO_3$ used as a white filler. Raw sienna had a little arsenic peak probably due to orpiment. Raw umber had a small manganese peak probably due to

black MnO_2.

Lamp black and Vandyke brown had no inorganic elements and are assumed to be completely organic in composition.

SUPPLIERS

Racanello 55 050 acrylic silane.

Ard.F. lli Racanello S.P.A.
Industria Vernici e Smalti,
Padua,
Italy

Winsor and Newton dry ground artist's pigments.

Winsor and Newton Artist Materials
51 Rathbone Place
W1P 1AB

tel. 071 636 4231

Rowney acrylic colours.

George Rowney and Co. ltd
12 Percy St.
London
W1A 2BP

tel. 071 636 8241

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- ILLUSTRATIONS -

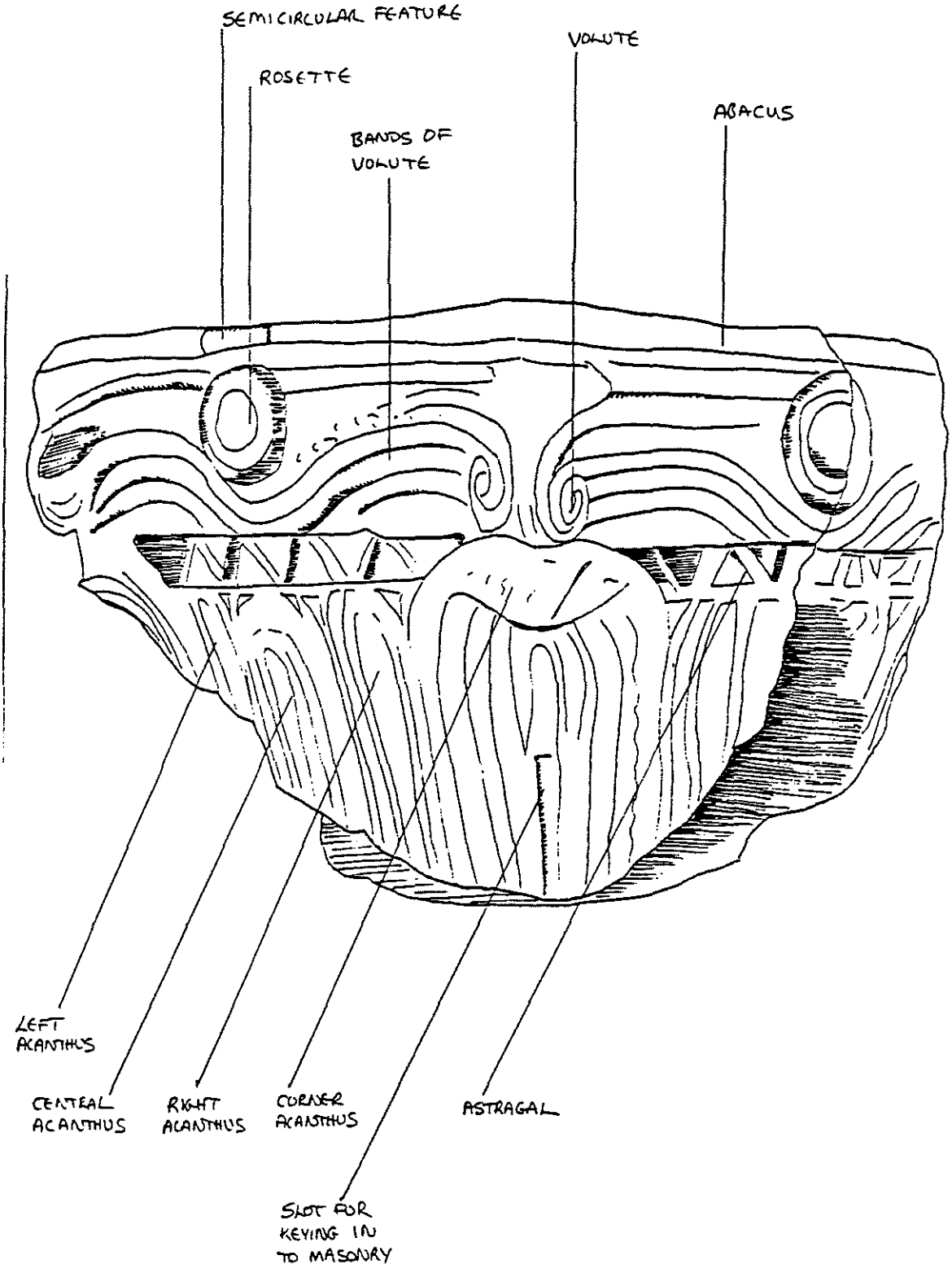

Fig 1. Diagram showing the morphology of the capital. Scale 1:4

Fig 2. Face 1 of the capital.

Fig 3. Face 2 of the capital.

