INTRODUCTION
Over 350 individual small finds of stone from the excavations of 1995 to 1999 were retained for determination. Generally recorded under the category of ‘worked stone’, relatively few of the specimens actually show evidence of any working or dressing and are probably better described as ‘building stone’ or ‘construction rubble’ (the finds, by their nature, are small in size). In the main it is only the marbles that show any evidence of working, and this is usually as thin slabs or slices of stone.

THE STONES
The small finds can be divided into four groups:
• Building stone – approx. 68%
• Decorative stone – approx. 8%
• Raw materials – approx. 14%
• Artefacts – approx. 4%
The balance is made up of natural materials (e.g. flint), and misidentified finds such as tile, slag, etc.

Building stone
The bulk of the stonework comprises a variety of sandstones, Mixon, chalk, other limestones, as well as a few more unusual materials.

• Sandstones: although a wide variety appears to be represented, they can be roughly divided into four groups. These are:
  (1) Large quantities of the typical pale grey, glauconitic and calcareous ‘malmstone’ of West Sussex (Lower Cretaceous, Upper Greensand Formation);
  (2) The darker, glauconitic, non-calcareous sandstones reminiscent of certain areas of the Isle of Wight (Lower Cretaceous, probably Upper Greensand Formation);
  (3) The orange-brown, slightly glauconitic sandstones similar to those found in the Midhurst — Petworth areas (Lower Cretaceous, Hythe Formation). This is the Pulborough Stone of Cunliffe (1971);
  (4) Other sandstones. Glauconitic and other varieties of sandstone occur abundantly in the Lower Cretaceous rocks (and some Tertiary rocks) of West Sussex and the Isle of Wight, as well as further afield. Malmstone is fairly distinctive, but other varieties of sandstone may have a number of different origins or could be simple variations within a single outcrop. Two fragments were suggestive of Horsham Stone, which is more commonly used as paving or roofing material.

• Mixon stone: Alternatively known as Mixen or Alveolina limestone (Eocene, Bracklesham Group, Selsey Formation), this distinctive foraminiferal limestone is now only available from a submerged reef off the tip of Selsey Bill, but may have been accessible for quarrying in Roman times. However, two of the pieces show evidence of an intertidal source, being water-worn and having marine borings.

• Chalk: A number of pieces, probably of local origin. Occasional traces of marine borings suggest an intertidal source for at least some of the material.

• Limestones: These are mostly of a type that can fairly confidently be ascribed to the Bembridge Limestone from the north of the Isle of Wight (Eocene age). In addition, there are two pieces of Calcaire Grossier from France (Eocene, Lutetian), a distinctive limestone with the tubes of the fossil marine worm Ditrupa. This material is known from other Roman sites, including column pieces in the main Fishbourne Palace site (Cunliffe 1971). A single piece of a slightly oolitic bioclastic limestone is also suggestive of a French, rather than British, origin.

• Other building stones include fragments of slate (roofing material?), tufa, and probable erratics. The latter includes small pieces of igneous and metamorphic rocks (e.g. hornblende granite, schist and quartzite) and sedimentary rocks (e.g. Carboniferous limestone, Palaeozoic sandstone), which are all probably erratics associated with
the flint gravels in the area. Sarsen stone is also represented (a residual silcrete that occurs as boulders and pebbles in superficial deposits on the South Downs and coastal plain). It is possible that the fragments of tufa were originally cut and used as a decorative stone. A single piece of clay concretion is probably of natural origin from the underlying geology.

The relative occurrence of the more common building stones is expressed in the following Table.

Table 6. The relative occurrence of the more common building stones.

