IAN K. WHITBREAD

# Petrographic analysis of ceramics from the Berbati Valley

## Introduction*

Petrographic analysis has been carried out on 241 samples of ceramics found in the Berbati Valley and dating from the Middle Neolithic to Medieval and Modern times. The aim of this study was to gain insight into the range of ceramic fabrics produced and used within the valley over time. It also offered an opportunity to assess the value of using ceramic petrography to study pottery found in field survey, based on material from the Berbati-Limnes Archaeological Survey,[1] with supporting material from excavations, notably at Pyrgouthi.[2] The analysis included samples of fabrics known to have been produced in the valley by their association with kiln sites dating to the Late Helladic, Classical and Late Antique periods, and kiln debris from the Medieval–Modern period. Other fabrics are likely to have been produced in the valley since their compositions are consistent with local geology, but sources from regions of similar geological character outside the valley, e.g. the Corinthia and the Argolid, cannot be ruled out. In a few cases, notably fabrics with substantial volcanic inclusions, the ceramics are likely to have been imported since outcrops of volcanic rock are not evident in the valley.[3]

Whitbread *et al.* have discussed the results of this analysis in their study of chronological developments in ceramic fabric occurrence.[4] The purpose of this paper, however, is to present a fuller account of the fabrics together with details of the archaeological materials sampled. This will provide a valuable reference for researchers studying developments in ceramic technology and ceramic exchange/trade in southern Greece.

The ceramic fabrics reflect the predominantly sedimentary character of the Berbati Valley, which is surrounded by crystalline limestones with cherts, marls and dolomites.[5] The shale-sandstone-chert formation crops out to the west, primarily composed of shales, and undivided flysch, which consists of shales, reddish marls, sandy marls, sandstones, conglomerates and clastic limestones. The northwest part of the valley is occupied by Pliocene-Pleistocene marls, sandy marls and conglomerates, with Quaternary cemented conglomerates occurring in the east. The centre of the valley is covered by Quaternary alluvial fans.

The fabrics are divided into groups and classes, denoted in the format: Group (class). Groups represent major compositional differences (mainly geological in character), and these are subdivided into classes, which constitute variations in composition and texture (mainly geological and technological in character). Fabrics attributed to a class can be uniform or display a range of variation, which is expressed in terms of the homogeneity of the class. Chips were taken from all samples and refired in an electric kiln at 1000°C for one hour in an oxidising atmosphere. This procedure allows a rough comparison of fired clay colours (red, reddish yellow and yellow) without the variations caused by differences in original firing conditions.[6] In some cases, a fabric class will contain both red- and yellow-refired samples, indicating that different clays were used even though the samples may look similar under the polarising microscope. Thin sections were taken from the sherds in their original state, not refired, and the refired results were not used to generate fabric classes, merely to check for variations in the clay used.

* *Acknowledgements*
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[1] See Wells, this volume; Wells 1996a. No samples from the 1999 Mastos survey, however, are included.
[2] Wells 2005; Penttinen 2005; Hjohlman 2005.
[3] Tataris *et al.* 1970.
[4] Whitbread, Ponting & Wells 2007.
[5] Whitbread, Ponting & Wells 2007; Tataris *et al.* 1970.
[6] Whitbread 1995, 390f.

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Felsic (chert limestone garnet)** | | | | | | | | | | |
| 14 | FN | probably jar | coarseware | closed | base fragment | FS400 | R | 34 | **701/242** | 43 |
| 140 | Roman | bowl | coarseware | open | rim fragment – 'Corinthian' | T523 | R | 160 | **843/8** | |
| 141 | Roman | bowl | coarseware | open | noted as 'Corinthian' | FS504 | R | 161 | **851/2** | 118 |
| 142 | Roman | bowl | coarseware | open | noted as 'Corinthian' | FS503 | R | 162 | **828/23** | |
| 145 | Roman | basin | coarseware | open | rim sherd | FS504 | R | 165 | **846/50** | |
| 150 | Roman | dish | coarseware | open | fragment | FS425 | R | 170 | **981/6** | 22 |
| 151 | Roman | basin | coarseware | open | rim fragment | FS500 | R | 171 | **548/19** | |
| 153 | Roman | pithos | coarseware | storage | rim fragment | FS503 | R | 173 | **826/27** | |
| 154 | Roman | bowl | coarseware | open | rim fragment | FS503 | R | 174 | **828/11** | 86 |
| 156 | Roman | cooking pot | coarseware | cooking | rim fragment | FS503 | R | 176 | **828/24** | |
| 157 | Roman | bowl | coarseware | open | rim fragment | FS504 | R | 177 | **846/28** | 120 |
| 158 | Roman | jar | coarseware | closed | rim fragment | FS504 | R | 178 | **846/4** | |
| 117 | Late Antique | cooking pot | coarseware | cooking | body sherd | Pyrgouthi | R | 137 | | |
| 152 | Late Antique | bowl | coarseware | open | rim | FS503 | R | 172 | **828/20** | 92 |
| 159 | Late Antique | null | coarseware | null | rim fragment | FS503 | R | 179 | **828/14** | |
| 174 | Late Antique | amphora | coarseware | transport | rim fragment | T556 | R | 194 | **985/5** | 36 |
| 175 | Late Antique | bowl | coarseware | open | rim fragment – imitation Phocean Red Slip? | T556 | R | 195 | **985/1** | 37 |
| 183 | Late Antique | jug | coarseware | closed | body sherd | Pyrgouthi | R | 203 | | |
| 184 | Late Antique | amphora | coarseware | transport | body sherd | Pyrgouthi | R | 204 | | |
| 186 | Late Antique | storage jar | coarseware | closed | body sherd | Pyrgouthi | R | 207 | | |
| 187 | Late Antique | cooking pot | coarseware | cooking | body sherd | Pyrgouthi | R | 208 | | |
| 188 | Late Antique | narrow necked jug | coarseware | closed | body sherd | Pyrgouthi | R | 209 | | |
| 189 | Late Antique | cooking pot | coarseware | cooking | rim fragment | Pyrgouthi | R | 210 | | |
| 190 | Late Antique | storage jar | coarseware | closed | rim fragment | Pyrgouthi | R | 211 | | |
| 191 | Late Antique | cooking pot | coarseware | cooking | body sherd | Pyrgouthi | R | 212 | | |
| 201 | Late Antique | amphora | coarseware | transport | body sherd | Pyrgouthi | R | 222 | | |
| 202 | Late Antique | bowl | coarseware | open | rim fragment | Pyrgouthi | R | 223 | | |
| 203 | Late Antique | null | coarseware | null | rim fragment | Pyrgouthi | R | 224 | | |
| 204 | Late Antique | null | coarseware | null | body sherd | Pyrgouthi | R | 225 | | |
| 205 | Late Antique | amphora | coarseware | transport | body sherd | Pyrgouthi | R | 226 | | |
| 244 | Late Antique | amphora | coarseware | transport | handle | FS13 | R | 266 | | |
| 172 | Med/Mod | amphora | coarseware | transport | body sherd | FS1 | R | 192 | **7/20** | 28 |
| **Felsic (quartz limestone)** | | | | | | | | | | |
| 10 | LN | pattern-painted bowl | fineware | open | body sherd | FS400 | R | 30 | **701/37** | 33 |
| 11 | FN | spreading bowl | coarseware | open | rim fragment | FS400 | R | 31 | **720/14** | 34 |
| 12 | FN | spreading bowl | coarseware | open | rim fragment | FS400 | R | 32 | **709/22** | 36 |
| 15 | FN | pierced lug | coarseware | null | fragment | FS405 | R | 35 | **901/39** | 48 |
| 47 | EHI | jar | coarseware | closed | rim fragment | Mastos | R | 67 | | |
| 124 | Classical | louterion | coarseware | open | rim fragment | FS523 | R | 144 | **990/11** | 35 |
| 249 | Classical | cooking pot | coarseware | cooking | rim fragment | Pyrgouthi | R | 271 | | |
| 146 | Roman | amphora | coarseware | transport | ribbed body sherd | FS504 | R/Y | 166 | **846/26** | |
| 148 | Roman | spacer pin | coarseware | building | fragment | FS500 | R | 168 | **690/11** | 47 |
| 160 | Roman | drain pipe | coarseware | building | fragment | FS500 | R | 180 | **548/44** | 45 |
| 168 | Med/Mod | cooking pot | coarseware | cooking | rim fragment | T81 | R | 188 | **37/3** | 14 |

*Table 1. Samples in the Felsic (chert limestone garnet) and (quartz limestone) classes.*

For ease of reference the group and class descriptions below are separated into two sections. The first section is for the general reader and contains summaries of the key petrographic characteristics of each class and discussion of the results. The second section presents more detailed petrographic descriptions of the thin sections for comparisons made using a polarising microscope.

The order of groups and classes is not fixed, but in this case it follows that used by Whitbread *et al.* for consistency.[7] The fabric groups are: Felsic (i.e. quartz/feldspar), Mudstone, Sandstone, Clay pellet, Volcanic, Calcareous sand, and Grog. Archaeological descriptions of the samples in each group and class, together with refiring results, can be found in *Tables 1–7*. These tables also include references to the Fitch Laboratory (British School at Athens) thin section numbers, catalogue numbers on the sherds, and numbers used in the Berbati-Limnes Archaeological Survey publication.[8]

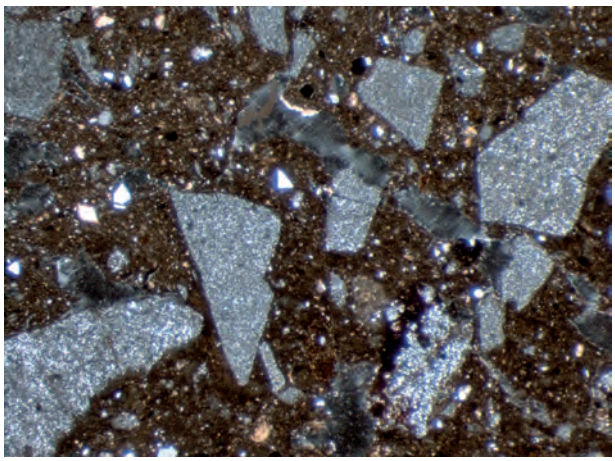

*Fig. 102. Felsic (chert limestone garnet). Sample 153 is a Roman pithos rim. Crossed polars, width of field is 3.7 mm. Large, angular grains of chert are embedded in optically inactive, grey micromass. The black to grey areas are voids.*

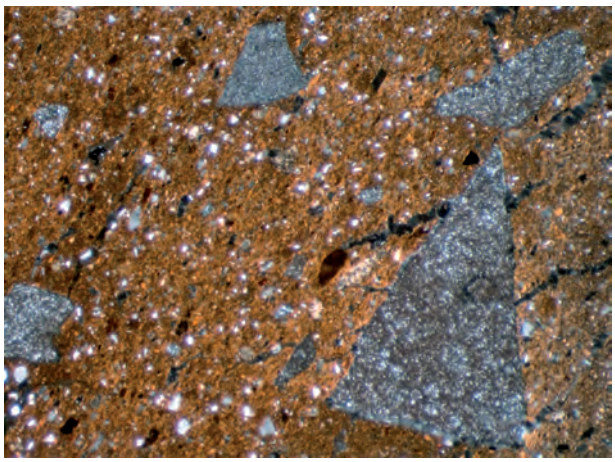

*Fig. 103. Natural clay fired at 700°C for 1 hour in oxidising conditions; sample 3. Crossed polars, width of field is 3.7 mm. Large, angular grains of chert are embedded in optically active micromass. Note the similarity of this natural clay to the Felsic (chert limestone garnet) fabric.*

[7] Whitbread, Ponting & Wells 2007.

## Petrographic summaries and discussion of the fabric groups and classes

### Felsic (chert limestone garnet)

*Number of samples*: 32 (*Table 1*, *Fig. 102*).

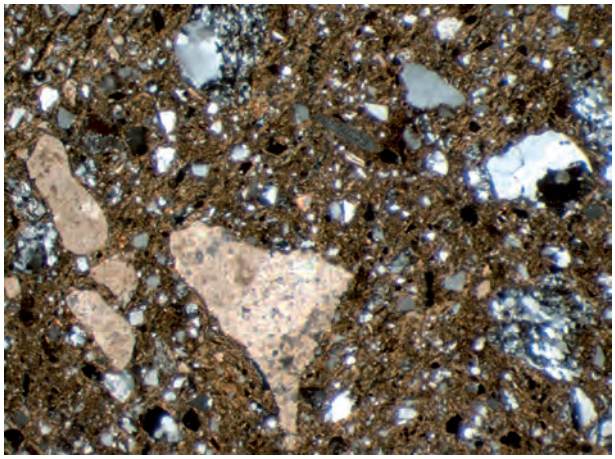

*Fig. 104. Felsic (quartz limestone). Sample 12 is a Neolithic spreading bowl rim. Crossed polars, width of field is 3.7 mm. The grey to white grains are mono- and polycrystalline quartz. The pale brown grains are limestone.*

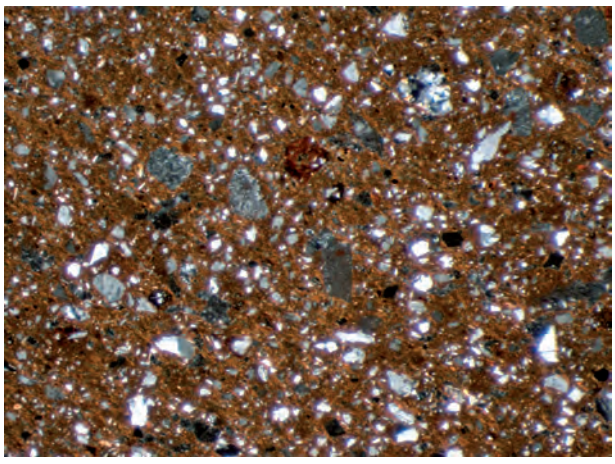

*Fig. 105. Felsic (fine sand). Sample 251 is a Classical cooking pot lid. Crossed polars, width of field is 3.7 mm. Larger grey grains are chert, but the field is dominated by well sorted white to grey mono- and polycrystalline quartz. There are a couple of dark reddish brown clay pellets.*

[8] Wells 1996a.