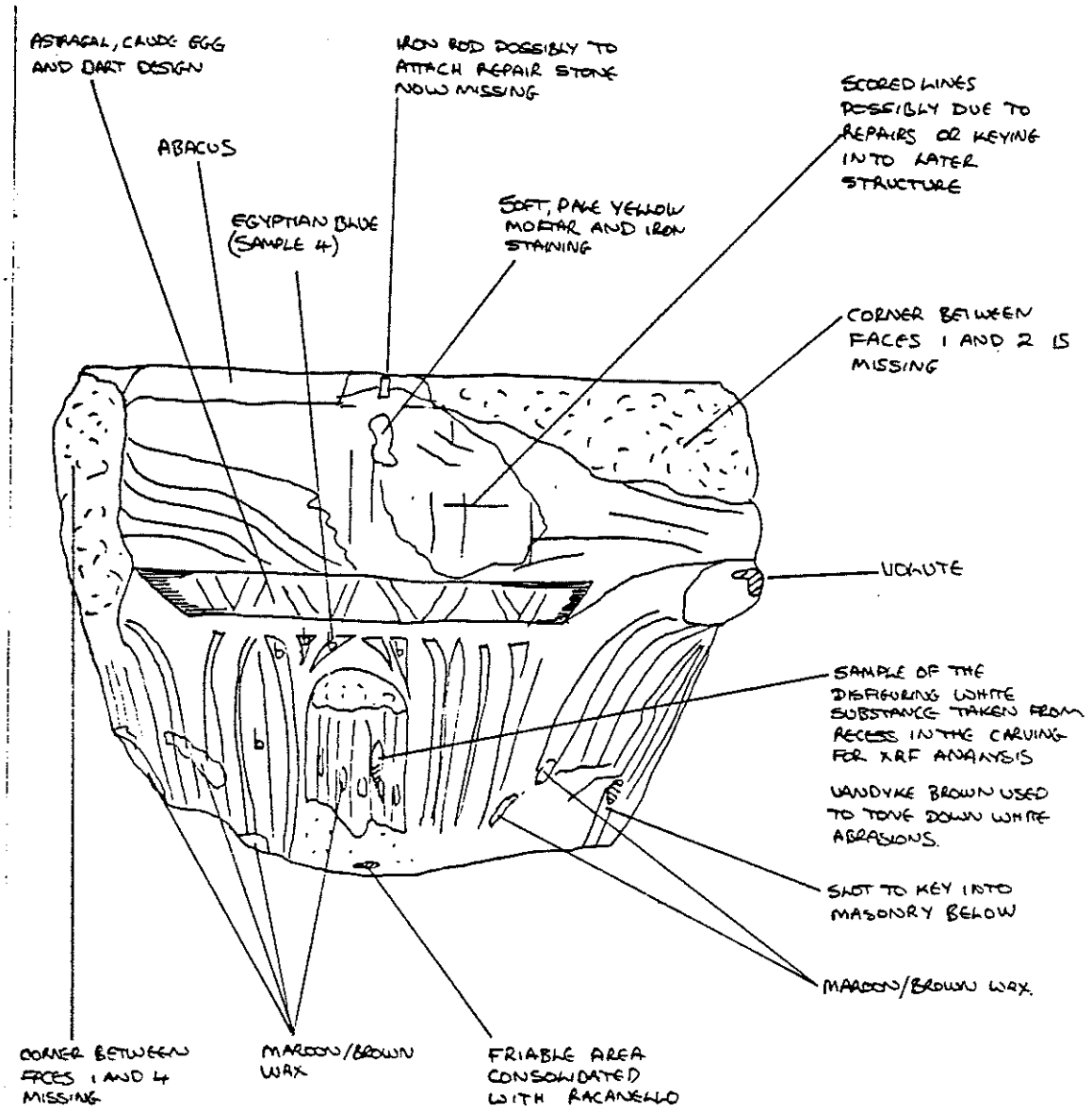

Fig 2. Face 1 of the capital. Scale 1:5

Key

	Abrasion
b	Egyptian blue
y	yellow ochre
r	red ochre

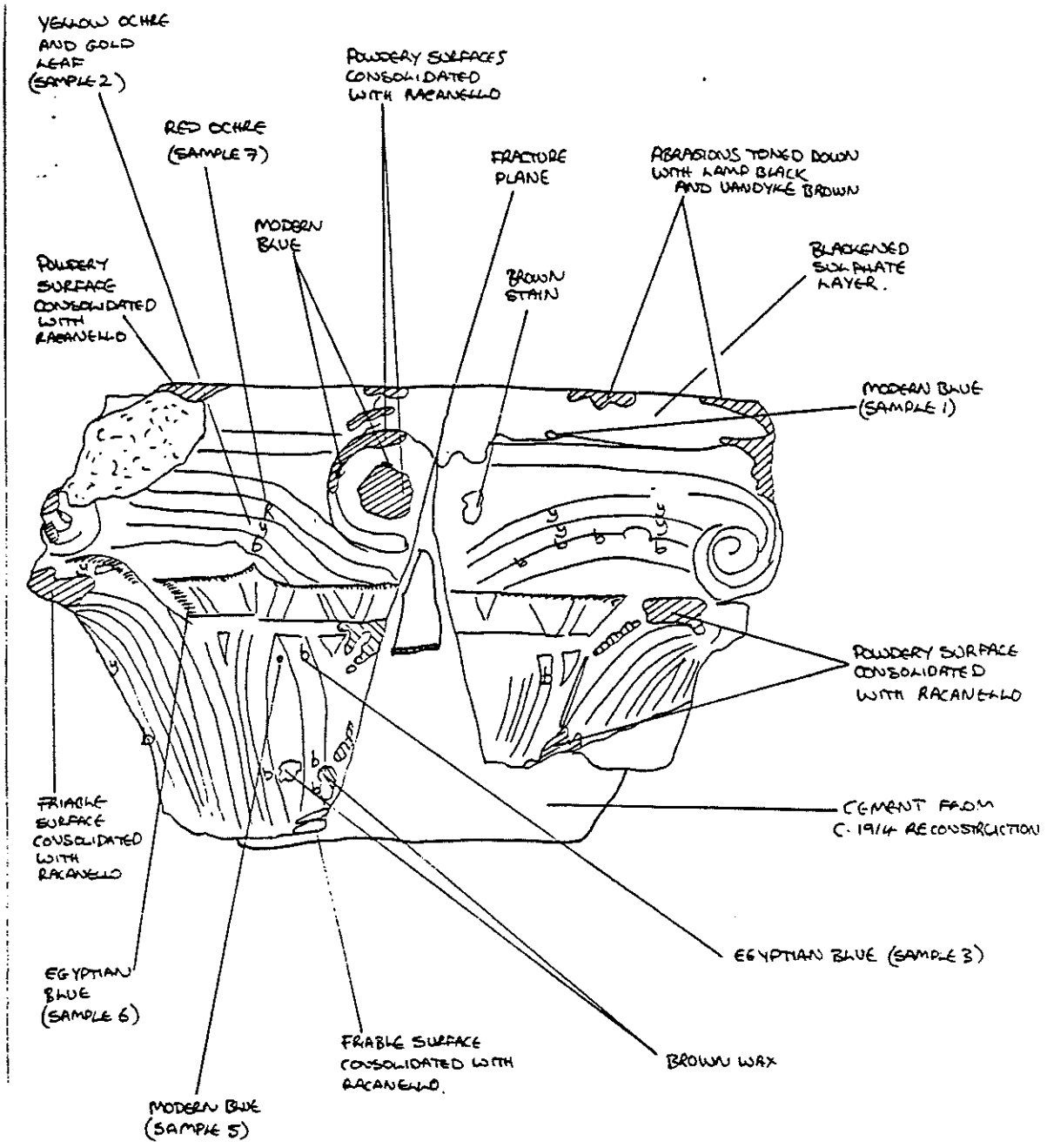

Fig 3. Face 2 of the capital. Scale 1:5

For key see fig 1

Fig 4. Face 3 of the capital.