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. % of all stone small finds</th>
<th>Approx. % of building stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandstone</td>
<td>40</td>
<td>57</td>
</tr>
<tr>
<td>Malmstone (Upper Greensand)</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td>Darker glauconitic stone (possibly IoW)</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Hythe Formation (Lower Greensand)</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Others</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Mixon (Selsey)</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Chalk</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Limestones (mainly Bembridge from IoW)</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Two examples are illustrated (Figs 120, 169)

Decorative stone

Although possibly used (or reused) as simple building material, the stone in this category is typically cut and polished. Unlike the building stone, many of the examples show evidence of working. Three groups of stone are represented:

- Foreign marble: only a few examples, and detailed identification has not been carried out.

- Purbeck ‘marble’: not a true marble in the geological sense, but still a stone that takes a high polish. Well represented and characterised by the presence of the small fossil gastropod *Viviparus cariniferus*. Other pieces of Purbeck stone with fossil bivalves also occur.

- Sussex ‘marble’: only one piece, similar to the Purbeck material but characterized by the larger fossil gastropod *Viviparus sussexiensis*.

- Red silty mudstone, fossiliferous (recorded by Cunliffe, 1971 as foreign, probably Mediterranean, origin) — a large number of small pieces. Cunliffe (1971) recorded it as a decorative stone and found in large quantities, but an alternative possibility is suggested here; the mudstone is relatively soft and could easily be ground up to make a pigment (red ochre) for wall plaster.

Raw materials

This category includes:

- Coal: a large number of small pieces from different contexts.

Artefacts

These include items that are not necessarily worked stone, but are worth mentioning.

- Stone counters: a number of small, rounded black flint pebbles have been labelled as ‘stone counters’. Whilst this may be correct, it is worth observing that care should be taken with such identification at the Fishbourne site. The geology beneath and adjacent to the excavation area includes the base of the London Clay Formation and the older Reading Formation (Eocene). The junction beds typically contain small black flint pebbles of exactly the form identified as “counters”, and these can be expected to occur in the overlying soil as well. Such pebbles found in the absence of any other larger, more irregular black flints stand a better chance of being real counters. Those found in association with other black flints are likely to be natural.

- Lava and pumice: several larger pieces and many fragments, often labelled as querns.

- Calcite crystals: a number of these have been found. Presumably these had some specific use, either as a raw material or as an artefact or curiosity.

KEY CONTEXT GROUPS

From among the many contexts from which unworked and worked stone was collected, some key context groups are worth commenting on. The first of these comprises the stones from the fill of the central pit (Phase AH) and from between the large greensand slabs forming the floor of the central pit (Phase AF). Details are provided in Table 7.

The highest proportion of worked stones came from the large midden deposit in Area A (Phase AF). This is consistent with the idea that such worked stones represent occasional building debris discarded from time to time during refurbishments to the Palace. A large amount of stone was recovered from
the midden in Area B (Phase BE). Finally, an amount of stone was collected from the northern pit in Area B (Phase BF). Some differentiation is evident in the distribution of various types of stone. It is noticeable that the worked pieces of marble were concentrated in the midden in Area A with much more general building stone in Area B.

STONE SUPPLY
West Sussex is generally poor in good quality building stones, as the underlying geology is principally chalk and flint, or unconsolidated Lower Cretaceous and Tertiary sands and clays. The variety of stone from the Fishbourne excavations indicates a number of different sources that demonstrates the need to look further afield for suitable construction materials. However, the principal building stones still appear to have originated from within the area of West Sussex and the Isle of Wight and only more select materials have come from more distant sources.

The principal sources are therefore:
- West Sussex and the Isle of Wight (maritime transport) — this includes the bulk of the material that can be classed as a building stone because of the larger specimen size and/or frequency of occurrence (ie Mixon, Upper Greensand ‘malmstone’, Hythe Formation sandstone, Horsham Stone, other sandstones characteristic of the Isle of Wight, chalk and Bembridge Lime- stone). Mixon stone, chalk and building stones from the Isle of Wight could easily have been worked from coastal outcrops and transported to Fishbourne by boat.
- West Sussex: malmstone, Hythe Formation sandstones, and Horsham Stone all form accessible outcrops to the north of the South Downs and are likely to have been well-known as a ready source of building material although requiring overland transport.
- Purbeck: a source of decorative stone (indicated by the number of worked pieces), but possibly not of building stone. The stone would have been transported by boat to Fishbourne, either as the raw material or as dressed stone.
- Further afield and overseas: this includes slate and coal (which are possibly of British origin), the foreign marbles, Calcaire Grossier limestone, red mudstone, and the lava and pumice querns.