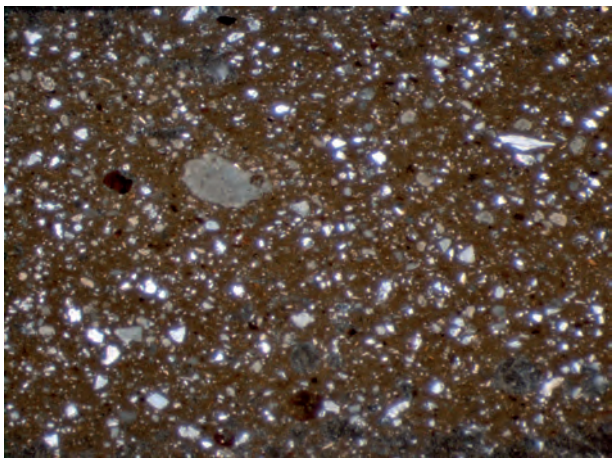

*Fig. 106. Felsic (very fine sand). Sample 96 is an Archaic kantharos. Crossed polars, width of field is 3.7 mm. Very well sorted white to grey grains of monocrystalline quartz, with very pale brown grains of limestone.*

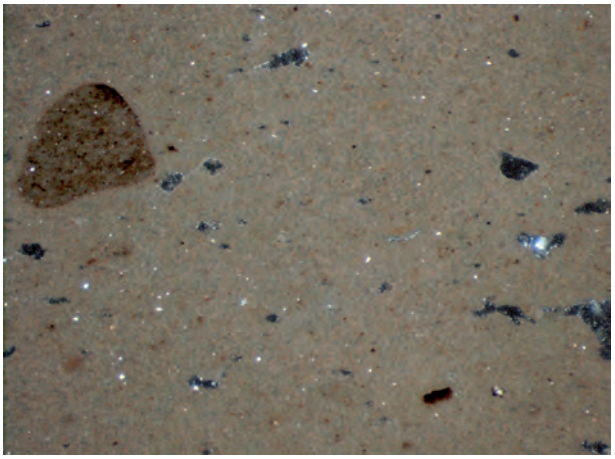

*Fig. 107. Felsic (silt–extremely fine). Sample 52 is a Late Helladic III kylix stem. Crossed polars, width of field is 3.7mm. There is a large, dark brown clay pellet and very rare grains of quartz silt.*

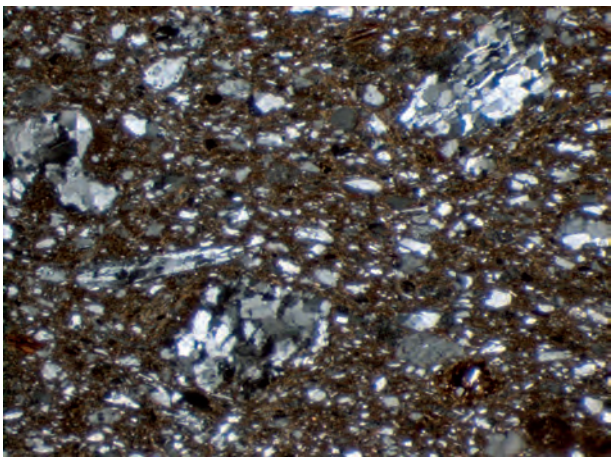

*Fig. 108. Felsic (packed quartz). Sample 247 is a Classical cooking pot rim. Crossed polars, width of field is 3.7 mm. The field is dominated by white to grey mono- and polycrystalline quartz.*

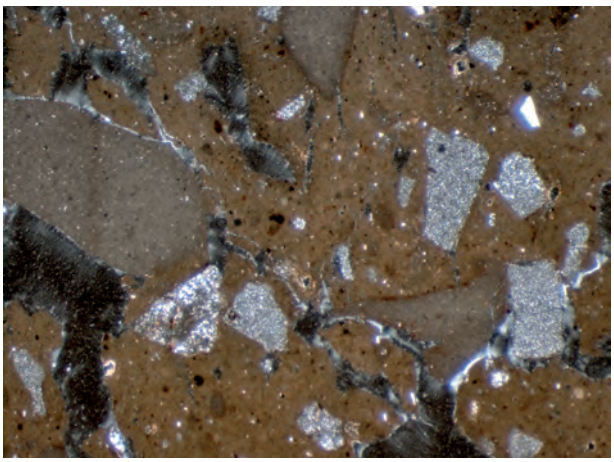

*Fig. 109. Felsic (chert mudstone). Sample 18 is an Early Helladic II? figurine left foot. Crossed polars, width of field is 3.7 mm. There are large, dark grey grains of mudstone and large pale grey grains of chert. The black areas are voids.*

*Periods*: Samples belong to the Final Neolithic, Roman, Late Antique and Medieval–Modern periods.
*Fabric class characteristics*: This is a homogenous class in which fabrics are characterised by moderately sorted, angular to subangular inclusions of chert and, in some cases, limestone. Yellow to dark reddish brown garnet is also present in most samples in various amounts.

*Discussion*: This is a distinctive class of fabrics, all of which refired red. There is one Final Neolithic jar and a Medieval–Modern amphora, but otherwise it appears only in the Roman and Late Antique periods in the current data set. This class was used for a wide range of wares, mainly utilitarian, but also for cooking pots. The homogeneity of the class suggests the consistent use of a particular type of raw material. The angularity and large size of the chert inclusions compared with the rest of the groundmass would normally indicate that the potters added them as temper. In this case, however, fabrics that are almost identical both petrographically, including the presence of garnet, and chemically[9], occur naturally as red clays in ravines situated in the central part of the valley, east of the Mastos (*Fig. 103*). It is therefore clear that the chert inclusions in these fabrics are natural and not added as temper.

[9] Whitbread, Ponting & Wells 2007.

## Felsic (quartz limestone)

*Number of samples*: 11 (*Table 1*, *Fig. 104*).
*Periods*: Samples come from the Late and Final Neolithic, Early Helladic I, Classical, Roman and Medieval–Modern periods.
*Fabric class characteristics*: This is a rather heterogeneous fabric class. All fabrics contain relatively coarse, sand-sized, inclusions primarily composed of quartz or limestone, with rarer chert and metamorphic rock fragments. The range of coarseness is varied. The sandy groundmass and metamorphic character, together with similarities in clay pellets, may indicate that the fabric class is related to Felsic (fine sand).

*Discussion*: The class has been used for a range of utilitarian ceramics, especially Neolithic bowls, Classical and Medieval–Modern cooking pots and Roman building materials.

## Felsic (fine sand)

*Number of samples*: 9 (*Table 2*, *Fig. 105*).
*Periods*: The samples come from Classical, Hellenistic, Roman, Late Antique and Medieval–Modern ceramics.
*Fabric class characteristics*: These fabrics all contain well sorted fine sand. Very few contain sandstone and metamorphic inclusions. The class may be related to the Felsic (very fine sand) and indeed the Sandstone group fabrics. It is distinguished from them by the presence of coarser grains, and their more clearly metamorphic or igneous character.

*Discussion*: The fabrics in this class were predominantly made in red-refired clay and used for a variety of table and utilitarian forms. They include two Classical cooking pots, demonstrating that the fabrics were viable for use with heat. The mixed designations of coarse ware and fine ware, which are based on unaided visual assessment, show that the fabrics can appear differently depending on context.

## Felsic (very fine sand)

*Number of samples*: 35 (*Table 2*, *Fig. 106*).
*Periods*: Samples come from the Geometric, Archaic, Classical, Hellenistic, Roman and Late Antique periods.
*Fabric class characteristics*: These fabrics all contain very well sorted very fine quartz sand. A few examples have more clay pellets but are not otherwise distinct. Sample **96** also has a component of calcareous sand. The slightly coarser samples have inclusions that might be indicative of a metamorphic source. The Felsic (very fine sand) and (fine sand) classes could be combined, but the high degree of sorting does allow these fabrics to be consistently separated within the current data set. There are similarities with Sandstone (sparse in very fine sand matrix), notably in grain-size and in the dark reddish to dark yellowish brown clay pellets, which are intrinsic to the clay source.

*Discussion*: The absence of very early ceramics from this class may be a sampling issue. The fabrics with more clay pellets belong to the Classical, Hellenistic and Late Antique periods, and may constitute slight variation in the raw materials' sources. Most fabrics in this class refired red. This suggests a non-calcareous clay source, possibly related to sandstone. If this class is related to Sandstone (sparse in very fine sand matrix), then the absence of sandstone might be a result of clay refinement by the potters, but natural variation in raw materials cannot be ruled out. Fabrics that refired yellow are present in Geometric wares, a couple of Archaic pieces and a 'bobbin' kiln support from the Classical kiln site at Pyrgouthi.

The ceramics produced in this fabric class are primarily table wares, but more utilitarian products are also represented, particularly tiles. The frequency of some vessel shapes by period, e.g. Geometric kraters and skyphoi and Archaic kantharoi, may be reinforcing the representation of the fabric class if these are the products of specific workshops. Designation of coarse ware and fine ware is mixed, possibly because these fabrics are border line in terms of criteria used to discriminate ware type; see Felsic (fine sand).

## Felsic (silt–extremely fine)

*Number of samples*: 40 (*Table 3*, *Fig. 107*).
*Periods*: These fabrics occur in the Early Helladic, Late Helladic, Geometric, Classical, Hellenistic and Medieval–Modern periods.
*Fabric class characteristics*: These fabrics are all silty to extremely fine. In general, the extremely fine fabrics occur in the samples of the Late Helladic and later periods. Such fine-grained fabrics are rarely diagnostic in petrographic terms, and more effectively studied using chemical analysis. There are, very rarely, slightly coarser grains of quartz, breccia, or biogenic material, but not enough to warrant allocation to other fabric classes. More noticeable in fabrics from ceramics identified as being like Corinthian blister ware, is the presence of silty clay pellets and warped clay pellets.

*Discussion*: Most of the fabrics refired yellow, notably those from the Late Helladic and Classical periods. The Late Helladic samples include pieces from the Mastos kiln (see Wells and Klintberg, this volume). Three refired reddish yellow, which may indicate use of a different clay body: an Early Helladic ladle and sauceboat, and a Late Helladic I–II painted sherd. Most of the Classical and Hellenistic samples refired red and are also distinguished by the presence of warped clay pellets. Although they fit within the Felsic (silty–extremely fine) fabric class, these samples could be placed in a class of

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Felsic (fine sand)** | | | | | | | | | | |
| 130 | Classical | lekane | coarseware | open | rim fragment | FS404 | R | 150 | **744/7** | 104 |
| 250 | Classical | cooking pot | coarseware | cooking | rim fragment | Pyrgouthi | R | 272 | | |
| 251 | Classical | cooking pot | coarseware | cooking | fragment of lid | Pyrgouthi | R | 273 | | |
| 192 | Hellenistic | lekane | fineware | open | rim fragment | Pyrgouthi | R | 213 | | |
| 230 | Hellenistic | plate or dish | fineware | open | rim fragment | Pyrgouthi | R | 252 | | |
| 143 | Roman | null | coarseware | null | base fragment | FS503 | R | 163 | **828/21** | |
| 155 | Roman | basin | fineware | open | rim fragment | FS503 | R | 175 | **828/17** | |
| 206 | Late Antique | amphora | coarseware | transport | body sherd | Pyrgouthi | R/Y | 228 | | |
| 164 | Med/Mod | loom weight | coarseware | weaving | reworked body sherd | FS13 | R | 184 | **63/115** | 218 |
| **Felsic (very fine sand)** | | | | | | | | | | |
| 83 | Geometric | krater | fineware | open | body sherd | FS24 | Y | 103 | **137/17** | |
| 84 | Geometric | krater | fineware | open | body sherd | FS525 | Y | 104 | **1018/3** | 65 |
| 85 | Geometric | skyphos | fineware | drinking | body sherd | FS20 | R/Y | 105 | **130/5** | 7 |
| 86 | Geometric | krater | fineware | open | base fragment | FS402 | R | 106 | **737/23** | 106 |
| 87 | Geometric | jug | fineware | closed | body sherd | FS402 | R | 107 | **737/61** | |
| 88 | Geometric | skyphos | fineware | drinking | body sherd | Mastos | Y | 108 | | |
| 89 | Geometric | skyphos | fineware | drinking | body sherd | Tholos tomb | R | 109 | | 33 |
| 90 | Geometric | skyphos | fineware | drinking | body sherd | Tholos tomb | R | 110 | | 7 |
| 92 | Archaic | kantharos or krater | fineware | drinking | rim fragment | Tholos tomb | R | 112 | | |
| 93 | Archaic | kantharos | fineware | drinking | foot | Tholos tomb | R | 113 | | |
| 94 | Archaic | kantharos | fineware | drinking | body sherd | Tholos tomb | R | 114 | | |
| 95 | Archaic | kantharos | fineware | drinking | rim fragment | Tholos tomb | R | 115 | | |
| 96 | Archaic | kantharos | fineware | drinking | body sherd | Tholos tomb | R | 116 | | |
| 97 | Archaic | kantharos | fineware | drinking | body sherd | Tholos tomb | R/Y | 117 | | |
| 98 | Archaic | kantharos or cup | fineware | drinking | body sherd | Tholos tomb | R | 118 | | |
| 99 | Archaic | jug | fineware | closed | body sherd | Tholos tomb | R | 119 | | |
| 100 | Archaic | pyxis | fineware | null | body sherd | Tholos tomb | Y | 120 | | 9 |
| 101 | Archaic | kanthariskos | fineware | drinking | body sherd – female protomes | Tholos tomb | Y | 121 | | 11 |
| 102 | Archaic | kanthariskos | fineware | drinking | body sherd – female protomes | Tholos tomb | R | 122 | | 19 |
| 111 | Classical | null | fineware | null | body sherd – slightly misfired | Pyrgouthi | R | 131 | | |
| 126 | Classical | Laconian krater | coarseware | open | rim fragment – 'Laconian' | FS426 | R | 146 | **2002/4** | 67 |
| 127 | Classical | Laconian krater | coarseware | open | rim fragment – 'Laconian' | FS426 | R | 147 | **2002/3** | 66 |
| 131 | Classical | lekane | coarseware | open | rim fragment | FS404 | R | 151 | **744/6** | 101 |
| 132 | Classical | lekane | coarseware | open | rim fragment | FS26 | R | 152 | **153/3** | 21 |
| 133 | Classical | lekane | coarseware | open | rim fragment | FS26 | R | 153 | **153/6** | |
| 134 | Classical | skyphos | fineware | drinking | base fragment – black glaze | FS506 | R | 154 | **875/5** | 150 |
| 213 | Classical | null | coarseware | null | body sherd | Pyrgouthi | R | 235 | | |
| 225 | Classical | kiln support | fineware | kiln | 'bobbin' | Pyrgouthi | Y | 247 | | |
| 219 | Class/Hell | tile | coarseware | tile | miscoloured fragment | Pyrgouthi | R | 241 | | |
| 118 | Hellenistic | tile | coarseware | tile | Laconian | null | R | 138 | | |
| 229 | Hellenistic | null | fineware | null | rim fragment | Pyrgouthi | R | 251 | | |
| 144 | Roman | bowl | fineware | open | base | T523 | R | 164 | **843/16** | |
| 163 | Roman | amphora | fineware | transport | rim fragment | FS513 | R | 183 | **981/20** | 23 |
| 119 | Late Antique | tile | coarseware | tile | Laconian cover tile | null | R | 139 | **586/2** | |
| 176 | Late Antique | lamp | coarseware | null | fragment with wick hole | T556 | R | 196 | **985/9** | 39 |

*Table 2. Samples in the Felsic (fine sand) and (very fine sand) classes.*

their own based on these properties. They bear a strong similarity to Corinthian blister ware.[10]

Almost all of the samples are classed as fine ware, consistent with the fine-grained character of the fabrics. The Late Helladic drainage channel **76** is over fired, as indicated by its vesicular microstructure, and this may in part explain why it was considered to be coarse ware. The Medieval–Modern kiln lining (?) **166** is also classed as coarse ware. This may be on account of the dark grey inclusions that superficially look like mudstone, but may be clay pellets. The vesicular microstructure in these inclusions would be consistent with the heat produced in a kiln lining, but the host fabric does not display the same degree of alteration.

## Felsic (packed quartz)

*Number of samples*: 1 (*Table 3*, *Fig. 108*).
*Period*: Classical.
*Fabric class characteristics*: This fabric is characterised by densely packed grains of mono- and polycrystalline quartz.