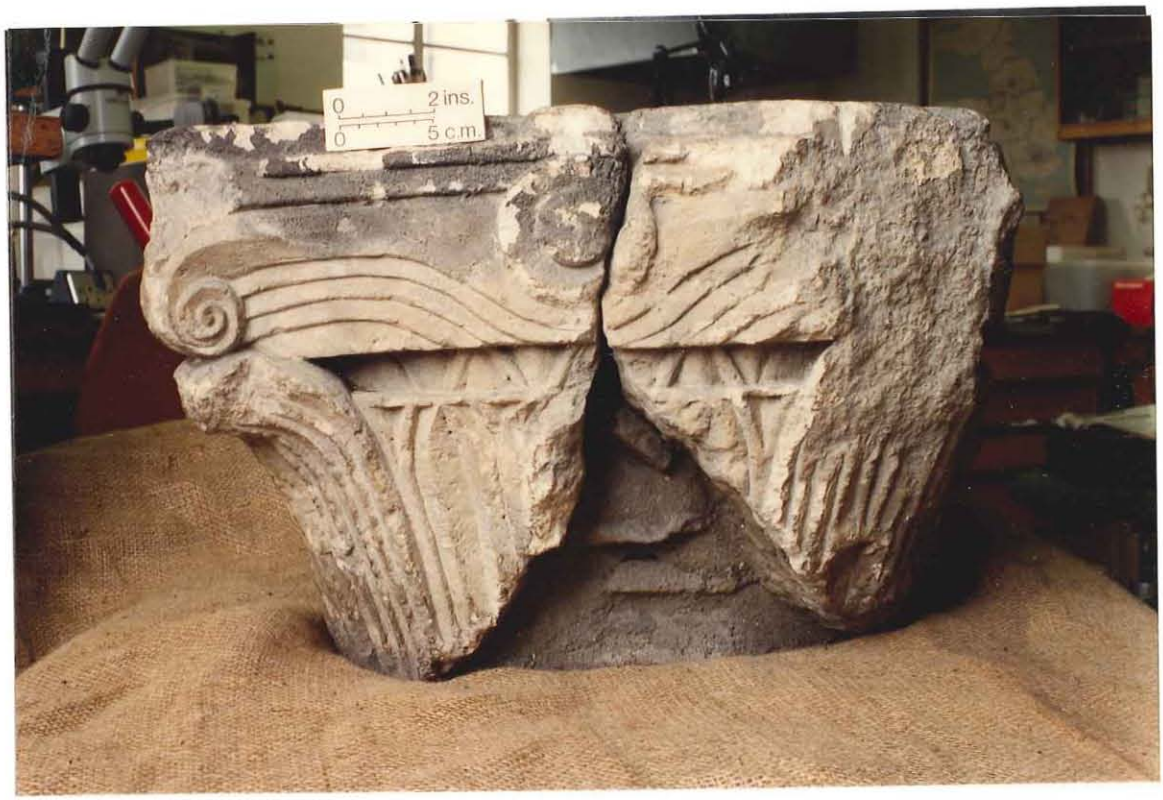

Fig 5. Face 4 of the capital.