DISCUSSION
The small finds stonework indicate a predominant usage of locally sourced material for building stone (West Sussex and Isle of Wight); Purbeck for decorative stonework and a smaller range of marbles and other exotic material from further afield. The local materials mainly include malmstone (Upper Greensand) and Mixon, with lesser quantities of other sandstones, limestones and chalk. Slate was also imported, presumably for use as roofing material. Industrial and/or construction activities are indicated by the presence of coal and red mudstone (a suggested source of red ochre). It is recommended that any further excavations include observations on the occurrence and character of flint pebbles as ‘stone counters’ and some of the foreign rocks could be of natural origin. A study of any larger building stones may also assist in more precise determination of the source for some of the material.

<table>
<thead>
<tr>
<th>Year</th>
<th>Small Find No.</th>
<th>Context</th>
<th>Context Type</th>
<th>Stone Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBE 96</td>
<td>755</td>
<td>237.2</td>
<td>fill of central pit</td>
<td>Purbeck ‘marble’ – limestone</td>
<td>With fossil <em>Viviparbus cariniferus</em> (small V. gastropods)</td>
</tr>
<tr>
<td>FBE 96</td>
<td>756</td>
<td>237.2</td>
<td>fill of central pit</td>
<td>Red silty mudstone</td>
<td>Foreign, probably Mediterranean origin (Cunliffe 1971)</td>
</tr>
<tr>
<td>FBE 96</td>
<td>784</td>
<td>284</td>
<td>in between large stones in central pit</td>
<td>Sandstone, glauconitic</td>
<td>Pale, whitish, slightly glauconitic, non-calcareous. Lower Cretaceous</td>
</tr>
<tr>
<td>FBE 96</td>
<td>785</td>
<td>284</td>
<td>&quot;</td>
<td>Sandstone, glauconitic</td>
<td>Larger piece. Typical of Lower Greensand</td>
</tr>
<tr>
<td>FBE 96</td>
<td>739</td>
<td>284</td>
<td>&quot;</td>
<td>Purbeck ‘marble’ – limestone</td>
<td>With fossil <em>Viviparbus cariniferus</em> (small V. gastropods). 2 pieces</td>
</tr>
<tr>
<td>FBE 96</td>
<td>741</td>
<td>284</td>
<td>&quot;</td>
<td>Mixon limestone</td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Stones from some key context groups.
During the five-year excavation period a total of 7,710.059 kg of Roman brick and tile was retrieved and cleaned (Figs 170–73).

**METHOD**
Table 8 below shows the weight of material by category. Categories are discussed individually in the report in the digital supplement. Throughout the report the unqualified word *tegula* is used for roof tile.

**CERAMIC RELIEF-PATTERNED TILES**

by Ernest Black

The excavations of 1995–99 produced 70 fragments of Relief-Patterned tile (Figs 172–74). These were usually small and often abraded. Dies previously recorded from Fishbourne were: 4, 13, 19, 22, 48, 55, 60, 81 and an uncertain Group 5 (Diamond and Lattice) die (Betts et al. 1997). Of these dies 4 (3 fragments), 13 (27 fragments), 22 (4 fragments), 48 (16 fragments), 55 (6 fragments) and 81 (a single fragment) are represented in the new material. Die 60 may be represented by a single uncertain fragment. New dies for the site are: 21 (5 fragments), 24 (2 fragments), and 37 (a single fragment). Dies 20 and 40 may each be represented by a single uncertain fragment. Two fragments seem to be Group 5 patterns but are too small for identification.