*Discussion*: Although this fabric may be related to Felsic (fine sand) it is coarser and more densely packed. It belongs to a

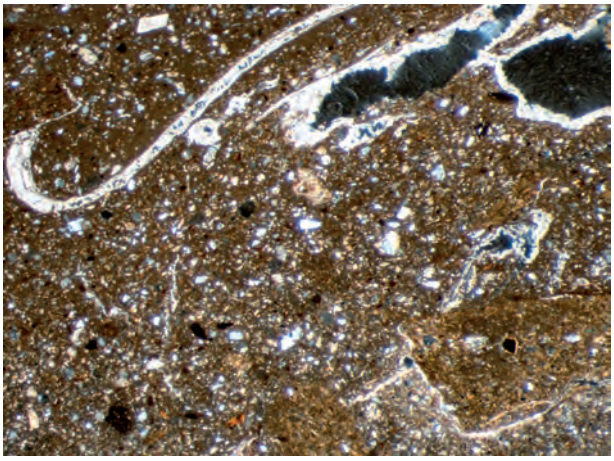

*Fig. 110. Mudstone (chaff). Sample 233 is a Late Helladic drainage channel. Crossed polars, width of field is 3.7 mm. The large, white sinuous and circular material is secondary calcite coating in voids left by burnt out chaff. There is a large, brown grain of mudstone in the opposite corner. The black areas are voids.*

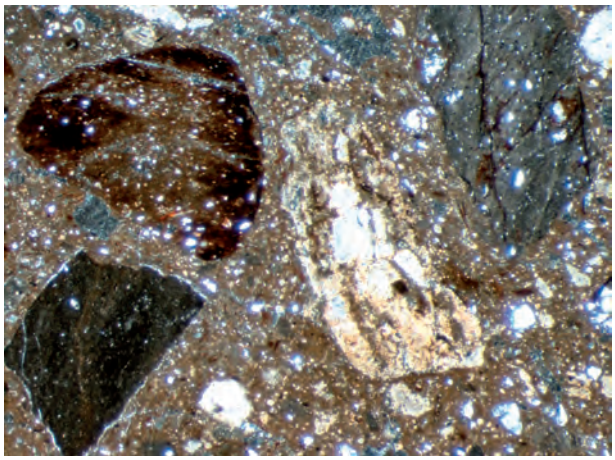

*Fig. 111. Mudstone (limestone). Sample 207 is a Late Antique pithos rim and wall fragment. Crossed polars, width of field is 3.7 mm. There are large, dark grey inclusions of mudstone, a large rounded brown clay pellet, and in the centre a white to pale yellowish brown grain of limestone.*

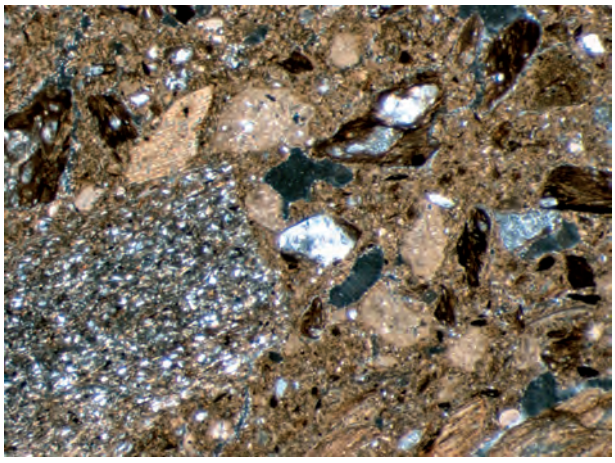

*Fig. 112. Mudstone (siltstone limestone). Sample 26 is an Early Helladic II keyhole hearth. Crossed polars, width of field is 3.7 mm. There is a large grain of siltstone in the corner. There are several pale yellowish brown grains of limestone, but note the very dark brown, turbid mudstone grains, containing pale grey quartz.*

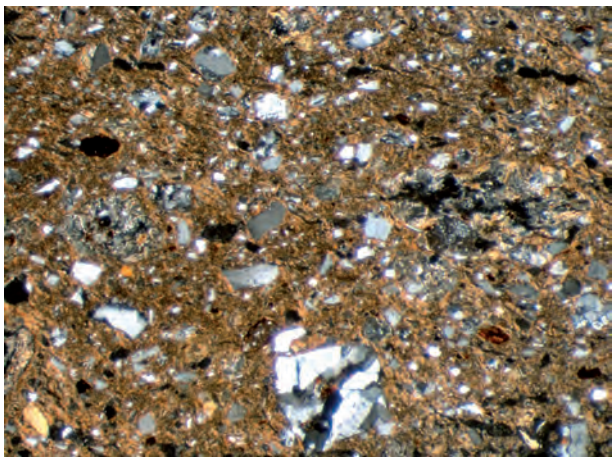

*Fig. 113. Mudstone (quartz sand and breccia). Sample 103 is an Archaic cooking pot. Crossed polars, width of field is 3.7 mm. White to grey mono- and polycrystalline quartz dominates the field with a couple of breccia grains (grey, black and yellowish brown) across the centre, embedded in an optically active micromass.*

[10] Whitbread 1995, 305.

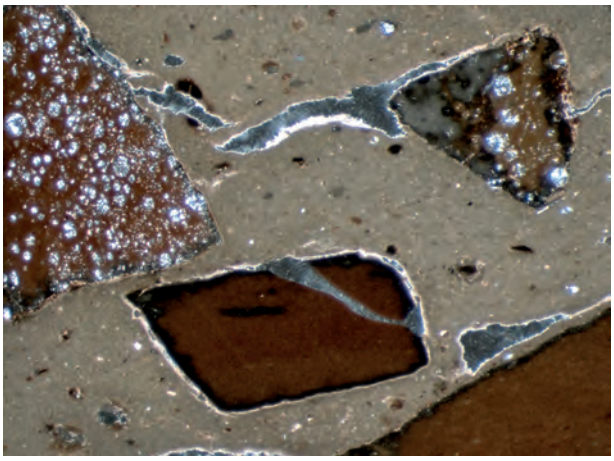

*Fig. 114. Mudstone (fine sand–extremely fine). Sample 122 is a fifth-century BC Corinthian cover tile. Crossed polars, width of field is 3.7 mm. The large, dark brown to grey inclusions are mudstone. Within a couple of these are white to grey circular inclusions, which are fossil radiolaria. The dark grey to black areas are voids.*

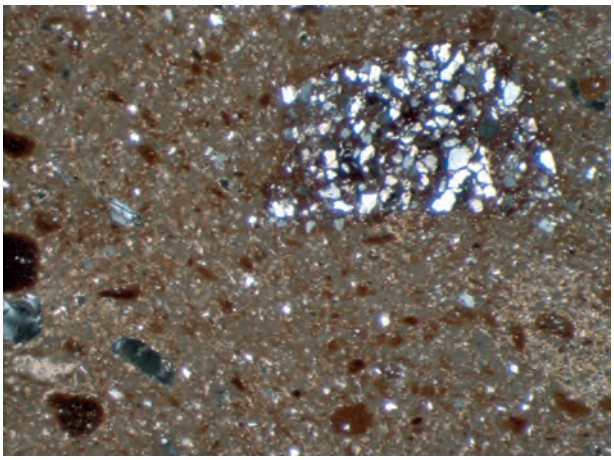

*Fig. 115. Sandstone (red clay pellets–sandy). Sample 197 is a Late Antique pan tile. Crossed polars, width of field is 3.7 mm. There is a large grain of well sorted sandstone (white to grey quartz in dark brown cement) and several small brown clay pellets. The micromass has areas of very pale brown crystallitic b-fabric.*

Classical cooking pot, and the large concentration of inclusions may be aimed at resisting thermal shock.

## Felsic (chert mudstone)

*Number of samples*: 2 (*Table 3*, *Fig. 109*).
*Period*: Early Helladic.
*Fabric class characteristics*: These fabrics are characterised by chert and mudstone in a fine groundmass.

*Discussion*: The fabrics in this class have properties in common with Mudstone (fine sand to extremely fine matrix) given the fine groundmass and large mudstone inclusions, but are distinguished by the presence of angular chert inclusions and red-refired clay. There are distinct similarities to Felsic (chert limestone garnet), but the groundmass is somewhat finer and no garnet was noted. Since it was demonstrated above that angular chert is a natural component of Felsic (chert limestone garnet) it is possible that Felsic (chert mudstone) represents an example of this fabric class with added mudstone. The clay pellets, which are intrinsic to the clay, are similar in both fabric classes, which might support this interpretation.

Only two pieces occur in this fabric class, an Early Helladic pithos (?) and an Early Helladic II left foot, both of which refired red. Clearly, on present evidence, it is not possible to attribute the fabric class more specifically than to thick-walled ceramics of the period.

## Mudstone (chaff)

*Number of samples*: 2 (*Table 4*, *Fig. 110*).
*Period*: Late Helladic.
*Fabric class characteristics*: Both samples contain mudstone, siltstone and breccia inclusions in a silty groundmass. The distinguishing feature of this class is the presence of sinuous channels (voids) indicative of burnt out organic matter. There is evidence of secondary calcite deposition in the voids. The class may be related to the Calcareous sand (chaff) class.

*Discussion*: These samples come from Late Helladic drainage channels. A similarly thick-walled Late Helladic drainage channel is classed as Mudstone (fine sand to extremely fine matrix), which differs from the above samples in the absence of sinuous channels and its red-refired clay. It is possible that the organic matter (chaff) was added intentionally as temper to the yellow-refired clay, but was considered unnecessary for red-refired clay. Chaff also occurs in Calcareous sand (chaff), which comprises two Late Helladic drainage channels and an Early Helladic tile, all of which refired yellow.

## Mudstone (limestone)

*Number of samples*: 8 (*Table 4*, *Fig. 111*).
*Periods*: Samples belong to the Early Helladic II and III, Middle Helladic, Roman and Late Antique periods.
*Fabric class characteristics*: These fabrics are distinguished by their coarse inclusions of angular to subangular mudstone and breccia (or tuffite, where minute grains of volcanic glass occur), and rounded limestone, in a quartz-rich sandy groundmass. Various clays are represented to judge from the range of refired colours. The fabrics of Helladic samples appear to be less well fired. This is based on the presence of optical activity in the mudstone grains and micromass, indicating that the clay minerals had not completely broken down during firing. The fabric class may be an extension of the Mudstone (fine

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Felsic (silt–extremely fine)** | | | | | | | | | | |
| 28 | EHII | small incurving bowl | fineware | open | large rim fragment | FS414 | Y | 48 | **943/9; 15–16;18** | 36 |
| 30 | EHII | ladle | fineware | null | fragment | FS414 | R/Y | 50 | **937/6** | 51 |
| 32 | EHII | sauceboat | fineware | liquid | rim fragment | FS405 | R/Y | 52 | **901/11** | 15 |
| 38 | EHIII | bowl | fineware | open | strap handle – fine grey burnished ware | Mastos | Y | 58 | | |
| 43 | EHIII | null | fineware | null | body sherd – dark-on-light | Mastos | Y | 63 | | |
| 76 | LH | drainage channel | coarseware | building | waster | Mastos | Y | 96 | | |
| 49 | LHI–II | null | fineware | null | painted fineware sherd | Mastos | R/Y | 69 | | |
| 63 | LHI–II | goblet | fineware | drinking | rim sherd – plain | Mastos | Y | 83 | | |
| 64 | LHI–II | goblet | fineware | drinking | rim sherd – Ephyrian goblet | Mastos | Y | 84 | | |
| 50 | LHIII | animal figurine | fineware | null | leg | Mastos | Y | 70 | | |
| 51 | LHIII | null | fineware | null | body sherd – dark-on-light | Mastos | Y | 71 | | |
| 52 | LHIII | kylix | fineware | drinking | stem fragment – slightly overfired | Mastos | Y | 72 | | |
| 53 | LHIII | kylix | fineware | drinking | stem fragment – poor shape – battered – manufacturing dump? | Mastos | Y | 73 | | |
| 54 | LHIII | kylix | fineware | drinking | rim fragment – overfired | Mastos | Y | 74 | | |
| 55 | LHIII | kylix | fineware | drinking | base fragment – overfired | Mastos | Y | 75 | | |
| 56 | LHIII | kylix | fineware | drinking | stem fragment – overfired | Mastos | Y | 76 | | |
| 57 | LHIII | kylix | fineware | drinking | rim fragment – overfired | Mastos | Y | 77 | | |
| 58 | LHIII | kylix | fineware | drinking | stem fragment – overfired – grey | Mastos | Y | 78 | | |
| 59 | LHIII | jug | fineware | closed | neck/shoulder fragment – overfired | Mastos | Y | 79 | | |
| 60 | LHIII | animal figurine | fineware | null | fragment of head – overfired | Mastos | Y | 80 | | |
| 75 | LHIII | null | fineware | null | warped waster | Mastos | Y | 95 | | |
| 82 | Geometric | cup | fineware | drinking | almost complete | Mastos | Y | 102 | **10598** | |
| 107 | Classical | krater | fineware | open | base | Pyrgouthi | Y | 127 | | 31 |
| 208 | Classical | jug | fineware | closed | rim fragment | Pyrgouthi | R | 230 | | |
| 223 | Classical | skyphos | fineware | drinking | base fragment | Pyrgouthi | Y | 245 | | |
| 224 | Classical | kiln support | fineware | kiln | shape – 'bobbin' | Pyrgouthi | Y | 246 | | |
| 226 | Classical | kotyle | fineware | drinking | base fragment – Corinthian | Pyrgouthi | Y | 248 | | |
| 227 | Classical | loom weight | fineware | null | fragment | Pyrgouthi | Y | 249 | | |
| 245 | Classical | skyphos | fineware | drinking | body sherd – Corinthian | Pyrgouthi | Y | 267 | | |
| 214 | Class/Hell | null | fineware | null | body sherd – like Corinthian blisterware | Pyrgouthi | R | 236 | | |
| 215 | Class/Hell | null | fineware | null | body sherd – like Corinthian blisterware | Pyrgouthi | R | 237 | | |
| 216 | Class/Hell | null | fineware | null | body sherd – like Corinthian blisterware | Pyrgouthi | R | 238 | | |
| 217 | Class/Hell | null | fineware | null | body sherd – pithos? – like Corinthian blisterware | Pyrgouthi | R | 239 | | |

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| 218 | Class/Hell | null | fineware | null | body sherd – like Corinthian blisterware | Pyrgouthi | R | 240 | | |
| 220 | Class/Hell | null | fineware | null | body sherd – like Corinthian blisterware | Pyrgouthi | R | 242 | | |
| 135 | Hellenistic | skyphos | fineware | drinking | base fragment – black glaze | FS506 | Y | 155 | **875/1** | 154 |
| 182 | Hellenistic | basin | fineware | open | body sherd | Pyrgouthi | R | 202 | | |
| 212 | Hellenistic | null | fineware | null | body sherd – like Corinthian blisterware | Pyrgouthi | R | 234 | | |
| 166 | Med/Mod | kiln lining? | coarseware | kiln | kiln lining? | FS22 | Y | 186 | **138/2** | 7 |
| 181 | Med/Mod | cup | fineware | drinking | rim fragment – Constantinopolitan White Ware II? | T120 | Y | 201 | **350/9** | 232 |
| **Felsic (packed quartz)** | | | | | | | | | | |
| 247 | Classical | cooking pot | coarseware | cooking | rim fragment | Pyrgouthi | R | 269 | | |
| **Felsic (chert mudstone)** | | | | | | | | | | |
| 18 | EHII | figurine | coarseware | null | left foot | FS12 | R | 38 | **54/1** | 133 |
| 67 | EH | pithos | coarseware | storage | pithos rim? | Mastos | R | 87 | | |

*Table 3. Samples in the Felsic (silt–extremely fine), (packed quartz) and (chert mudstone) classes.*

sand to extremely fine matrix) and related to Mudstone (siltstone limestone).