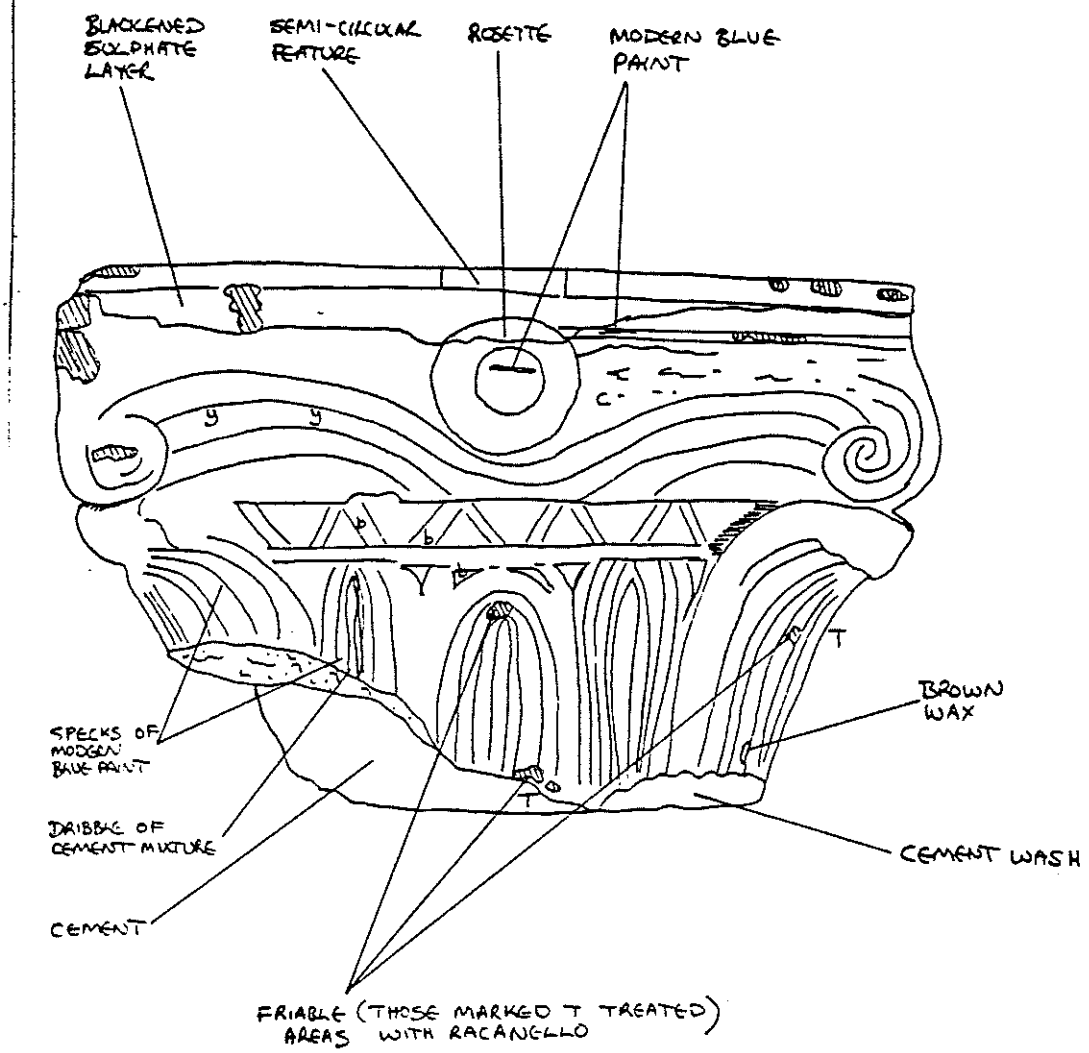

Fig 4. Face 3 of the capital. Scale 1:5

For key see fig 1

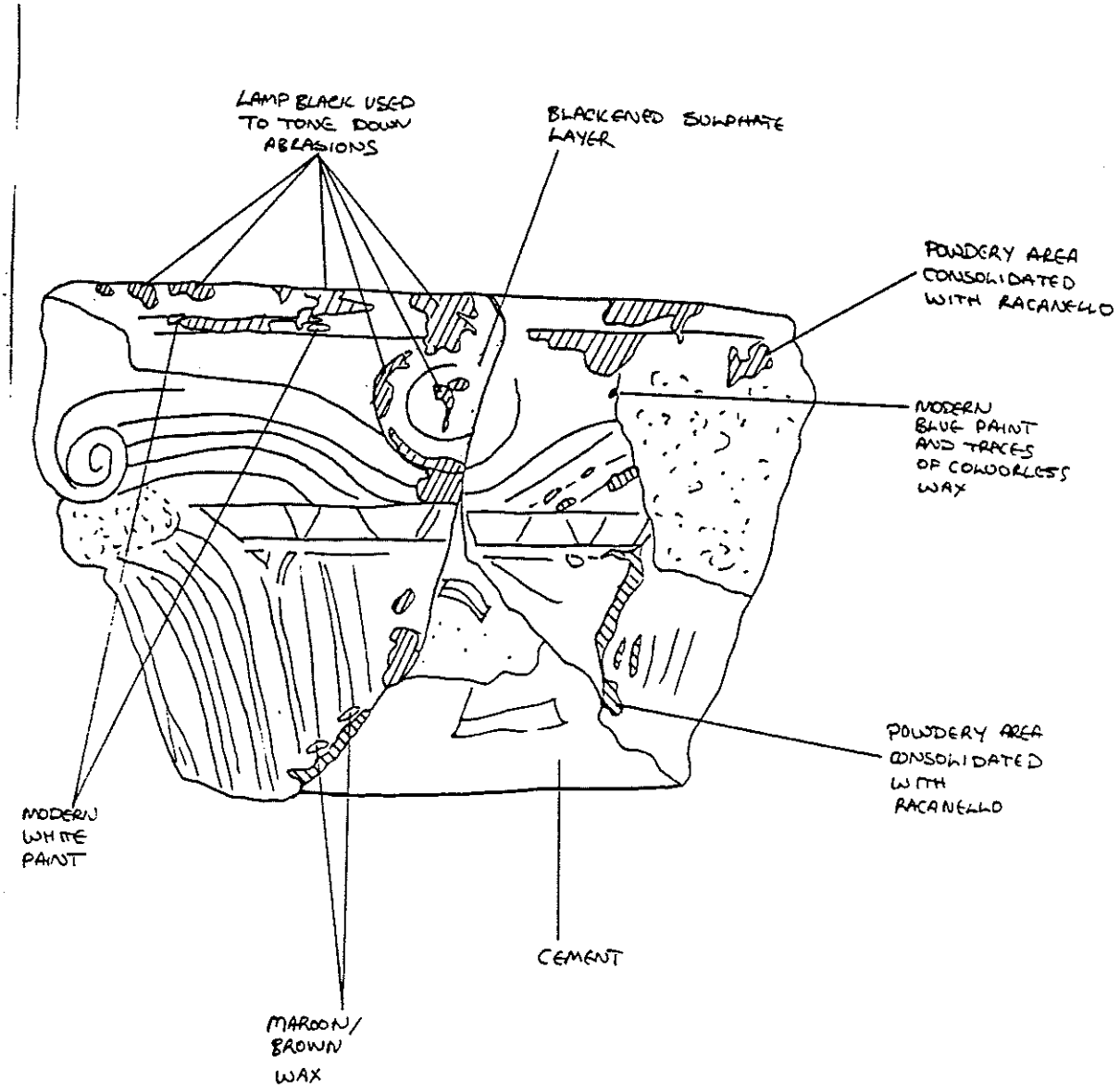

Fig 5. Face 4 of the capital. Scale 1:5

For key see fig 1

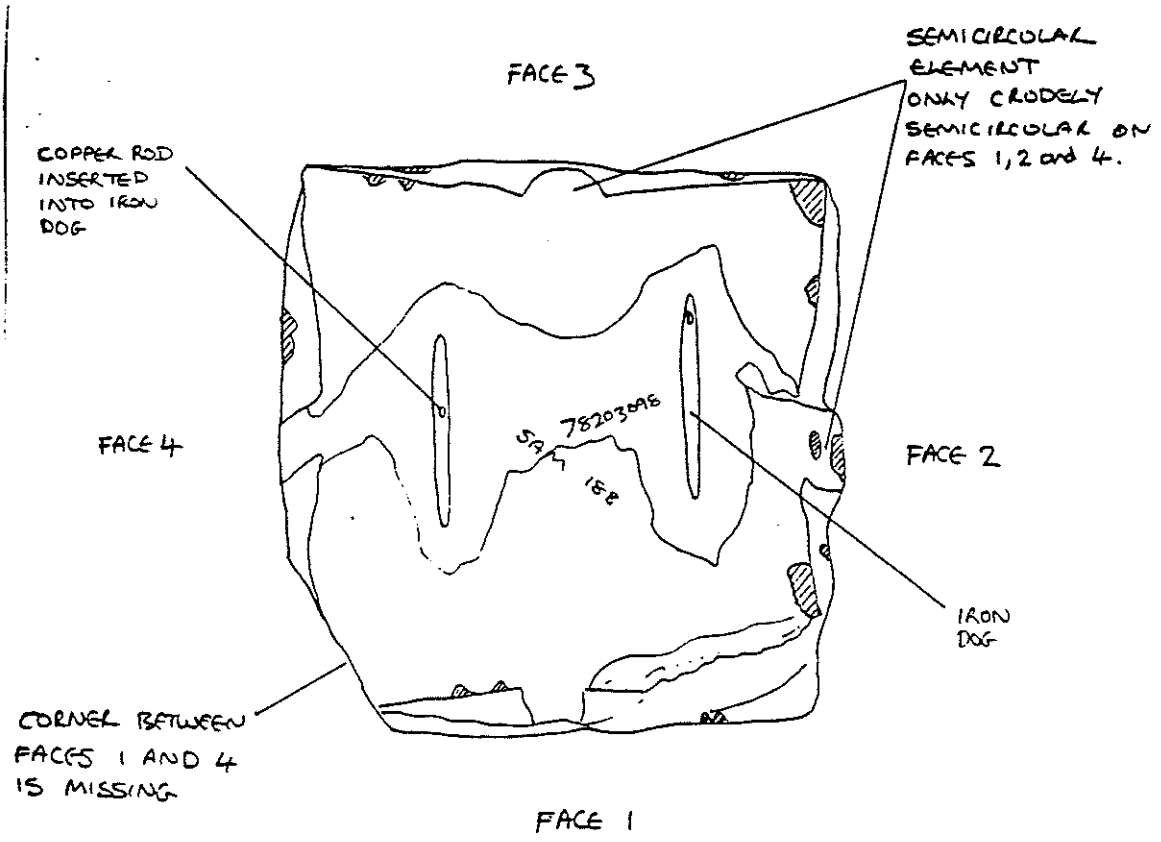