**DISTRIBUTION OF KEYED TILE**

This category comprises fragments of box-tile keyed with relief-patterned keying, scouring or combing, as well as a few fragments of keyed bricks. The distribution of keyed tile follows a familiar pattern. Most examples are from the filling of the stream, the pitfills of Area B, or lie north of Building 3. Those keyed tile fragments that encroach over the western end of Building 3 are from contexts associated with the demolition of the Palace. To the north-east of Building 3 the tile fragments occur at higher levels found in post-Roman levels. The contexts in which the majority of the keyed tile fragments were found bear this out. Context 443 is a Palace-demolition spread (Phase AH), while contexts 904 & 905 are 2nd- and 3rd-century midden deposits (Phase BE) in Area B. Context 909 is the fill-

<table>
<thead>
<tr>
<th>Year</th>
<th>Unclas</th>
<th>Tegula</th>
<th>Imbræx</th>
<th>Brick</th>
<th>Flue</th>
<th>Pipe</th>
<th>Other</th>
<th>Discards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>64.85</td>
<td>69.775</td>
<td>6.350</td>
<td>41.425</td>
<td>2.125</td>
<td>1.300</td>
<td>1.025</td>
<td>187.050</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>132.345</td>
<td>167.980</td>
<td>9.715</td>
<td>64.670</td>
<td>7.285</td>
<td>0.875</td>
<td>1.455</td>
<td>384.325</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>1202.380</td>
<td>1484.920</td>
<td>347.320</td>
<td>317.495</td>
<td>25.595</td>
<td>8.020</td>
<td>1.055</td>
<td>3386.785</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1702.408</td>
<td>2074.227</td>
<td>451.615</td>
<td>1122.014</td>
<td>62.155</td>
<td>49.620</td>
<td>20.945</td>
<td>2227.075</td>
<td>7710.059</td>
</tr>
</tbody>
</table>

Fig. 172. The distribution of selected Roman keyed tile finds. Levels are in metres above sea-level; numbers in brackets indicate actual number of finds. This is the same for all finds distribution maps. **Usually only finds with three-dimensional locational co-ordinates are plotted — hence ‘selected’**.
THE TESSERAE
by Derek Turner

GENERAL
During a survey of the small finds relating to the five years’ excavation, it was noted that three contexts (C558, C585 and C598) associated with a midden deposit (Phase AF) contained an unusually large number of tesserae relative to the total found. It was decided to look at these three assemblages. As a result of the preliminary findings, it became apparent that it would be useful to look at the whole five-year assemblage before the next phase of excavations commenced. The bar- and pie charts in the ADS supplement show the contexts where the larger numbers and percentages occur (Figs 175, 176).

A manual count shows that some 1442 tesserae have been collected over the five years—despite the quantity it should be remembered that this number represents an area of floor of a maximum 490 mm square. However, the number is sufficient to allow some modest analysis leading to a useful conclusion.

DISTRIBUTION
The distribution of all tesserae shows a pattern similar to that of the distribution of most categories of small finds. The tesserae are almost exclusively to the north of Building 3. Since there is no hint of Building 3 having ever housed a mosaic floor, the likelihood is that all the tesserae, and indeed most of the associated finds from the north of Building 3, came from the Palace next door as repeated dumps of domestic rubbish. Their concentration in midden deposits (C558, C585 and C598) of Phase AF, and in Building 3 demolition deposit C559 (Phase AG) argues for a refurbishment of a mosaic or mosaics in the later 2nd/early 3rd century.