*Discussion*: All of the fabrics in this class belong to coarse ware, with a range of functions: bowls, possibly cooking ware, an architectural spacer pin, tiles and pithoi. The Early Helladic III bowl is classed as very early Grey Minyan (a ware typical of the Middle Helladic period), whereas the Middle Helladic sample is from a very different ware, an incised 'Adriatic' vessel. Use of the fabric in the Late Antique period appears to focus on large ceramics including tiles and pithoi.

## Mudstone (siltstone limestone)

*Number of samples*: 6 (*Table 4*, *Fig. 112*).
*Periods*: Samples are from the Early Helladic II, Hellenistic and Medieval–Modern periods.
*Fabric class characteristics*: These fabrics are distinguished by coarse inclusions of angular to rounded mudstone, siltstone and breccia, rounded limestone and angular to subrounded chert in a groundmass with very few sand and silt grains. For the most part, the fabrics are less well fired compared to other samples of the Mudstone group. This is evident in the micromass b-fabrics and in optical activity in the mudstone, siltstone and breccia grains. The mudstone inclusions are also distinctive, especially in Early Helladic II fabrics, owing to their turbid internal structure. Characteristically the fabric is poorly sorted and relatively tightly packed.

*Discussion*: All of these samples are from coarse ware. Of the four Early Helladic II samples, two are from keyhole hearths (**26** and **27**), refired yellow, and form a tight pairing. The two Early Helladic II hemispherical bowls (**23** and **29**) show greater diversity in terms of limestone and chert proportions, and both refired red, but they still have strong similarities to the keyhole hearths. The Hellenistic pithos, **137**, differs from the Early Helladic samples in the character of the mudstone and in fabric packing. The Medieval–Modern handle, **165**, is well fired, unlike other samples in the class, but also has a greater concentration of chert inclusions; it may be reclassified if further samples become available.

## Mudstone (quartz sand and breccia)

*Number of samples*: 2 (*Table 4*, *Fig. 113*).
*Period*: Archaic.
*Fabric class characteristics*: These fabrics are very distinctive and are characterised by the presence of closely packed and very well sorted quartz sand and mudstone breccia.

*Discussion*: Both samples belong to Archaic cooking pots. They could be classified as Felsic (breccia) and may be related to another cooking ware fabric class, Felsic (packed quartz). Given the distinctive nature of the fabrics it was decided to highlight their breccia component and place them in the Mudstone group. As noted for Felsic (packed quartz), the concentration of inclusions may have been intended to address thermal shock.

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mudstone (chaff)** | | | | | | | | | | |
| 233 | LH | drainage channel | coarseware | building | fragment | Mastos | Y | 255 | | |
| 234 | LH | drainage channel | coarseware | building | fragment | Mastos | Y | 256 | | |
| **Mudstone (limestone)** | | | | | | | | | | |
| 46 | EHII | bowl | coarseware | open | T-rim | Mastos | R/Y | 66 | | |
| 48 | EHIII | bowl | coarseware | open | very early grey minyan | Mastos | R/Y | 68 | | |
| 40 | MH | null | coarseware | null | coarse incised cooking ware – 'Adriatic' ware | Mastos | R | 60 | | |
| 149 | Roman | spacer pin | coarseware | building | fragment | T513 | R | 169 | **831/12** | |
| 195 | Late Antique | Laconian cover tile | coarseware | tile | Laconian cover | Pyrgouthi | Y | 216 | | |
| 198 | Late Antique | Laconian pantile | coarseware | tile | Laconian pantile | Pyrgouthi | Y | 219 | | |
| 207 | Late Antique | pithos | coarseware | storage | rim and wall fragment | Pyrgouthi | R | 229 | | |
| 246 | Late Antique | pithos | coarseware | storage | body sherd | Pyrgouthi | Y | 268 | | |
| **Mudstone (siltstone limestone)** | | | | | | | | | | |
| 23 | EHII | large hemispherical bowl | coarseware | open | large rim fragment with taenia | FS39 | R | 43 | **774/6** | 95 |
| 26 | EHII | keyhole hearth | coarseware | cooking | fragment | FS414 | Y | 46 | **943/8** | 54 |
| 27 | EHII | keyhole hearth | coarseware | cooking | fragment | FS414 | Y | 47 | **943/20** | 53 |
| 29 | EHII | large hemispherical bowl | coarseware | open | rim fragment with taenia | FS414 | R | 49 | **937/63** | 40 |
| 137 | Hellenistic | pithos | coarseware | storage | base fragment | T529 | R | 157 | **876/9** | 162 |
| 165 | Med/Mod | null | coarseware | null | handle | FS13 | R | 185 | **67/8** | 176 |
| **Mudstone (quartz sand and breccia)** | | | | | | | | | | |
| 103 | Archaic | cooking pot | coarseware | cooking | body sherd | Tholos tomb | R | 123 | | |
| 104 | Archaic | cooking pot | coarseware | cooking | body sherd | Tholos tomb | R | 124 | | |

*Table 4. Samples in the Mudstone (chaff), (limestone), (siltstone limestone) and (quartz sand and breccia) classes.*

## Mudstone (fine sand–extremely fine matrix)

*Number of samples*: 37 (*Table 5*, *Fig. 114*).
*Periods*: These samples belong to the Early Helladic to Late Helladic, Archaic to Classical/Hellenistic, Late Antique and Medieval–Modern periods.
*Fabric class characteristics*: Fabrics are distinguished by coarse, angular to subangular inclusions of mudstone, siltstone and mudstone breccia (or tuffite, where minute grains of volcanic glass occur) in a fine sand to extremely fine matrix. Heterogeneity within the class results from grain-size variation amongst the quartz inclusions. The slightly coarser fabrics (fine sand to silty) are more prominent amongst the later samples.

*Discussion*: The majority of the ceramics represented in this class are coarse wares, reflecting the presence of large mudstone inclusions. One Hellenistic krater, **112**, is classed as fine ware; a situation which can occur where very few mudstone inclusions are present. Many of the samples come from large ceramics, such as the sima fragment, pithoi, tiles, drainage channel, louterion, bowls, jars and hydria. The class also includes four kiln supports, two from the area of the Classical kiln at Pyrgoúthi, in the centre of the valley, and two from survey findspots FS26 and FS426 at the western end of the valley.

Samples containing breccia fall predominantly in the reddish yellow (R/Y) refired category, otherwise there is no clear petrographic distinction between red (R), reddish yellow (R/Y), red and yellow (R and Y) and yellow (Y) refired fabrics. The refired colour variation suggests that several different clays were used for this class over time, though Middle Helladic and Classical samples predominantly refired yellow, indicating a preference for calcareous clays.

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| 31 | EHI | large shallow bowl | coarseware | open | fragment with lug | FS414 | R/Y | 51 | **937/50** | 31 |
| 35 | EHII | large shallow bowl | coarseware | open | rim fragment with trumpet lug | FS35 | R/Y | 55 | **593/1** | 9 |
| 39 | EHIII | null | coarseware | null | solidly painted and un-burnished ware fragment | Mastos | Y | 59 | | |
| 41 | EHIII | null | coarseware | null | body sherd – dark-on-light | Mastos | R/Y | 61 | | |
| 42 | EHIII | jar | coarseware | closed | rim sherd – dark-on-light | Mastos | R/Y | 62 | | |
| 68 | MH | jug | coarseware | closed | neck/shoulder fragment – matt painted | Mastos | R/Y | 88 | | |
| 69 | MH | null | coarseware | null | body sherd | Mastos | Y | 89 | | |
| 70 | MH | null | coarseware | null | body sherd – overfired | Mastos | Y | 90 | | |
| 71 | MH | jar | coarseware | closed | body sherd – matt painted | Mastos | Y | 91 | | |
| 72 | MH | null | coarseware | null | body sherd – overfired | Mastos | Y | 92 | | |
| 73 | MH | jar | coarseware | closed | body sherd with stap handle | Mastos | Y | 93 | | |
| 237 | LH | drainage channel | coarseware | building | fragment | SM2 | R | 259 | **4/8** | 14 |
| 80 | Archaic | relief fiale | coarseware | drinking | body sherd | FS516 | R | 100 | **538/64** | 89 |
| 81 | Archaic | hydria | coarseware | open | body sherd | FS516 | R/Y | 101 | **538/82** | |
| 77 | Classical | Laconian pantile | coarseware | tile | fragment | FS20 | Y | 97 | **134/6** | 24 |
| 78 | Classical | basin or mortar | coarseware | open | large rim fragment | FS20 | Y | 98 | **131/8** | 15 |
| 79 | Classical | pithos | coarseware | storage | rim fragment | FS24 | R&Y | 99 | **139/1** | 36 |
| 105 | Classical | kiln support | coarseware | kiln | wedge shape | Pyrgouthi | Y | 125 | | 27 |
| 106 | Classical | kiln support | coarseware | kiln | tripod | Pyrgouthi | Y | 126 | | 29 |
| 114 | Classical | tile | coarseware | tile | fragment | Pyrgouthi | Y | 134 | | |
| 116 | Classical | pithos | coarseware | storage | rim sherd | Pyrgouthi | Y | 136 | | |
| 122 | Classical | tile | coarseware | tile | Corinthian cover | Pyrgouthi | Y | 142 | | |
| 123 | Classical | louterion | coarseware | open | rim fragment | Pyrgouthi | Y | 143 | | |
| 125 | Classical | kiln support | coarseware | kiln | tripod | FS26 | Y | 145 | **1042/7** | 24 |
| 128 | Classical | kiln support | coarseware | kiln | shape – 'bobbin' | FS426 | Y | 148 | **2002/7** | 72 |
| 129 | Classical | sima | coarseware | building | fragment | FS409 | Y | 149 | **923/1** | 134 |
| 136 | Classical | pithos | coarseware | storage | base fragment | FS412 | R | 156 | **932/12** | 137 |
| 194 | Classical | null | coarseware | null | body sherd | Pyrgouthi | R | 215 | | |
| 221 | Classical | basin or lekane | coarseware | open | rim fragment | Pyrgouthi | Y | 243 | | |
| 222 | Classical | hydria? | coarseware | open | fragment of coarseware handle | Pyrgouthi | Y | 244 | | |
| 228 | Classical | mortar | coarseware | open | base fragment | Pyrgouthi | Y | 250 | | |
| 252 | Classical | tile | coarseware | tile | fragment | Pyrgouthi | Y | 1 | | |
| 112 | Class/Hell | krater | fineware | open | body sherd | Pyrgouthi | R/Y | 132 | | |
| 115 | Late Antique | null | coarseware | null | body sherd | Pyrgouthi | R/Y | 135 | | |
| 200 | Late Antique | pithos | coarseware | storage | rim fragment | Pyrgouthi | Y | 221 | | |
| 239 | Late Antique | tile | coarseware | tile | fragment cover | Pyrgouthi | Y | 261 | | |
| 171 | MedMod | basin? | coarseware | open | rim sherd | FS8 | Y | 191 | **48/6** | 24 |

*Table 5. Samples in the Mudstone (fine sand–extremely fine matrix) class.*

## Sandstone (red clay pellets—sandy)

*Number of samples*: 4 (*Table 6*, *Fig. 115*).
*Period*: Late Antique.
*Fabric class characteristics*: These fabrics are characterised by the presence of very fine sandstone and well sorted red clay pellets in a very fine sand groundmass.

*Discussion*: This class belongs to a group of Late Antique tile fragments from Pyrgoúthi. The prominence of numerous red clay pellets and the yellow-refired clay distinguishes it from the Sandstone (sparse in very fine sand matrix) class.

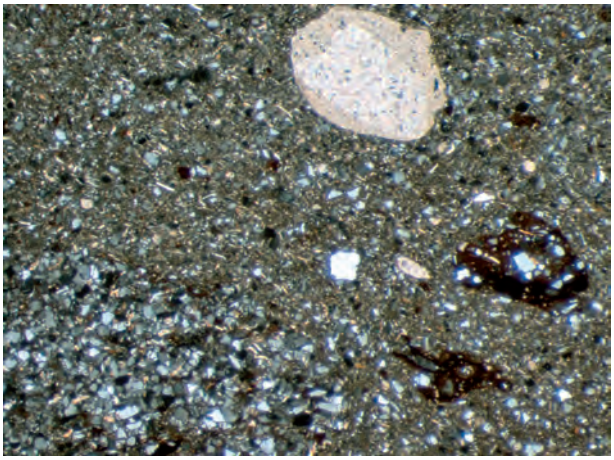

*Fig. 116. Sandstone (sparse in very fine sand matrix). Sample 179 is a Medieval–Modern green and brown bowl base. Crossed polars, width of field is 3.7 mm. A large grain of very well sorted sandstone is in the corner. There is a well rounded, pale brown grain of limestone and two dark brown clay pellets. Very well sorted quartz grains and mica laths dominate the groundmass.*

## Sandstone (sparse in very fine sand matrix)

*Number of samples*: 23 (*Table 6*, *Fig. 116*).
*Periods*: Samples belong to the Middle Neolithic, Early Helladic I and II, Hellenistic and Medieval–Modern periods.
*Fabric class characteristics*: This is a relatively homogeneous class, characterised by sparse very fine sandstone and a very fine sand groundmass. It may be related to the Felsic (fine sand) and (very fine sand) classes.

*Discussion*: All samples refired red except **21**, which refired reddish yellow. Various utilitarian and table wares were produced in this fabric class. It includes all of the Middle Neolithic samples, comprising basins, bowls and jars. This consistency in Neolithic fabrics may be related to their coming from one findspot, FS400. The dominant portion of Early Helladic I samples also occur in this class, including most samples of Talioti ware. Perhaps the most striking product is the Early Helladic II keyhole hearth, of which the other two examples have Mudstone (siltstone limestone) fabrics.

## Sandstone (calcareous sandstone)

*Number of samples*: 1 (*Table 6*, *Fig. 117*).
*Period*: Early Helladic.
*Fabric class characteristics*: This fabric is characterised by the presence of calcareous fine sandstone, its fine-grained groundmass and mesochannels, which probably originate from burnt out chaff.

*Discussion*: The fabric belongs to an Early Helladic tile and refired yellow.