Fig 6. Top surface of the capital. Scale 1:6

For key see fig 1

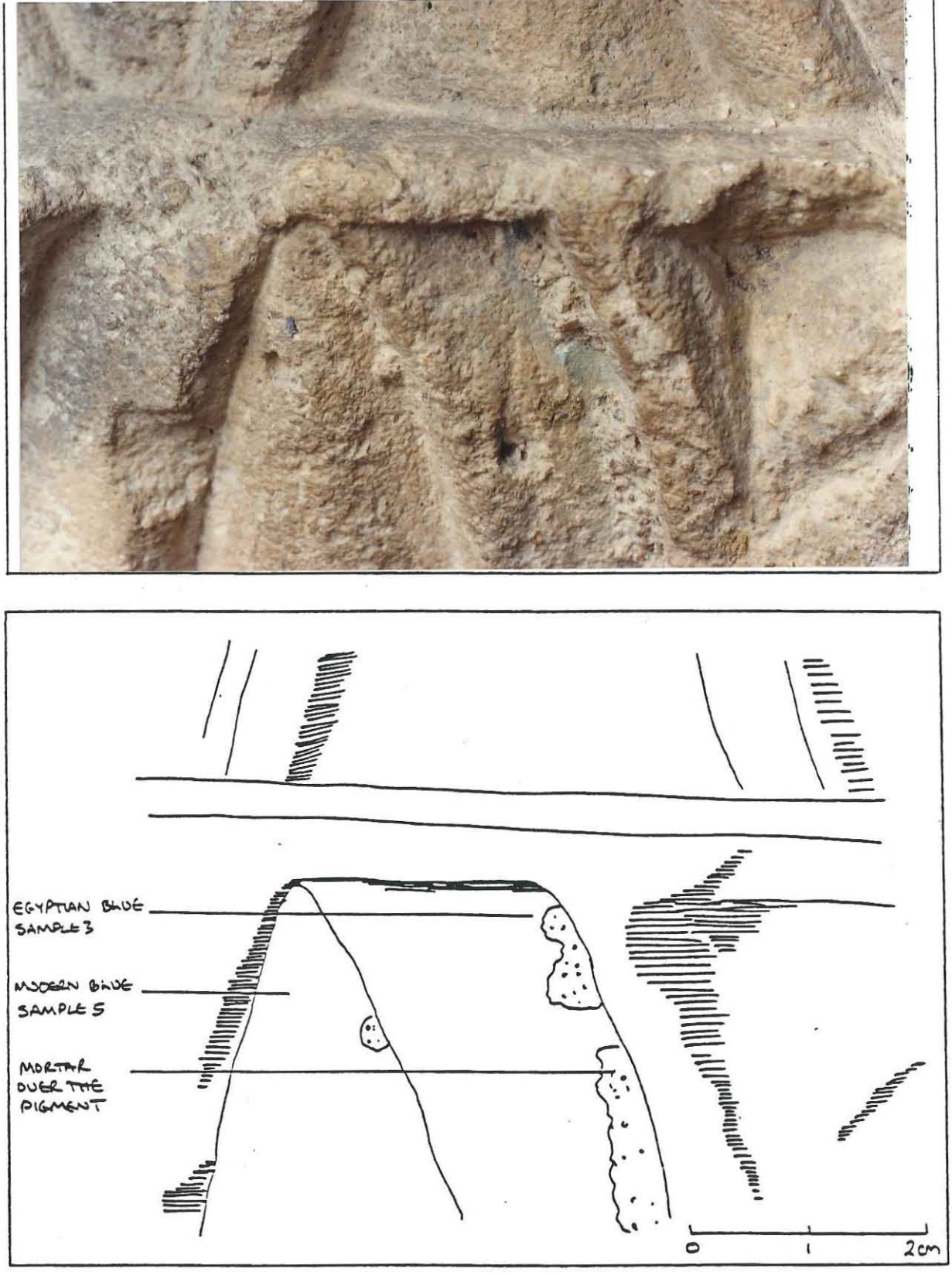

Fig 7. Photograph showing the Egyptian blue beneath the lime mortar, at the top of the left aconthus leaf on face 2. The diagram anotates the photograph (x2).