DISCUSSION
It seems clear that the bulk of the material in these deposits was either unused or had been prepared for re-use. The presence of plaster fragments suggest that a room or rooms were being renovated and that a mosaic or mosaics were being restored or replaced. The clean larger red tesserae may indicate that a new mosaic, with red tessellated edging under the new plaster, was being laid. It is possible of course, that several rooms were being modified or renovated. The rods of red material used in the production of tesserae were very well fashioned, suggesting the presence of a skilled mosaic maker on site. Although white tesserae predominated, the number of ‘strong’ colours such as red and yellow and the considerable variety of shading between near black and dark brown, plus grey, together with a few light fawn tesserae, suggest a polychrome mosaic floor under repair or construction.

It noticeable that in five of the six largest ‘populations’ (50 or more tesserae) the white content is skewed markedly above the ‘global’, all contexts, result. In the sixth case (context 507 with 96 tesserae) the result is markedly skewed towards the grey/dark and red shades—especially the former. Since the five large contexts (C598, C558, C585, C559 and C535) represent 59.64% of all tesserae found, it is clear that the smaller population contexts must in the main be skewed away from white towards the ‘colours’. However, it is not the rule that the smaller the number of tesserae in the context, the lesser the proportion of white.
tesserae) is 85% red and 15% grey dark (which may simply indicate that the reds are both larger and more easily spotted) while S56 (with only 12 finds) was 91.7% white.

Too much importance should not be adduced to apparent statistical anomalies. It would be fair possibly to associate contexts where the ‘red’ (and often larger-sized) tesserae percentage is high with work being done in the Palace on a tessellated corridor or at the edge of a mosaic floor.

All the colours and shades noted can be found in 2nd- and 3rd century mosaics in the Palace north wing. There is no intrinsic evidence from the 1995–1999 excavations to suggest which century restoration of mosaics was being undertaken, but other dating evidence within the contexts will suggest which is the more probable.

CONCLUSION
The tesseral evidence suggests that one or more rooms of the Palace were modified or renovated in the later 2nd or early 3rd century, including the replacement of plaster and mosaic construction.

BLUE FRIT
by Susan Clegg & Julia Freeman

The aim of this report is to present results following the analysis of 26 blue pellets recovered from the excavations. The word pigment (Latin pigmentum) means a coloured substance, usually in the form of a dry powder which, when mixed with a vehicle, constitutes a ‘paint’. Pigments, whether crystalline or amorphous, were ground into uniform particles and, as they have no adhesive qualities, required a binding material or medium to hold them in place (Mora et al. 1984).

Pigments may be divided into different categories such as mineral or organic, and natural or artificial, depending on their origin. Natural pigments are found in the earth in the form of carbonates, sulphates, sulphides and oxides. After extraction the mineral was left to dry naturally in the sun. It was then roughly ground and sieved to remove any impurities, reground to a fine powder, cleaned and dried. Artificial mineral pigments are the product of a well-defined chemical process. They are obtained by sublimation or by a wet method through precipitation of chemical solutions (Mora 1984).

It was during the 3rd millennium BC that Egyptian artisans, being ‘... masters [in] the art of fire ...’ began to develop the first synthetic pigment known as blue frit (Delmare & Guineau 1999, 22). Large samples of blue pigment were found in flat-bottomed containers dating from the mid- to late 14th century BC by Sir Flinders Petrie at a ‘factory’ site in the ancient metropolis of Tel el Amarna in Middle Egypt in the late 1890s. These samples, which were examined by Spurrell (1895), consisted of a crystalline compound resulting from the fusion of silica, copper ore and an alkali. Their colours varied from a pale to a dark blue.

The manufacture of blue frit (Figs 177, 178) was codified by Vestorius at the Campanian city of Puteoli in the 1st century BC (Ling 1992). The procedure involved the mixing of finely ground silica, copper filings and flowers of soda into a water-based paste which was then rolled into small pellets. The pellets were allowed to dry naturally then placed in earthenware pots and finally placed in an oven and, according to Vitruvius:

... As soon as the copper and sand grow hot and unite under the intensity of the fire, they mutually receive each other’s sweat, relinquishing their particular qualities, and having lost their properties through the intensity of the fire, they are reduced to a blue colour. (Book VII, 219:1).