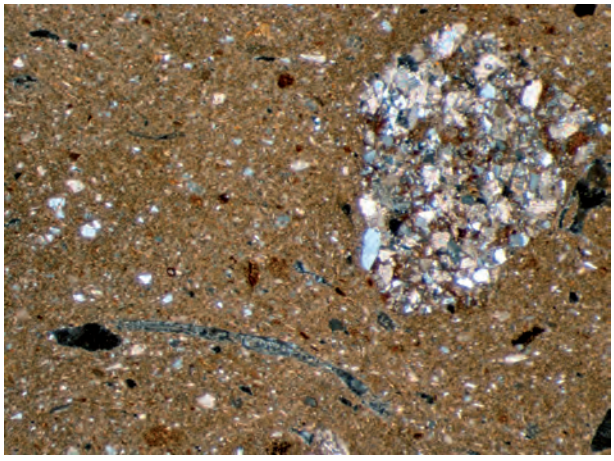

*Fig. 117. Sandstone (calcareous sandstone). Sample 241 is an Early Helladic tile. Crossed polars, width of field is 3.7 mm. The large grain is well sorted sandstone containing white to grey quartz and very pale yellowish limestone. Note the very dark grey to black curved void resulting from burnt out organic material.*

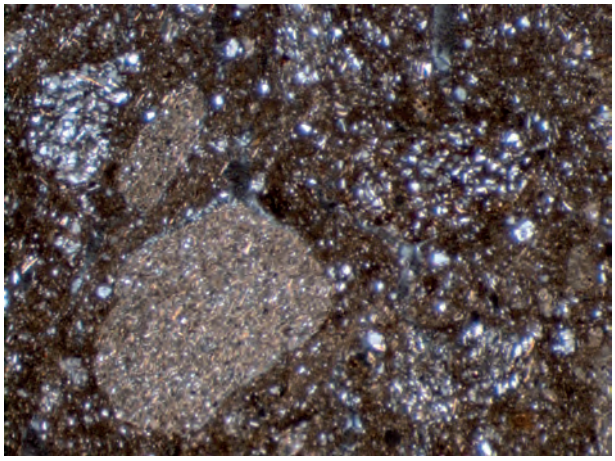

*Fig. 118. Sandstone (siltstone mudstone). Sample 22 is an Early Helladic I late, large spreading bowl in Talioti ware. Crossed polars, width of field is 3.7 mm. There are large grains of sandstone with well sorted, white to grey quartz and a couple of large, rounded grains of siltstone with quartz and numerous pale brown laths of mica.*

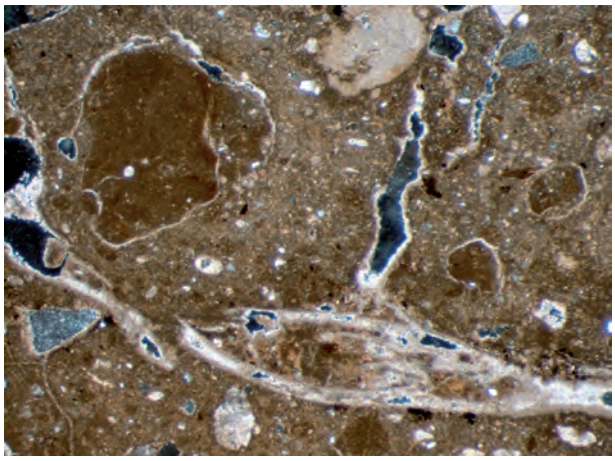

*Fig. 119. Clay pellet (highly calcareous). Sample 113 is clayey material from inside the fifth-century BC Pyrgouthi kiln. Crossed polars, width of field is 3.7 mm. There are large, dark brown clay pellets, pale yellowish brown to white limestone and calcareous coatings in voids, grey chert, and pale brown crystallitic b-fabric.*

## Sandstone (siltstone mudstone)

*Number of samples*: 1 (*Table 6*, *Fig. 118*).
*Period*: Early Helladic I.
*Fabric class characteristics*: The fabric is characterised by very well sorted very fine sandstone, siltstone and mudstone. It could be placed in the Mudstone fabric group.

*Discussion*: This is an Early Helladic I late bowl in Talioti ware, which refired red. The optically active nature of the mudstone indicates that it was fired at a relatively low temperature. It may be the case that mudstone and siltstone were added to a clay body of sandstone occurring naturally in red (refired) clay, perhaps similar to Sandstone (sparse in very fine sand matrix).

## Clay pellet (highly calcareous)

*Number of samples*: 2 (*Table 7*, *Fig. 119*).
*Period*: Classical.
*Fabric class characteristics*: These fabrics are distinguished by their very fine matrix and very few inclusions other than clay pellets, large voids and common crystallitic concentration features.

*Discussion*: Both samples come from Pyrgouthi. One is daub and the other is clayey material from inside the Classical kiln, both of which refired yellow. The fabrics are different from ceramics in the data set, cf. Clay pellet (red clay pellets in silty matrix), although there is some similarity to Clay pellet (large fine clay pellets), which was used for Late Antique tiles.

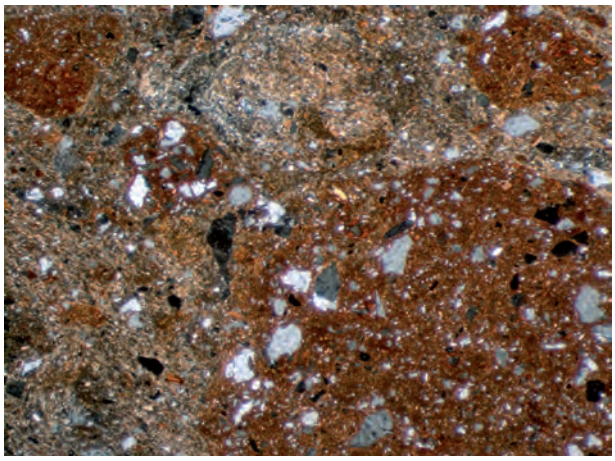

*Fig. 120. Clay pellet (red silty clay pellets). Sample 167 is a Medieval cooking pot, 15th century. Crossed polars, width of field is 3.7 mm. The field is dominated by reddish brown clay pellets containing white to grey quartz silt to sand-sized particles.*

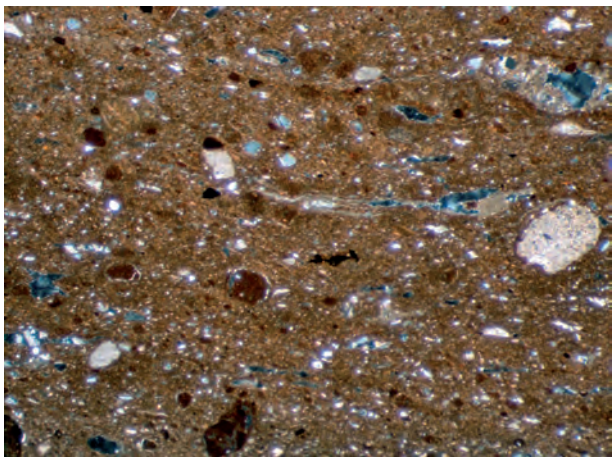

*Fig. 121. Clay pellet (red clay pellets in silty matrix). Sample 139 is a Roman amphora stand. Crossed polars, width of field is 3.7 mm. There are several dark reddish brown clay pellets, well rounded pale yellowish brown limestone and sparse very dark brown to black 'amorphous' concentration features.*

## Clay pellet (red silty clay pellets)

*Number of samples*: 4 (*Table 7*, *Fig. 120*).
*Periods*: Late Antique and Medieval–Modern.
*Fabric class characteristics*: The fabrics are distinguished by being fine-grained with very few inclusions and red silty to sandy clay pellets.

*Discussion*: The fabrics are found in a range of shapes: a Late Antique tile, and a Medieval–Modern transport amphora, bowl and cooking pot. Both red- and yellow-refired clays are represented.

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sandstone (red clay pellets – sandy)** | | | | | | | | | | |
| 196 | Late Antique | Laconian pantile | coarseware | tile | Laconian pantile | Pyrgouthi | Y/R | 217 | | |
| 197 | Late Antique | tile | coarseware | tile | pantile | Pyrgouthi | Y | 218 | | |
| 238 | Late Antique | tile | coarseware | tile | fragment pantile | Pyrgouthi | Y | 260 | | |
| 243 | Late Antique | tile | coarseware | tile | fragment pantile | Pyrgouthi | Y | 265 | | |
| **Sandstone (sparse in very fine sand matrix)** | | | | | | | | | | |
| 1 | MN | probably basin | fineware | open | high ring base | FS400 | R | 21 | **701/88** | 9 |
| 2 | MN | probably basin | fineware | open | high ring base | FS400 | R | 22 | **701/137** | 10 |
| 3 | MN | probably basin | fineware | open | high ring base | FS400 | R | 23 | **701/135** | 11 |
| 4 | MN | probably basin | fineware | open | low ring base | FS400 | R | 24 | **701/43** | 14 |
| 5 | MN | probably jar | fineware | closed | low ring base | FS400 | R | 25 | **709/6** | 15 |
| 6 | MN | probably bowl | fineware | open | low ring base | FS400 | R | 26 | **701/40** | 17 |
| 7 | MN | probably basin | fineware | open | concave base | FS400 | R | 27 | **701/58** | 21 |
| 8 | MN | deep bowl | fineware | open | rim fragment – urfirnis | FS400 | R | 28 | **701/90** | 24 |
| 9 | MN | Urfirnis husking-bowl | fineware | open | rim gouged bowl | FS400 | R | 29 | **701/79** | 25 |
| 21 | EHI | fruitstand | coarseware | open | rim sherd – Talioti ware | FS39 | R/Y | 41 | **777/35** | 72 |
| 25 | EHI | fruitstand | coarseware | open | junction of bowl and pedestal – Talioti ware | FS40 | R | 45 | **763/16** | 108 |
| 36 | EHI | fruitstand | coarseware | open | rim fragment | FS518 | R | 56 | **535/21** | 4 |
| 37 | EHI | jar | coarseware | closed | strap handle | FS518 | R | 57 | **535/34** | 5 |
| 44 | EHI | fruitstand | fineware | open | rim sherd – Talioti ware | Mastos | R | 64 | | |
| 19 | EHII | keyhole hearth | coarseware | cooking | fragment | FS12 | R | 39 | **57/1** | 132 |
| 193 | Hellenistic | lekane | fineware | open | rim fragment | Pyrgouthi | R | 214 | | |
| 232 | Hellenistic | beehive | coarseware | null | fragment | Pyrgouthi | R | 254 | | 62 |
| 248 | Hellenistic | amphora | fineware | transport | rim fragment | Pyrgouthi | R | 270 | | |
| 169 | Med/Mod | bowl | fineware | open | green painted body sherd | FS5 | R | 189 | **11/6** | 2 |
| 170 | Med/Mod | bowl | coarseware | open | rim fragment | FS8 | R | 190 | **48/8** | 23 |
| 177 | Med/Mod | pithos | coarseware | storage | body sherd | FS404 | R | 197 | **743/1** | 85 |
| 179 | Med/Mod | bowl | fineware | open | base fragment – green and brown | FS13 | R | 199 | **63/14** | 145 |
| 180 | Med/Mod | jug | fineware | closed | body sherd – plain glazed | FS13 | R | 200 | **63/34** | 159 |
| **Sandstone (calcareous sandstone)** | | | | | | | | | | |
| 241 | EH | tile | coarseware | tile | fragment | Mastos | Y | 263 | | |
| **Sandstone (siltstone mudstone)** | | | | | | | | | | |
| 22 | EHI | large spreading bowl | coarseware | open | Talioti ware | FS39 | R | 42 | **774/18** | 75 |

*Table 6. Samples in the Sandstone group.*

## Clay pellet (red clay pellets in silty matrix)

*Number of samples*: 3 (*Table 7*, *Fig. 121*).
*Periods*: Late Hellenistic to Roman.

*Fabric class characteristics*: The fabrics are distinguished by their fine-grained groundmass with very few quartz and limestone inclusions and small red clay pellets.

| *Sample* | *Period* | *Shape* | *Ware* | *Function* | *Description* | *Site* | *Refired* | *Fitch* | *Cat. #* | *Pub. #* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Clay pellet (highly calcareous)** | | | | | | | | | | |
| 108 | Classical | | | building | daub? | Pyrgouthi | Y | 128 | | |
| 113 | Classical | | | kiln | clayey material from inside basin (inner wall) of kiln | Pyrgouthi | Y | 133 | | |
| **Clay pellet (red silty clay pellets)** | | | | | | | | | | |
| 120 | Late Antique | tile | coarseware | tile | tile | Pyrgouthi | Y | 140 | | |
| 167 | Med/Mod | cooking pot | fineware | cooking | rim sherd – glazed | FS17 | R | 187 | **73/10** | 13 |
| 173 | Med/Mod | amphora | fineware | transport | rim fragment | FS528 | Y | 193 | **996/25** | 31 |
| 178 | Med/Mod | bowl | coarseware | open | rim fragment – plain glazed | FS303 | R | 198 | **652/12** | 102 |
| **Clay pellet (red clay pellets in silty matrix)** | | | | | | | | | | |
| 110 | Classical | | | building | mudbrick? | Pyrgouthi | R/Y | 130 | | |
| 138 | Roman | amphora stand | coarseware | null | fragment | FS503 | R | 158 | **826/28** | |
| 139 | Roman | amphora stand | coarseware | null | fragment | FS500 | R/Y | 159 | **548/10** | 43 |
| **Clay pellet (large fine clay pellets)** | | | | | | | | | | |
| 161 | Late Antique | tile | coarseware | tile | fragment | FS500 | Y | 181 | **690/32** | |
| 162 | Late Antique | tile | coarseware | tile | fragment | FS500 | Y | 182 | **690/31** | |
| **Volcanic (cryptocrystalline with phenocrysts)** | | | | | | | | | | |
| 33 | EHII | large incurving bowl | coarseware | open | rim fragment with taenia | FS405 | Y | 53 | **901/88** | 23 |
| **Volcanic (silicified?)** | | | | | | | | | | |
| 13 | FN | probably jar | coarseware | closed | base fragment | FS400 | R | 33 | **701/236** | 42 |
| 16 | FN | saucer or bowl | coarseware | open | base fragment | FS39 | R | 36 | **767/4** | 53 |
| 20 | EHII | pithos | coarseware | storage | rim fragment with impression | FS12 | R | 40 | **53/1** | 126 |
| **Volcanic (fresh well sorted)** | | | | | | | | | | |
| 34 | EHI | 'frying pan' | coarseware | null | fragment | FS35 | R | 54 | **571/21** | 8 |
| **Calcareous sand (calcareous sand)** | | | | | | | | | | |
| 45 | EHII | sauceboat | fineware | liquid | spout | Mastos | Y | 65 | | |
| 91 | Archaic | kantharos | fineware | drinking | body sherd – footed three-handled | Tholos tomb | Y | 111 | | 5 |
| 121 | Hellenistic | Laconian pantile | coarseware | tile | Laconian pantile | null | R/Y | 141 | **888/9** | |
| 147 | Roman | amphora | coarseware | transport | ribbed body sherd | FS504 | R | 167 | **851/23** | |
| 185 | Late Antique | amphora | fineware | transport | body sherd | Pyrgouthi | R/Y | 206 | | |
| 242 | Late Antique | tile | coarseware | tile | fragment pantile | Pyrgouthi | R | 264 | | |
| **Calcareous sand (chaff)** | | | | | | | | | | |
| 240 | EH | tile | coarseware | tile | fragment | Mastos | Y | 262 | | |
| 235 | LH | drainage channel | coarseware | building | fragment | Mastos | Y | 257 | | |
| 236 | LH | drainage channel | coarseware | building | fragment | Mastos | Y | 258 | | |
| **Grog** | | | | | | | | | | |
| 17 | FN | bowl or jar | coarseware | open | base fragment bowl or jar | FS39 | R | 37 | **770/1** | 54 |
| 24 | EHII | pithos | coarseware | storage | knob with taenia | FS39 | R | 44 | **767/14** | 101 |

*Table 7. Samples in the Clay pellet, Volcanic, Calcareous sand and Grog groups.*

*Discussion*: These fabrics belong to a Late Hellenistic to Early Roman mudbrick, which refired reddish yellow, and two Roman amphora stands, which refired red and reddish yellow. Unlike Clay pellet (highly calcareous) there seems to be evidence here of petrographically similar clays being found in ceramics and building material.