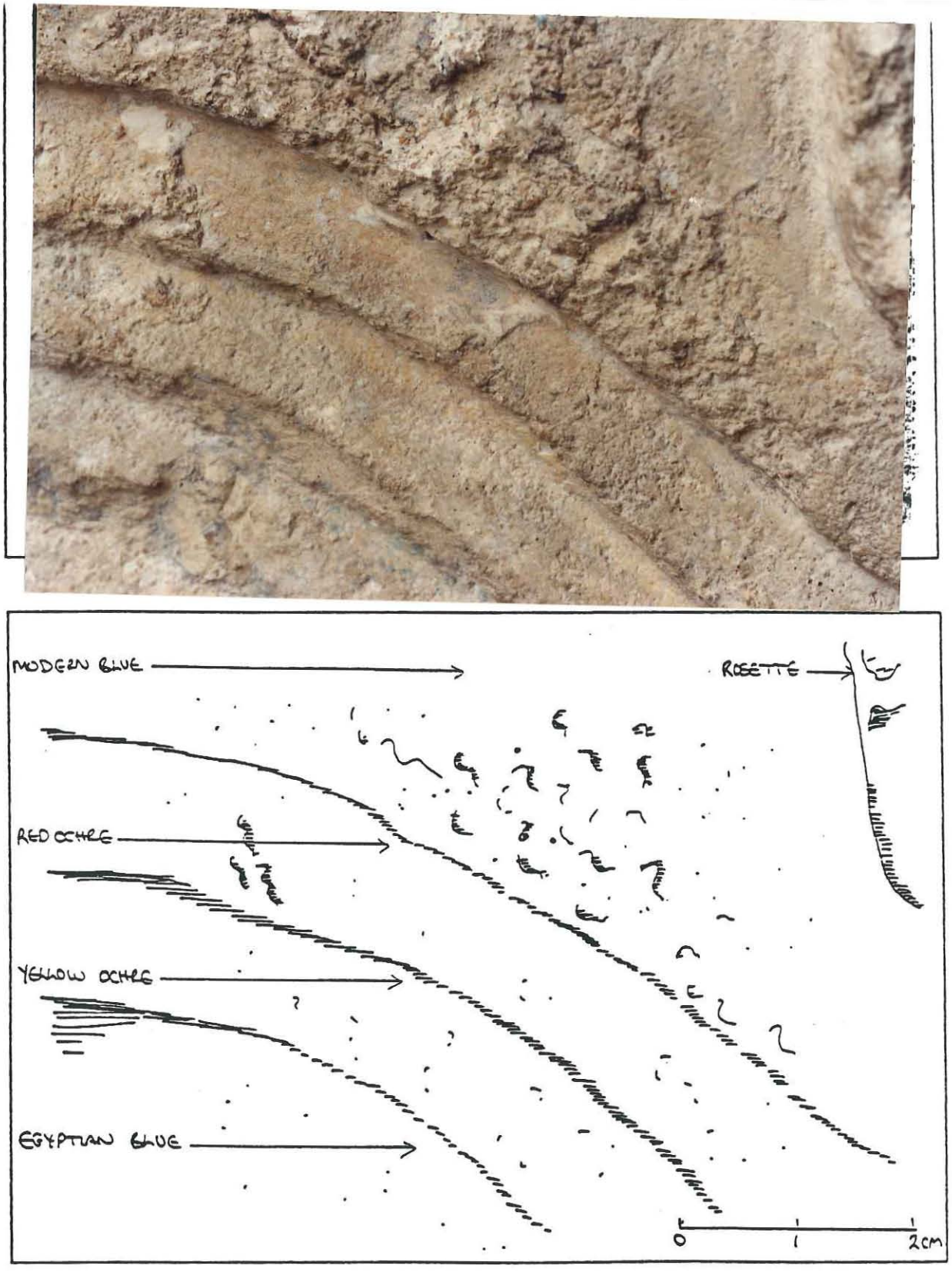

Fig 8. Photograph showing the pigments on bands to the left of the rosette on face 2. The diagram anotates the photograph (x2).

Fig 9. Egyptian blue above the central acanthus leaf of face 1 (x2).

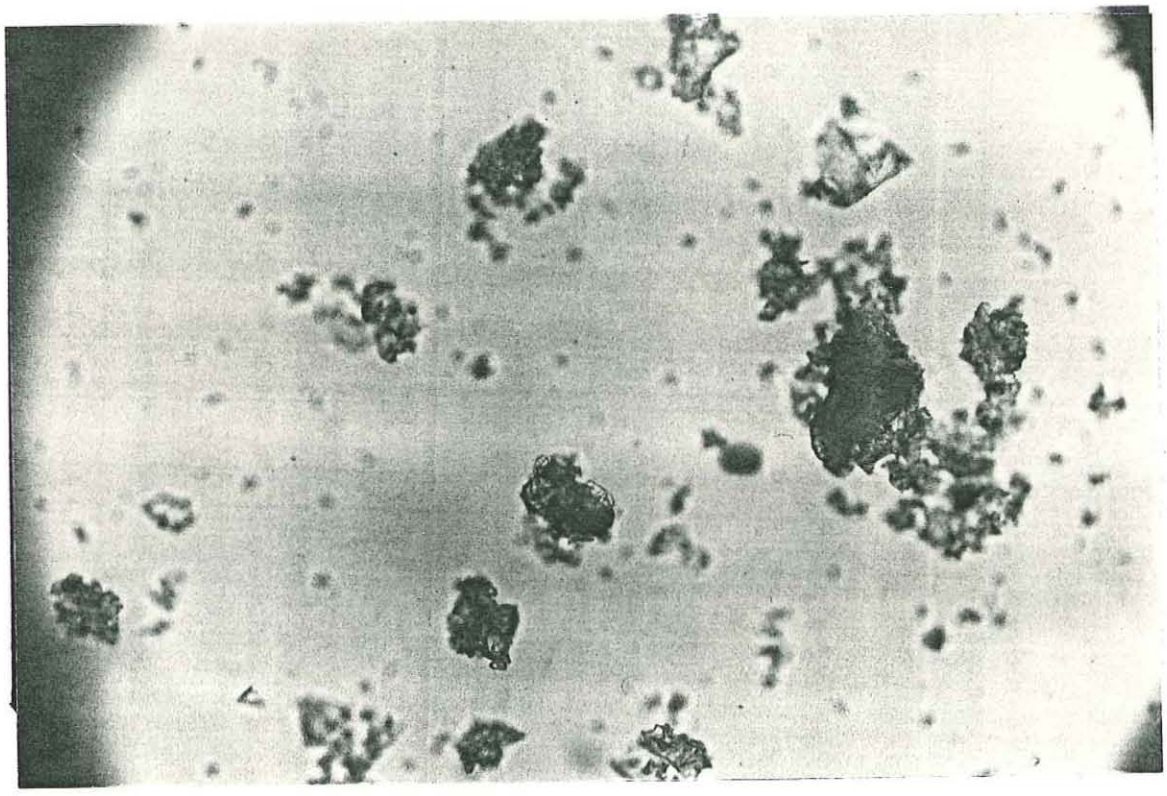

Fig 10. Particles of Egyptian blue with colourless quartz particles of the same size. (x100)