The resulting blue crystalline compound was coarsely ground before use. Blue pigmented pellets have been found on different Romano-British sites and were examined, using X-ray diffraction analysis, by the late Leo Biek in the early 1980s (Davey and Ling, 1982).

MATERIALS AND METHODS

RESULTS
Included in this report are photographs, together with a magnified view, of the pellets found in various contexts at the Fishbourne Roman Palace during the excavation seasons of 1997, 1998 and 1999 (Figs 177, 178). Beneath each photograph is a print-out of the XRF results obtained for each of the pellets.

DISCUSSION
After detailed examination by Stereomicroscopy (for fabric) and XRF (for chemical composition) the pellets were divided into four different fabric and structure groups. Those of FRP Type I and III are the most dominant; there is a strong tendency for both of these types to have the chemical ingredients of
Group 2. There is a small scattering of FRP Types II and IV which have the chemical ingredients of Groups 1 and 3. A few examples of FRP Types 1 and III can be seen in Group 4.

Group 1 contains lower proportions of calcium than the other groups; whereas Group 4 pellets contain higher levels of impurity elements. The contents of the two intermediate Groups (2 and 3) differ slightly in the proportions of copper and iron.

The essential elements for making blue frit measured by XRF are copper and calcium. Iron is mainly introduced as a contamination in the sand ingredient. Group 2 pellets seem to have been made with a sand contaminated with more iron than the other groups. Calcium may also be present as tiny shell fragments in the sand, so a higher calcium content (Group 1) may result from the choice of sand used. Lead and arsenic are most likely to have been accidentally introduced together with copper scrap.

Most of the pellets found in this study have the chemical composition of Group 2, but why this recipe was so popular is unclear. Indeed, why the groups varied at all is also unclear, but it may have been down to the individual manufacturer’s technique and the available materials. Alternatively, different ingredients may have been used in order to produce a variety of differing shades of blue. Cost may have come into consideration. If the pellet had been made with discarded or scrap metal, they might have been cheaper to manufacture and may have been used to produce a background colour for a wall painting. However, if the pellet had been constructed using the copper derived from the natural mineral malachite, it would have been an expensive product and would have been much more likely to be painted on the walls as part of a scene (Damiani et al. 2003).

There is no reason to suggest that this product could not have been produced whilst Fishbourne Roman Palace was under construction, as most of the ingredients (calcium, silica and discarded metal) would have been found locally. Unfortunately, no evidence, such as the remains of a kiln, has been found to suggest that blue frit was being manufactured on site (the authors are attempting to reproduce blue frit using ingredients and techniques similar to those described by Vitruvius). The ancient artist, on the other hand, may have brought all the pigments he required for painting the interior walls of the Palace with him. Samples of yellow ochre were found, in tablet form, during the excavation season of 2002, which lends support to the proposition that the artists brought the ‘tools of their trade’ with them.

Blue frit was widely used to decorate the interior walls in Fishbourne Roman Palace and has been found on many samples of painted plaster dating from the 1st to 2nd century AD. A fine example of a 2nd century wall painting is the famous balcony scene, which is on display in the Fishbourne Roman Palace museum. This sample has not been examined by XRF (it is too large to be processed by the instrument). Close inspection of this painting shows that a blue pigment was used. Another example is a large fragment found in Room 1 in the North Wing (Cunliffe 1998).

It appears that there was no standard method for the production of the chemical matrix used in the blue frit pellets found at Fishbourne Roman Palace. This synthetic pigment was used in many different wall paintings, the remains of which were found in the extensive 1960s excavations of the Palace. The pellets may have been manufactured on site or, as seems more likely, they were transported by the ancient artisans. We may never know the answer: were evidence of a kiln to be found during a future excavation, it may then be suggested that at least some blue frit was locally manufactured.