## Clay pellet (large fine clay pellets)

*Number of samples*: 2 (*Table 7*, *Fig. 122*).
*Period*: Late Antique.
*Fabric class characteristics*: These fabrics are fine-grained with very few inclusions and large, merging clay-pellets.

*Discussion*: Both samples are of Late Antique tile from FS500, and both refired yellow. They bear some similarity to the Clay pellet (highly calcareous) fabrics. They also bear some similarity to tiles from the Late Antique kiln situated in the valley, excavated by the Greek Archaeological Service.

## Volcanic (cryptocrystalline with phenocrysts)

*Number of samples*: 1 (*Table 7*, *Fig. 123*).
*Period*: Early Helladic II.
*Fabric class characteristics*: The fabric has a fine matrix with coarse, rounded inclusions of altered volcanic rock. The rock is characterised by its groundmass of brown volcanic glass and large, well formed phenocrysts of plagioclase and hornblende.

*Discussion*: The sample comes from a large incurving bowl rim with taenia. Its composition is consistent with a source in a region of volcanic rock. Given the absence of significant outcrops of volcanic material in the Berbati Valley, it is likely to be an import. The sample refired yellow.

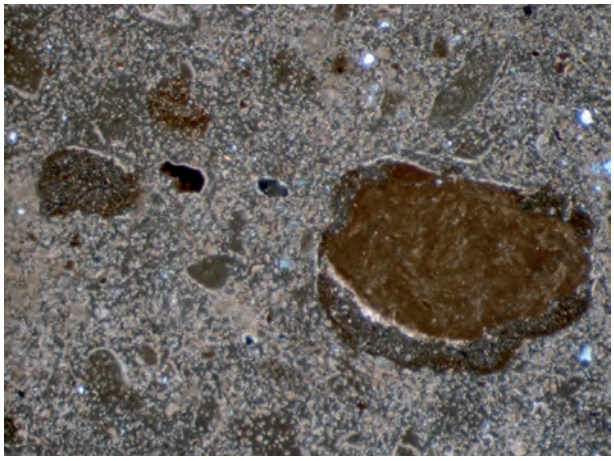

*Fig. 122. Clay pellet (large fine clay pellets). Sample 162 is a Late Antique tile. Crossed polars, width of field is 3.7 mm. Large dark to pale brown clay pellets in a micromass dominated by pale brown crystallitic b-fabric.*

## Volcanic (silicified?)

*Number of samples*: 3 (*Table 7*, *Fig. 124*).
*Periods*: Final Neolithic and Early Helladic II.
*Fabric class characteristics*: These fabrics have a fine matrix with coarse, rounded inclusions of heavily altered volcanic rock. The rock is characterised by its fine, apparently silicified, groundmass and what appear to be remnant phenocrysts.

*Discussion*: These fabrics belong to two Final Neolithic samples, a jar and a bowl or saucer, and an Early Helladic II pithos. Although the inclusions appear to be volcanic in origin, their heavily altered character means that they may come from recrystallised and perhaps transported bodies. Such rocks are not restricted to volcanic regions, and might be found in lo-

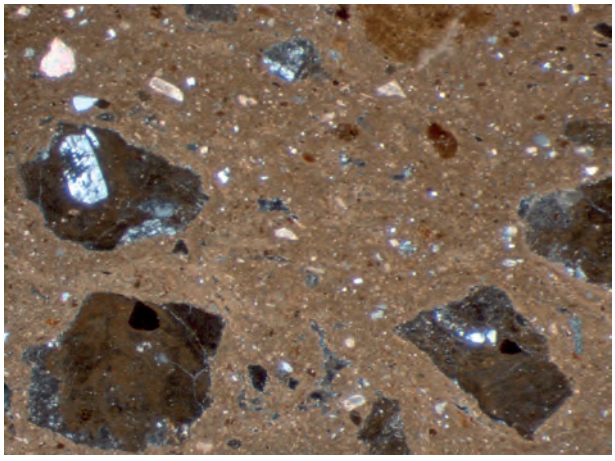

*Fig. 123. Volcanic (cryptocrystalline with phenocrysts). Sample 33 is an Early Helladic II large incurving rim bowl with taenia. Crossed polars, width of field is 3.7 mm. There are large, dark brown to grey inclusions of volcanic rock, one with a well formed pale grey feldspar phenocryst.*

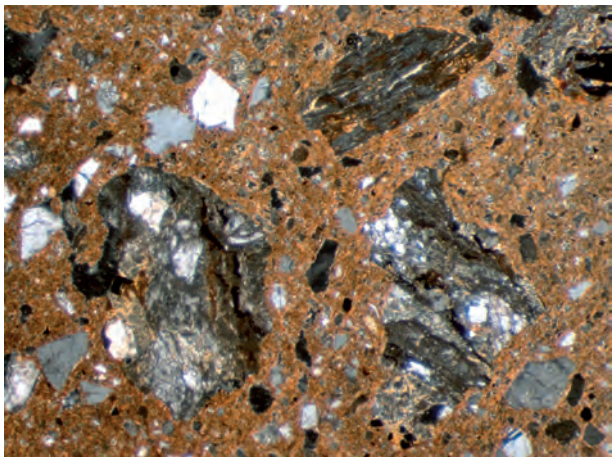

*Fig. 124. Volcanic (silicified?). Sample 13 is a Final Neolithic jar base. Crossed polars, width of field is 3.7 mm. There are large grains of chert, which appear to be silicified volcanic rock, with white to grey quartz and yellow to dark brown alteration products.*

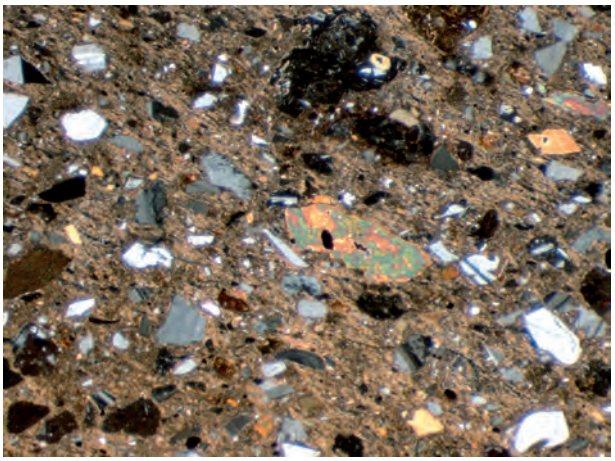

*Fig. 125. Volcanic (fresh well sorted). Sample 34 is an Early Helladic I 'frying pan'. Crossed polars, width of field is 3.7 mm. The white to grey inclusions are feldspar and quartz, the coloured inclusion in the centre is hornblende, and the very dark grey to black inclusions are volcanic rock.*

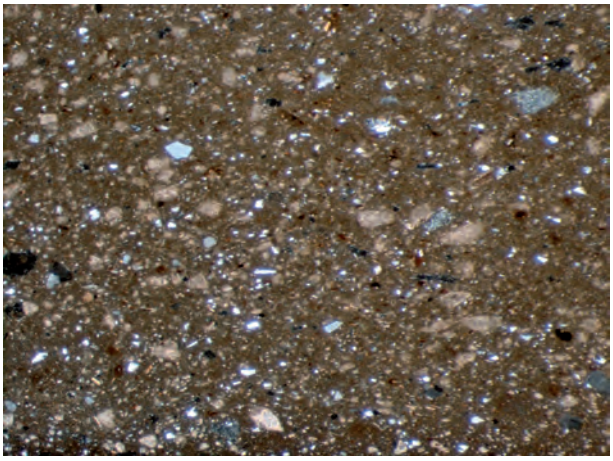

*Fig. 126. Calcareous sand (calcareous sand). Sample 91 is an Archaic kantharos body sherd. Crossed polars, width of field is 3.7 mm. The well sorted, pale yellowish brown inclusions are limestone (calcareous) sand, and the white to grey inclusions are quartz.*

calised outcrops in regions of metamorphic and sedimentary character. A source in the Berbati Valley cannot be ruled out, although it does seem unlikely judging from the geological map.[11] All samples refired red.

## Volcanic (fresh well sorted)

*Number of samples*: 1 (*Table 7*, *Fig. 125*).
*Period*: Early Helladic I.
*Fabric class characteristics*: The fabric is characterised by well sorted, fresh volcanic rock fragments and minerals.

[11] Tataris *et al.* 1970.

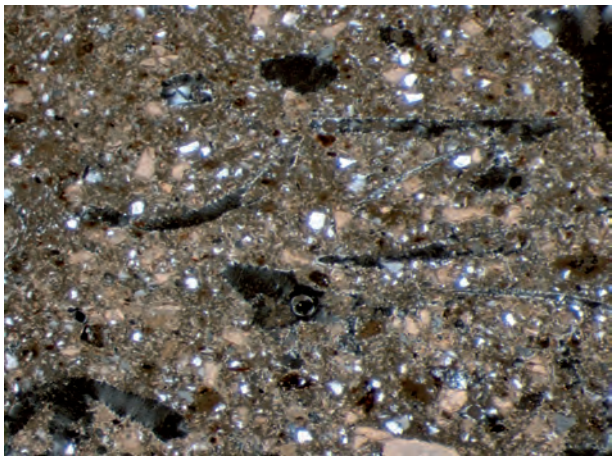

*Fig. 127. Calcareous sand (chaff). Sample 236 is a Late Helladic drainage channel. Crossed polars, width of field is 3.7 mm. The pale yellowish brown inclusions are limestone (calcareous) sand, the white to grey inclusions are quartz, and the curved black areas are voids resulting from burnt out chaff.*

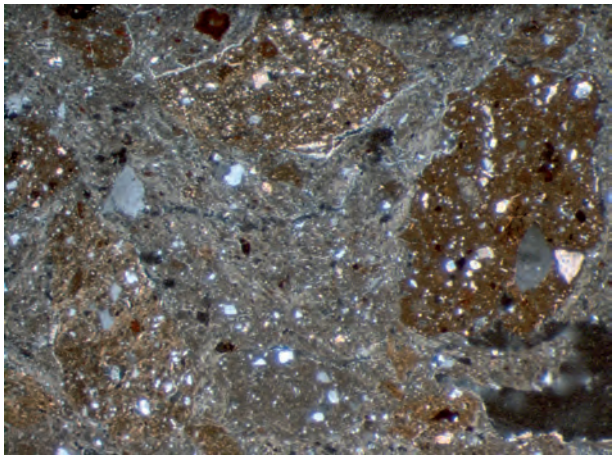

*Fig. 128. Grog. Sample 24 is an Early Helladic II (probably) pithos with knob and taenia. Crossed polars, width of field is 3.7 mm. The large, brown inclusions are grog, some of which have optically active micromass. The grog contains quartz and limestone.*

*Discussion*: The Berbati Valley is not a volcanic region, though volcano-sedimentary units can be part of the shale-sandstone-chert formation; see references to breccia/tuffite in the petrographic descriptions. In the case of this fabric, the predominance of volcanic rock and mineral inclusions and the freshness of their condition indicate a source in a volcanic region. The Early Helladic 'frying pan' from which the sample was taken is therefore identified as an import. The sample refired red.

### Calcareous sand (calcareous sand)

*Number of samples*: 6 (*Table 7*, *Fig. 126*).
*Periods*: Early Helladic II, Archaic, Hellenistic, Roman and Late Antique.
*Fabric class characteristics*: These fabrics are distinguished by well sorted calcareous (micritic limestone) sand and quartz.

*Discussion*: Despite the few samples, this class covers a wide range of periods. It was used for a wide range of ceramic shapes including an Early Helladic II sauceboat, Archaic kantharos, Hellenistic tile, Roman transport amphora and a Late Antique transport amphora and tile. The diverse range of dates and vessel shapes is matched by variation in refired colours.

### Calcareous sand (chaff)

*Number of samples*: 3 (*Table 7*, *Fig. 127*).
*Periods*: Early Helladic and Late Helladic.
*Fabric class characteristics*: These fabrics are distinguished by well sorted calcareous (micritic limestone) sand and a sinuous channel microstructure that is characteristic of burnt out organic material; see Mudstone (chaff).

*Discussion*: The fabrics belong to an Early Helladic tile and two Late Helladic drainage channels. All samples refired yellow. The fabric class may be related to yellow-refired examples of Calcareous sand (calcareous sand), with the addition of chaff. Late Helladic drainage channels were also produced in Mudstone (chaff) fabrics.

### Grog

*Number of samples*: 2 (*Table 7*, *Fig. 128*).
*Periods*: Final Neolithic and Early Helladic II.
*Fabric class characteristics*: The class is identified by the presence of grog in a poorly sorted groundmass.

*Discussion*: There are only broad similarities between these two fabrics, mainly based on their both containing grog, possessing a similar range of inclusion compositions, though in different proportions, and both having refired red. It may be significant that both come from FS39, though further sampling would be necessary to determine whether this is more than a coincidence. The grog fabrics have inclusions of quartz and limestone, which are consistent with a source in the Berbati Valley. There is no striking match with other Neolithic and Early Helladic fabrics in this data set, but they may belong to a fine-grained variant of Felsic (quartz limestone).

## Detailed petrographic descriptions of the fabric groups and classes

The petrographic descriptions of ceramic fabrics below follow the method and terminology outlined by Whitbread.[12] References to specific samples identify exceptional cases within a fabric class. For ease of reference key terms are briefly described here.

In *microstructure*, vesicles are voids with regular shape and smooth surfaces (i.e. approximately circular), vughs are voids with an irregular shape, whereas channels are linear cylindrical voids (mega >2mm, macro 0.5–2mm, meso 0.05–0.5mm, micro <0.05mm). In porphyric related distributions, grains embedded in a finer matrix are single-spaced (distance between grains equals their mean diameters), double-spaced (double the mean diameters) or open-spaced (greater than double-spaced).

Under *groundmass*, homogeneity refers to the degree of similarity in petrographic properties within a fabric class or an individual fabric as specified. Fabric classes contain fabrics of similar character, but in some cases individual samples display differences that are distinct, but not significant enough to place them in another class. Micromass refers to material <10μ, effectively the fired clay matrix. Optical activity is seen in micromass that has a birefringent fabric where clay minerals have not completely broken down as a result of firing.[13] Crystallitic b-fabric refers to the presence of very fine grained (primarily) carbonate inclusions within the micromass.

The percentage proportion of *inclusions* is represented by the coarse, fine and void distribution (c:f:v), with the specified division between coarse and fine components, usually 10μ, which is the boundary between micromass and coarser material. Inclusion compositions are presented in order of estimated frequency: predominant >70%, dominant 50–70%, frequent 30–50%, common 15–30%, few 5–15%, very few 2–5%, rare 0.5–2%, and very rare <0.5%. These proportions are based on visual estimates and comparator charts.