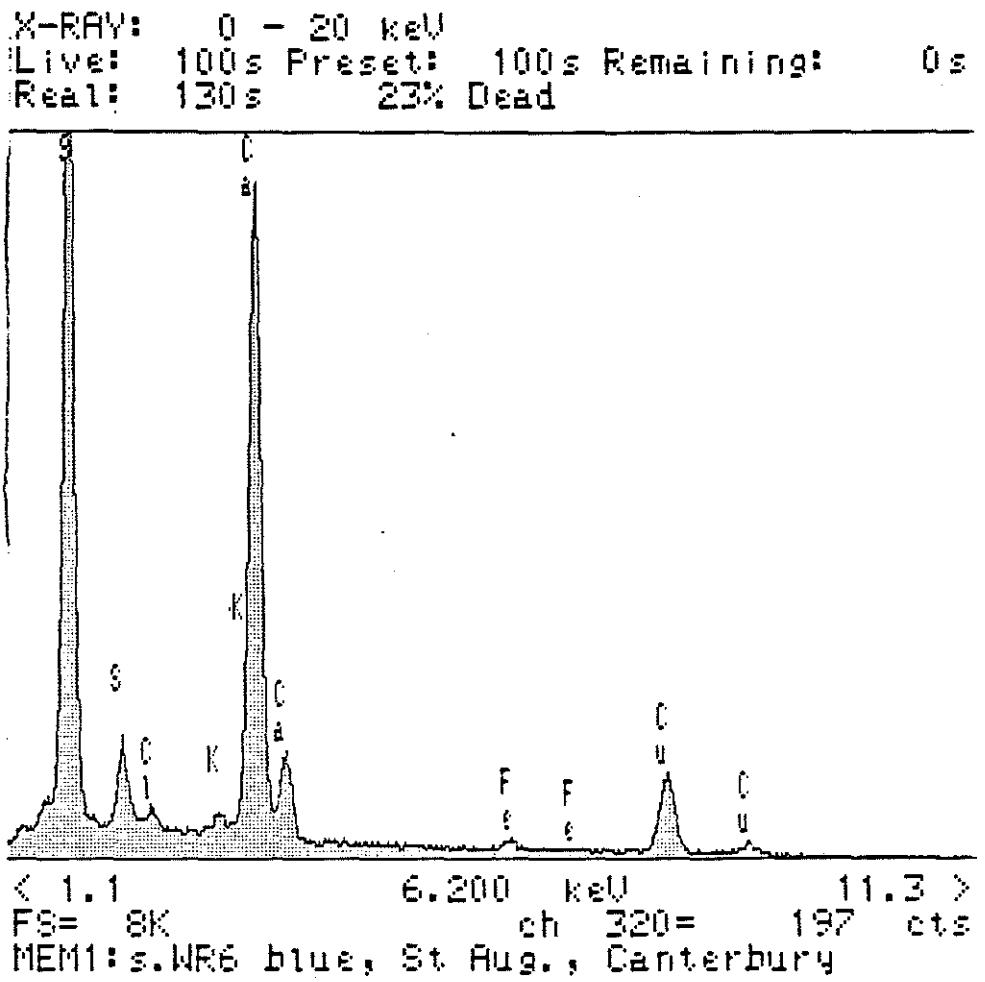

Fig 11. SEM/EDXA of a sample of the blue, showing high silicon, calcium and copper peaks, from which it can be deduced that the pigment is Egyptian blue (Ca Cu Si_4 O_{10}).