*Concentration (depletion) features* are components of the fabric distinct from aplastic material and the encompassing micromass. They are varied in appearance, ranging between discrete particles to 'amorphous' collections of submicroscopic material that appear as variation in optical density of the micromass. *Textural concentration features* (tcf) are concentrations of clay-based material. These are commonly discrete inclusions or clay pellets with clear boundaries, but in some cases their borders are poorly defined and they appear to merge with the micromass. *'Amorphous' concentration features*

[12] Whitbread 1995, 365.
[13] Whitbread 1995, Table A3.6, b-fabric.

(acf) commonly occur as discrete grains of opaque material, but are also common as variation in the optical density of the micromass, often merging with the micromass. In the latter case, these concentrations appear to be amorphous at the optical microscopic scale, but are probably concentrations of discrete, submicroscopic particles. *Crystallitic concentration features* (kcf) are similar to 'amorphous' concentration features, but composed of minute crystalline material, most likely calcium carbonate and related minerals.

## Felsic (chert limestone garnet) (*Fig. 102*)

*Microstructure*: Frequent meso- to microvughs and mesochannels. They have a single-spaced porphyric related distribution. Preferred orientation is well developed, evident primarily in b-fabric, when present, and channel orientations.

*Groundmass*: Fabrics are homogeneous. Micromass: predominantly optically inactive to slightly active with very rare stipple-specked b-fabric. Colour: dark reddish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 10:85:5 to 25:65:10.
**Predominant**: Chert: inclusions are 1.7–0.04mm, mode *c.* 0.2mm, moderately sorted, angular to subangular, rarely with radiolaria.
**Common–very rare**: Limestone: inclusions are 0.9–0.03mm, mode *c.* 0.2mm, subangular to well rounded, predominantly micrite (very rarely containing rare quartz silt), rarely crystalline.
**Few–very few**: Monocrystalline quartz: inclusions are 0.2–0.03mm, mode *c.* 0.06mm, angular to subrounded, moderately sorted. Polycrystalline quartz: inclusions are 0.32–0.12mm, mode *c.* 0.14mm, angular to rounded, the latter in coarser grains, moderately sorted and rarely containing white mica.
**Very few–very rare**: Garnet: inclusions are 0.3–0.03mm, subangular to rounded, moderately sorted, yellow to dark reddish brown, rarely with a dark reaction rim around the circumference. They are present in almost all samples. Siltstone/mudstone: 1–0.25mm, mode *c.* 0.5mm, well rounded, well sorted, containing well sorted, frequent to very few inclusions, predominantly calcareous silt with very few monocrystalline quartz, biotite and white mica (**157**). It is possible that these inclusions are tcfs rather than siltstone/mudstone given that almost all are well rounded.
**Very rare**: Mica: inclusions are 0.12–0.03mm, mode *c.* 0.03mm, angular, well sorted, predominantly biotite, commonly white mica. Biogenic fragment: the inclusion is an arc of thin shell (**150**). Calcareous sandstone: inclusions are 1–0.6mm, rounded, containing well sorted grains of micrite, mono- and polycrystalline quartz, biotite and white mica in a micrite cement (**175**).

*Clay pellets (textural concentration features)*: 0–10%.
Dark reddish brown (xp and pp, x30), (**157**), 1.2–0.36mm, mode *c.* 0.16mm, high to neutral optical density, sharp to clear boundaries, well rounded and with high apparent sphericity, very rare examples are optically active with stipple-speckled b-fabric. Constituents: *c.* 0–40%, well sorted, silt-sized grains, predominant–frequent monocrystalline quartz and frequent to very rare biotite and white mica.

Medium grey (xp and pp, x30), (**191**), 1.2–0.54mm, mode *c.* 0.42mm, low optical density, sharp to clear boundaries, rounded and with medium apparent sphericity. Constituents: *c.* 0–3%, well sorted, silt-sized grains, predominantly monocrystalline quartz. These clay pellets are characterised by the presence of polygonal cracks and it is possible that they are mudstone rather than clay pellets.

*'Amorphous' concentration (depletion) features*: <1–2%. These are predominantly pure, opaque nodules with clear to diffuse boundaries, 0.25–0.03mm, mode *c.* 0.05mm. Concentric concretions occur in **14**, **151** and **159**, 0.3–0.03mm, mode *c.* 0.1mm.

*Crystalline concentration (depletion) features*: 0–5%. When present they predominantly occur as crystallitic coatings on voids.

## Felsic (quartz limestone) (*Fig. 104*)

*Microstructure*: Predominant to frequent meso- to microvughs and frequent to common mesochannels. Fabrics have a single-spaced porphyric related distribution. Preferred orientation can be well defined where it is evident in b-fabric and channel orientations.

*Groundmass*: The fabric class is heterogeneous. It may represent a coarser version of the fine sand class, but there is variation in the quantity of limestone and the degree of coarseness of inclusions. Micromass: frequently optically inactive and frequently optically active with stipple-specked (**11**) and striated (**12**) b-fabrics. Colour: reddish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 15:80:5 to 30:60:10.
**Predominant**: Polycrystalline quartz: inclusions are 1.7–0.06mm, mode *c.* 0.5mm, angular to rounded, the latter in coarser grains, poorly sorted, with different degrees of internal sorting and grain size.
**Frequent–few**: Monocrystalline quartz: inclusions are 1.2–0.03mm, mode *c.* 0.25mm, angular to subangular, moderately

sorted, although there are very few to rare examples of well sorted grains *c.* 0.05mm.
**Common–very few**: Limestone: inclusions are 1.55–0.15mm, mode *c.* 0.6mm, subangular to well rounded, micrite.
**Few–rare**: Chert: inclusions are 3.2–0.15mm, mode *c.* 0.5mm, poorly to moderately sorted, angular to subangular, very few have radiolaria (**12**). Sandstone: inclusions are 3.12mm, subangular, with poorly sorted grains 0.55–0.05mm (**12**) that are subrounded to subangular grains in silica cement. There are common to few examples, *c.* 1mm, with well sorted grains *c.* 0.15mm, very few of which have brown matrix, and a rare example with calcareous matrix (**124**).
**Rare**: Mica: inclusions are 0.3–0.03mm, mode *c.* 0.06mm, angular, moderately sorted, predominantly biotite, commonly white mica. Quartz ± plagioclase ± biotite ± muscovite: the rock fragments are 1.8–0.2mm, mode *c.* 0.6mm, angular to subrounded, well sorted (**11**).
**Very rare**: Plagioclase: inclusions are 0.42–0.28mm, subangular, fresh (**11**). Orthoclase: it is *c.* 0.22mm, subangular and fresh (**12**). Phyllite: it is 0.5mm, rounded, biotite quartz phyllite (**11**).

*Clay pellets (textural concentration features)*: 0–10%.
Dark reddish brown to dark yellowish brown (xp and pp, x30), 2–0.3mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity, very rare examples are optically active with stipple-speckled b-fabric. Constituents: *c.* 0–3%, very well sorted grains, 0.06–0.03mm, predominant–frequent monocrystalline quartz and frequent to very rare biotite and white mica.

*'Amorphous' concentration (depletion) features*: <1–2%. These are predominantly pure, opaque, nodules with clear to diffuse boundaries, *c.* 0.04mm.

*Crystalline concentration (depletion) features*: 0–5%. When present these predominantly occur as weakly impregnated crystallitic segregations.

## Felsic (fine sand) (*Fig. 105*)

*Microstructure*: Predominantly meso- to microvughs. They have a single-spaced porphyric related distribution. Preferred orientation is poorly defined, where evident (**251**), it is in b-fabric, void and elongate grain orientations.

*Groundmass*: Fabrics are homogeneous in character. Micromass: predominantly optically inactive to slightly active with very rare traces of striated b-fabric (**251**) and stipple-speckled b-fabric (**155**). Colour: dark reddish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 10:87:3 to 20:77:3 and 10:80:10 to 20:70:10.
**Predominant**: Monocrystalline quartz: inclusions are 0.34–0.03mm, mode *c.* 0.1mm, angular, very well sorted, although there are very few to very rare examples of medium sand-sized quartz (**250**).
**Common–rare**: Mica: inclusions are 0.1–0.03mm, mode *c.* 0.06mm, angular, moderately sorted, predominantly biotite, commonly white mica.
**Few**: Polycrystalline quartz: inclusions are 0.98–0.03mm, mode *c.* 0.14mm, angular to rounded (in coarser grains), and moderately sorted (**206**).
**Very few–very rare**: Quartz-plagioclase-biotite: rock fragments 0.72–0.36mm, subangular to subrounded, well sorted. Sandstone: inclusions are 0.76–0.6mm, rounded, containing subangular, very well sorted, very fine sand, with frequent mono- and polycrystalline quartz, and very few to rare biotite (**192**). Chert: inclusions are 0.7–0.1mm, mode *c.* 0.18mm, moderately sorted, angular to subangular (**250**). Limestone: inclusions are 0.66–0.06mm, mode *c.* 0.16mm, subangular to well rounded, micrite (**230**).
**Very rare**: Plagioclase: subangular, fresh, *c.* 0.22mm. Biogenic fragments: inclusions are arcs of thin shell, 1.7–0.54mm, (**130**) and (**164**). Weathered volcanic rock: this inclusion is 0.44mm, well rounded, plagioclase laths in dark reddish brown 'amorphous' matrix (**143**). Schist: inclusions are 0.6–0.36mm, mode *c.* 0.42mm, subrounded, well sorted, quartz muscovite schist (**155**). Phyllite: inclusions are 0.38–0.26mm, rounded, biotite quartz phyllite, (**155**) and (**164**).

*Clay pellets (textural concentration features)*: 0–10%.
Dark reddish brown to dark yellowish brown (xp and pp, x30), 0.84–0.12mm, mode *c.* 0.42mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity, very rare examples are optically active with stipple-speckled b-fabric (**251**). Constituents: *c.* 0–3%, very well sorted, silt-sized grains, predominant–frequent monocrystalline quartz and frequent to very rare biotite and white mica; constituents can constitute 25% in one case each in (**250**) and (**251**).

*'Amorphous' concentration (depletion) features*: <1–2%. Predominantly are pure opaque nodules with clear to diffuse boundaries, 0.06–0.03mm.

*Crystalline concentration (depletion) features*: 0–5%. When present they predominantly occur as weakly impregnated crystallitic segregations.

## Felsic (very fine sand) (*Fig. 106*)

*Microstructure*: Predominantly meso- to microvughs. They have a double to single-spaced porphyric related distribution. Preferred orientation is rarely apparent, where it is evident, (**144**), it occurs as b-fabric, void and elongate grain orientations.

*Groundmass*: Fabrics are homogeneous, though there is some variation in quantities of mica and clay pellets. Micromass: predominantly optically inactive to slightly active with very rare traces of striated b-fabric (**144**). Colour: dark yellowish brown to dark reddish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 10:87:3 to 20:70:10.
**Predominant**: Monocrystalline quartz: inclusions are 0.14–0.03mm, mode *c.* 0.07mm, angular, very well sorted.
**Common–rare**: Mica: inclusions are 0.14–0.03mm, mode *c.* 0.04mm, angular, very well sorted, predominantly biotite, commonly white mica.
**Common–very rare**: Limestone: inclusions are 0.78–0.03mm, mode *c.* 0.08mm, (**119**), well rounded, micrite. In **96** it is common as calcareous sand.
**Few**: Polycrystalline quartz: inclusions are 0.38–0.08mm, mode *c.* 0.1mm, angular, well sorted.
**Very few–very rare**: Quartz-plagioclase-biotite: rock fragments are 0.6–0.34mm, subangular to subrounded, well sorted (**133**).
**Very rare**: Chert: inclusions are 0.56–0.06mm, moderately sorted, angular to subangular (**176**). Plagioclase: it is 0.24mm, subangular and fresh (**131**). Biogenic fragments: inclusions are arcs of thin shell, 0.38mm in **92** and 4.88mm in **93**. Sandstone: it is 0.9mm, rounded, containing subangular, very well sorted, very fine sand, with frequent mono- and polycrystalline quartz, rare plagioclase and biotite (**133**).

*Clay pellets (textural concentration features)*: 0–10%.
Dark reddish brown to dark yellowish brown (xp and pp, x30), **133** and **86**, 1.8–0.1mm, mode *c.* 0.2mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. Constituents: *c.* 0–3%, very well sorted, silt-sized grains, predominant–frequent monocrystalline quartz and frequent to very rare biotite and white mica.

*'Amorphous' concentration (depletion) features*: <1%. Predominantly pure opaque nodules with clear to diffuse boundaries, 0.1–0.03mm, mode *c.* 0.04mm.

*Crystalline concentration (depletion) features*: 0–10%. When present they predominantly occur as moderately to weakly impregnated crystallitic segregations (**119**).

## Felsic (silt-extremely fine) (*Fig. 107*)

*Microstructure*: Predominantly meso- to microvughs. In the case of **76** the microstructure is predominantly vesicular. There is an open-spaced porphyric related distribution. Preferred orientation is not apparent.

*Groundmass*: Homogeneous apart from the presence of silt-sized inclusions in some samples, some extremely fine fabrics are very well fired (vitrified) and fabrics similar to Corinthian 'blister ware' with clay pellets and warped clay pellets, **212**, **214–218** and **220**. Silt fabrics also display some variation in the quantity of mica and clay pellets.

*Micromass*: Optically inactive, but slightly active in very few silt fabrics with faint traces of striated b-fabric, and rarely optically active with striated b-fabric (**51**), a LH III dark-on-light body sherd. Colour: yellowish brown to yellowish green (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 3:94:3 to 7:83:10.
**Predominant–frequent**: Monocrystalline quartz: inclusions are 0.14–0.03mm, mode *c.* 0.04mm, angular, very well sorted.
**Common–very rare**: Mica: biotite and white mica, 0.14–0.03mm, mode *c.* 0.04mm, angular, very well sorted.
**Rare**: Polycrystalline quartz: inclusions are 0.12–0.05mm, mode *c.* 0.05mm, angular, very well sorted.
**Rare–very rare**: Limestone: inclusions are 0.55–0.05mm, mode *c.* 0.125mm micrite, moderately sorted, subrounded to rounded.
**Very rare**: Plagioclase: two examples, *c.* 0.2mm, subrounded, cloudy (**30**). Breccia: it is 0.35mm, contains simple-twinned plagioclase (**50**). Biogenic fragments: inclusions are thin arcs of shell, 0.58 and 0.78mm, (**38**) and (**51**).

*Clay pellets (textural concentration features)*: 0–15%.
Dark yellowish brown to reddish brown (xp and pp, x30), 2.55–0.05mm, mode *c.* 0.25mm, neutral to high optical density, clear to diffuse boundaries, well rounded and with high apparent sphericity. They are rarely optically active with stipple-speckled b-fabric. Constituents: <2%, predominantly very well sorted, biotite silt. When present, crystallitic b-fabric (1–15%) occurs in these clay pellets in **212**, **214–218** and **220**, contrasting with its absence in the micromass of the fabrics.