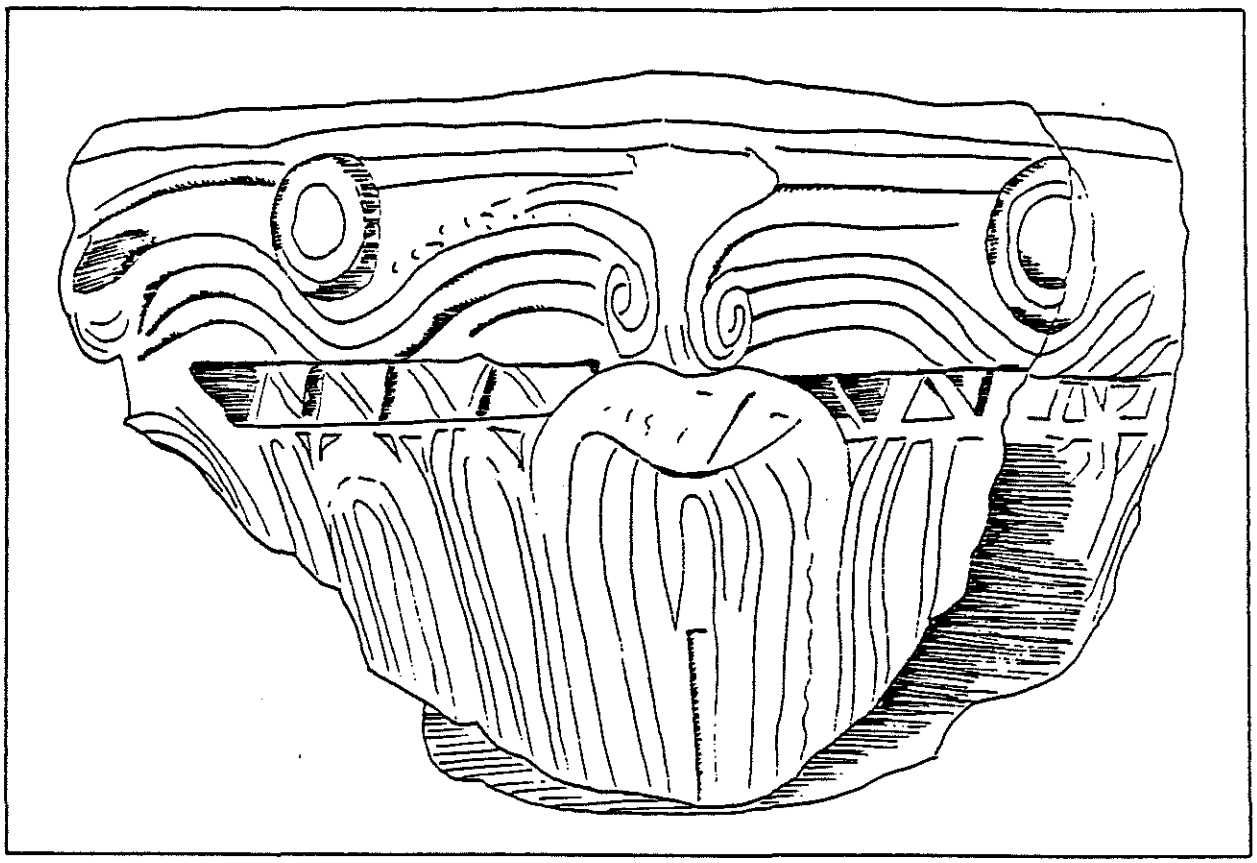

Fig 12. Suggested reconstruction of the paintwork. Scale 1:4

Key

Egyptian blue

Red ochre

Gold leaf over yellow ochre bole

Fig 13. Face 4 of the capital after treatment. Scale 1:5

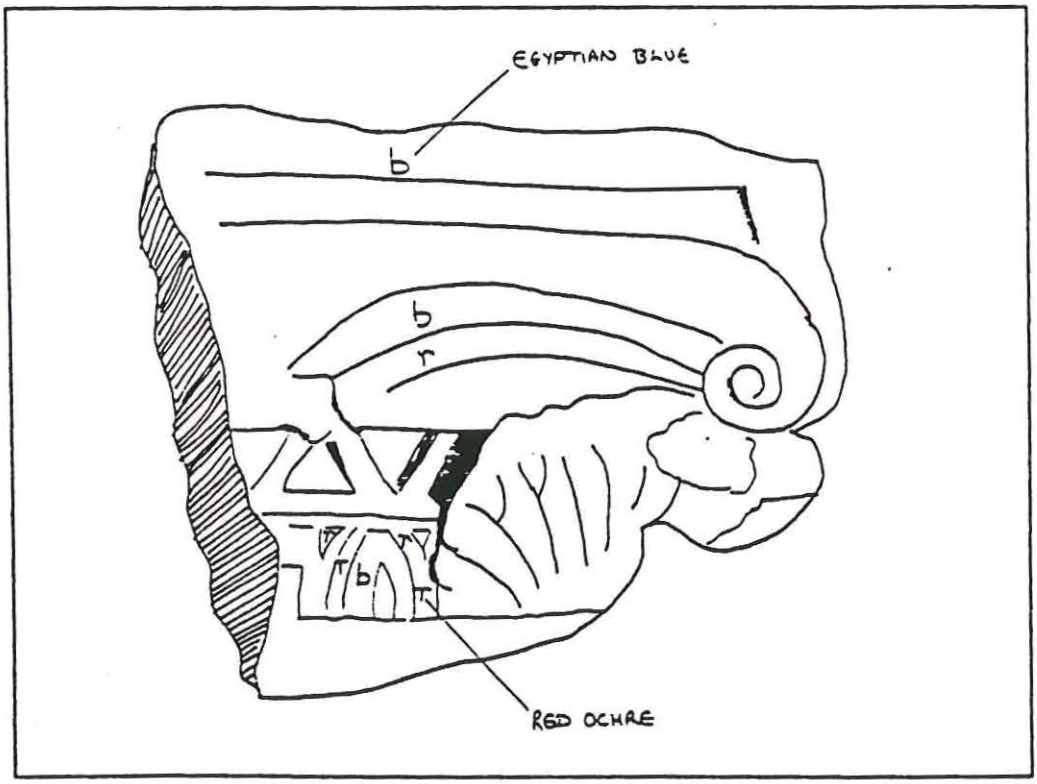

Fig 14. Quarter capital (AML 78203656). Scale 1:4

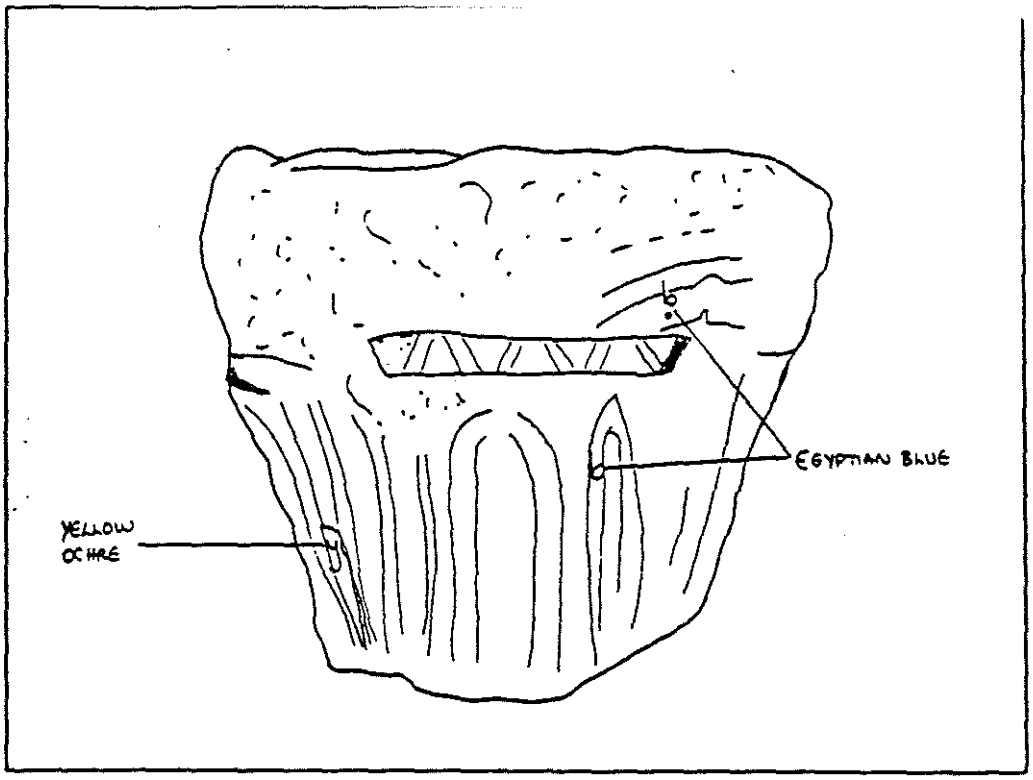

Fig 15. Half capital (AML 78203093). Scale 1:5

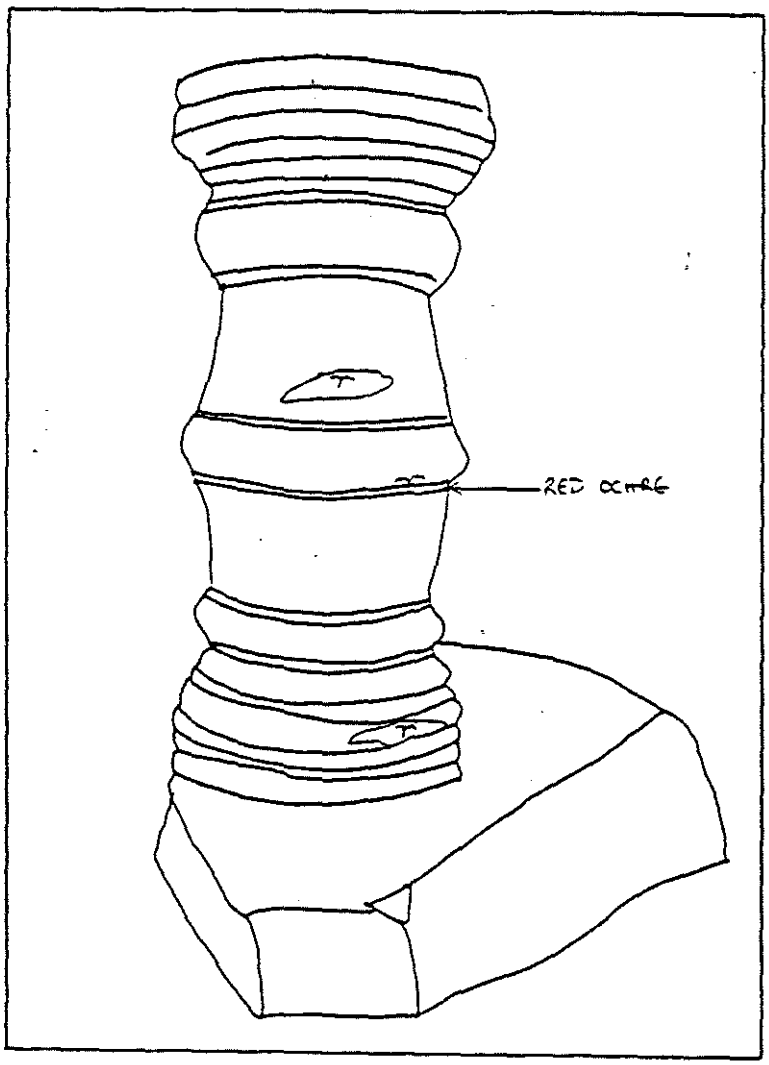

Fig 16. Baluster shaft (AML 78203095). Scale 1:6