Pale yellowish brown (xp and pp, x30), 3.05–0.2mm, mode *c.* 0.35mm, low optical density and very low apparent sphericity. Constituents: 0%. These are long, thin bands present within 'blister ware' samples that are warped and follow preferred orientation subparallel with the vessel walls. They are warped alongside high apparent sphericity clay pellets, suggesting that this type of clay pellet material was plastic at the time of vessel forming, unlike other clay pellets.

Pale yellowish brown (xp and pp, x30), 0.65–0.2mm, mode *c.* 0.35mm, low optical density and high apparent sphericity, although rarely warped. Constituents: 15%, very well sorted silt-sized grains of predominant–dominant monocrystalline quartz, common–very few calcite, few–very rare biotite and white mica. These clay pellets occur in silt samples **28**, **30**, **32**, **38**, **43**, **49–51**, **53–56**, **58**, **64**, **135** and **224**, possibly suggesting that extremely fine and silt fabrics come from different clay deposits.

Dark grey (xp and pp, x30), 1.5–0.2mm, mode *c.* 0.35mm, high to neutral optical density, subangular to subrounded, high apparent sphericity, sharp to clear boundaries. Constituents: <1%, predominantly quartz silt. These inclusions occur in **166** and are distinguished by a vesicular microstructure. They are inconsistent with the host fabric, which has an optically inactive micromass, but a vughy microstructure. It is possible that these are over fired mudstone inclusions[14] but, given the lack of vesicular microstructure in the host fabric, they could be another type of inclusion.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure opaque nodules with clear to diffuse boundaries, 0.15–0.03mm, mode *c.* 0.05mm.

*Crystalline concentration (depletion) features*: 0–3%. When present they predominantly occur as crystallitic coatings around voids, although few samples have weakly impregnated crystallitic segregations.

## Felsic (packed quartz) (*Fig. 108*)

*Microstructure*: Predominant mesochannels and very few meso- to microvughs. The fabric has a single-spaced porphyric related distribution. Preferred orientation is well defined in b-fabric, channel orientations and orientation of elongate grains.

*Groundmass*: The fabric is homogeneous. Micromass: optically active with striated b-fabric. Colour: reddish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 40:50:10.
**Predominant**: Polycrystalline quartz: inclusions are 1–0.08mm, mode *c.* 0.2mm, angular to rounded, the latter in coarser grains, poorly sorted, with different degrees of internal sorting and grain size, and rarely containing very rare white mica.
**Common**: Monocrystalline quartz: inclusions are 0.4–0.03mm, mode *c.* 0.16mm, angular to subangular, moderately sorted.
**Rare**: Chert: inclusions are 1.05–0.08mm, poorly to moderately sorted, angular to subangular, very few have radiolaria. Mica: inclusions are 0.26–0.03mm, mode *c.* 0.1mm, angular, moderately sorted, predominantly biotite, commonly white mica.

*Clay pellets (textural concentration features)*: 0–10%.
Dark reddish brown (xp and pp, x30), 1.05–0.1mm, mode *c.* 0.45mm, high optical density, sharp to clear boundaries, subrounded to rounded with high apparent sphericity. Constituents: *c.* 0–3%, well sorted grains, 0.14–0.03mm, predominantly monocrystalline quartz with very rare biotite and white mica.

*'Amorphous' concentration (depletion) features*: <1–2%. These are predominantly pure, opaque, nodules with clear to diffuse boundaries, 0.16–0.03mm, mode *c.* 0.03mm.

*Crystalline concentration (depletion) features*: 0%.

## Felsic (chert mudstone) (*Fig. 109*)

*Microstructure*: Predominant macro- to mesochannels and very few mesovughs. They have a single-spaced porphyric related distribution. Preferred orientation is only defined by channels.

*Groundmass*: These fabrics are homogeneous for inclusion compositions, but there are differences in texture. Micromass: optically inactive. Colour: yellowish brown and dark grey (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 20:60:20 (**18**) and 15:80:5.
**Frequent**: Chert: inclusions are 2.3–0.06mm, mode *c.* 0.35mm, poorly to moderately sorted, angular to subangular, very few have radiolaria. Mudstone: inclusions are 3.92–0.24mm, mode *c.* 0.55mm, grey, subangular to rounded, very rarely with radiolaria, predominantly with polygonal cracks.
**Rare**: Limestone: inclusions are 1–0.1mm, mode *c.* 0.4mm, micrite, subangular to rounded. Monocrystalline quartz: inclusions are 0.55–0.03mm, mode *c.* 0.04mm, angular to subangular, moderately sorted.

*Clay pellets (textural concentration features)*: 0–10%.
Dark reddish brown (xp and pp, x30), 1.5–0.5mm, mode *c.* 0.5mm, high optical density, sharp to clear boundaries, subrounded to rounded with high apparent sphericity. Constituents: *c.* 0–3%, very well sorted, 0.06–0.03mm, predominantly monocrystalline quartz with very rare biotite and white mica.

*'Amorphous' concentration (depletion) features*: <1–2%. These are predominant to very few pure, opaque, nodules with clear to diffuse boundaries, 0.2–0.03mm, mode *c.* 0.4mm. In **67**

[14] E.g. Whitbread 1995, Plate 5.7.

they are predominantly hypocoatings of very dark grey material (carbon?) around voids, suggesting burnt out organic matter.

*Crystalline concentration (depletion) features*: 0%.

## Mudstone (chaff) (*Fig. 110*)

*Microstructure*: Frequent mesovughs and macro- to mesochannels. The shapes of these channels, especially the long sinuous and round varieties, suggest that they are relics of organic material (chaff) that was burnt out during firing. The fabrics have a single-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: Homogeneous. Micromass is predominantly optically inactive. Crystallitic b-fabric is rare to very few. Colour is yellowish brown to yellowish green (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 20:70:10.
**Frequent**: Mudstone: inclusions are 2.1–0.6mm, mode *c.* 1.5mm, yellowish brown (**233**) and dark grey (**234**), moderately sorted, subangular to subrounded. Rare examples display unistrial optical activity (**233**). Siltstone: inclusions are 6.1–1.25mm, mode *c.* 2.5mm and have similar properties to the mudstone. In **233** there are examples of mudstone bedded with siltstone in a single inclusion, demonstrating a common source. Breccia: it occurs in (**233**) with a similar size range to the mudstone.
**Very few**: Monocrystalline quartz: inclusions are 0.2–0.03mm, mode *c.* 0.05mm, very well sorted.
**Very few–very rare**: Limestone: inclusions are 0.3–0.03mm, mode *c.* 0.1mm, micrite, well rounded (**233**).
**Rare–very rare**: Chert: inclusions are 0.3–0.03mm, mode *c.* 0.1mm, moderately sorted, angular to subangular. Mica: frequent biotite and white mica (**233**) inclusions have sizes of 0.3–0.03mm, mode *c.* 0.1mm.
**Very rare**: Polycrystalline quartz: inclusions are *c.* 0.15mm, angular to subangular, moderately sorted.

*Clay pellets (textural concentration features)*: 3–10%.
Reddish brown (**233**) to dark yellowish green (234) (xp and pp, x30) examples are 0.75–0.1mm, mode *c.* 0.3mm, with high optical density, sharp to clear boundaries, and are well rounded with high apparent sphericity. Constituents: c. 0%.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure opaque nodules, 0.2–0.03mm, mode *c.* 0.05mm.

*Crystalline concentration (depletion) features*: 5–10%. Predominantly occur as channel coatings and display infill structures indicating that they occupied open cavities left by the burning out of organic matter (chaff).

## Mudstone (limestone) (*Fig. 111*)

*Microstructure*: Vugh and channel microstructure with frequent mesovughs and mesochannels. The fabrics have single- to double-spaced porphyric related distributions and preferred orientation is very rarely evident in channels and tcfs.

*Groundmass*: Heterogeneous, apart from well sorted, quartz 0.35–0.03mm, mode *c.* 0.1mm (**149**), and a predominance of clay pellets (**195**). Micromass is optically active with stipple-speckled b-fabric (**40**, **46** and **48**) to optically inactive. Crystallitic b-fabric is rarely present. Colours vary from yellowish to reddish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 10:85:5 to 30:65:5.
**Dominant–common**: Mudstone: inclusions are 4.5–0.65mm, mode *c.* 2.75mm, grey and dark reddish to yellowish brown, moderately sorted, and angular to subrounded. They very rarely contain radiolaria and quartz grains, and have a thin, dark grey rim around their circumference or display reddish brown cores. Optically active examples of mudstone (**40**, **46** and **48**) have stipple-speckled to unistrial b-fabrics and, in the latter case, well developed preferred orientation in silt-sized white mica. Limestone: inclusions are 2.5–0.1mm, mode *c.* 0.6mm, predominantly micrite, but with common to rare crystalline limestone. Grains are moderately to poorly sorted, rounded to well rounded. In **48** there is a grain of very well sorted calcareous sand in a micrite matrix.
**Common–very few**: Monocrystalline quartz: inclusions are 0.25–0.03mm, mode, *c.* 0.1mm, moderately to very well sorted (**149**).
**Common–very rare**: Breccia (or tuffite, where minute grains of volcanic glass occur): inclusions are 1.9–0.75mm, mode *c.* 1mm, grey and dark reddish to yellowish brown, moderately sorted, subangular to rounded. They are composed of very well sorted, very fine sand-sized, subangular to rounded, pale grey to yellowish brown (pp, x100) argillaceous grains, and rarely grains of mono- and polycrystalline quartz, isotropic to anisotropic, orange (pp, x35) material which is probably volcanic glass, chert, micritic limestone and silt-sized laths, possibly of mica.
**Few–very rare**: Chert: inclusions are 0.75–0.03mm, mode *c.* 0.1mm, moderately sorted, angular to subangular.
**Very few**: Monocrystalline quartz: inclusions are 0.2–0.03, mode *c.* 0.03mm, moderately to very well sorted.
**Very few–very rare**: Polycrystalline quartz: inclusions are 0.25–0.1mm, mode *c.* 0.2mm, angular to subangular, moderately sorted, mainly in **40**.

*Clay pellets (textural concentration features)*: 1–20%.
Reddish brown (xp and pp, x30), 1.5–0.1mm, mode c. 0.4mm (195) examples have high optical density, clear to diffuse boundaries, are rounded to well rounded and with high apparent sphericity. Very rarely there is evidence of warping (48). Constituents: c. 0–20%, predominantly mono- and polycrystalline quartz and common white mica silt. These tcfs were plastic at the time of vessel forming and display strong preferred orientation sub-parallel with the vessel wall.

Yellowish green (xp and pp, x30), 0.75–0.1mm, mode c. 0.5mm (195) clay pellets have high optical density, clear to diffuse boundaries, and are rounded to well rounded and with high apparent sphericity. Constituents: 0%.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure opaque nodules, 0.3–0.03mm, mode *c.* 0.1mm.

*Crystalline concentration (depletion) features*: 0–30%. Predominantly occur as crystallitic segregations, 2.2–0.3mm, mode *c.* 0.6mm, weakly to strongly impregnated and with clear boundaries.

## Mudstone (siltstone limestone) (*Fig. 112*)

*Microstructure*: Predominantly mesovughs. It has a single-spaced porphyric related distribution. Preferred orientation is evident as a general alignment of coarse inclusions.

*Groundmass*: Homogeneous for EH II samples in general, although **23** and **29** do display greater variation than **26** and **27**. In contrast, **137** is more like the EH II samples, but is different in the character of the mudstone and the packing of the fabric. **165** is more fired (i.e. optically inactive) and with further sampling might be reclassified given the large proportion of chert inclusions. Micromass: predominantly optically active with stipple-speckled b-fabric. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 20:75:5.
**Common**: Mudstone: inclusions are 3.2–0.2mm, mode *c.* 0.8mm, yellowish brown, poorly sorted, angular to subangular. They are optically inactive to slightly active with stipple-speckled to unistrial and commonly to rarely strial b-fabrics, the latter especially in **29**. The optically inactive mudstone is massive and contains very rare quartz silt, especially in **23**. The predominant mudstone type, however, contains angular to subangular quartz very fine sand and has a 'rope-like' texture with laminae that appear to interweave through the inclusions, which are predominantly very fine sand but can reach 0.25mm and are composed of rounded polycrystalline quartz. The mudstone grades into siltstone depending on the quantity of inclusions. Breccia (or tuffite, where minute grains of volcanic glass occur): inclusions are 1.5–0.2mm, mode *c.* 0.8mm, dark yellowish brown, poorly sorted, subangular to rounded, composed of very well sorted, fine sand-sized, subangular to rounded inclusions of yellowish brown (pp, x100) 'amorphous' inclusions that look to be argillaceous and rarely contain silt-sized laths, mono- and polycrystalline quartz, isotropic to anisotropic, orange (pp, x35) material, chert and micritic limestone.
**Common–rare**: Limestone: inclusions are 1.05–0.1mm, mode *c.* 0.6mm, predominantly micrite, and rarely crystalline. The limestone grains are poorly sorted and subangular to well rounded.
**Common–very rare**: Chert: inclusions are 1.7–0.2mm, mode *c.* 1mm, moderately sorted, subangular to subrounded. They are common in **23**.
**Few–very rare**: Siltstone: inclusions are 3.25–0.2mm, mode *c.* 0.8mm subangular to rounded, poorly sorted, dark yellowish brown with very well sorted very fine sand-sized inclusions, predominantly quartz with very few muscovite mica (**26**).
**Very few**: Polycrystalline quartz: inclusions are 1.15–0.15mm, mode *c.* 0.5mm, moderately sorted, subangular grains composed of poorly sorted crystals. Monocrystalline quartz: inclusions are 0.2–0.03mm, mode *c.* 0.075mm, moderately sorted.

*Clay pellets (textural concentration features)*: 0%.

*'Amorphous' concentration (depletion) features*: *c.* 3%. These are predominantly pure, opaque, nodules, 0.3–0.03mm, mode *c.* 0.1mm.

*Crystalline concentration (depletion) features*: 0%.

## Mudstone (quartz sand and breccia) (*Fig. 113*)

*Microstructure*: Predominantly meso- to microchannels. The samples have a single-spaced porphyric related distribution. Preferred orientation is well developed in voids and striated b-fabric and, to a lesser extent, in the inclusions.

*Groundmass*: Homogeneous, the samples appear to be almost identical. Micromass: optically active with a striated b-fabric. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 25:70:5.
**Dominant**: Polycrystalline quartz: inclusions are 0.7–0.175mm, mode *c.* 0.2mm, moderately sorted, subangular grains, rarely rounded.
**Common**: Monocrystalline quartz: inclusions are 0.65–0.03mm, mode *c.* 0.2mm, angular to subangular, moderately sorted.

**Very few**: Breccia (Tuffite): inclusions are 1.25–0.4mm, mode *c.* 1mm, dark yellowish brown, moderately sorted, subrounded, composed of very well sorted, fine sand-sized, subangular to rounded inclusions of yellowish brown (pp, x100) 'amorphous' inclusions that look to be argillaceous and rarely contain silt-sized laths, mono- and polycrystalline quartz, isotropic to anisotropic, orange (pp, x35) volcanic glass, chert and micritic limestone.
**Rare**: Chert: inclusions are 0.65–0.35mm, subangular to rounded. Sandstone: the inclusion is 1.75mm, well rounded, dark brown with very well sorted inclusions, *c.* 0.075mm, predominantly quartz with very few muscovite mica and very rare plagioclase.
**Very rare**: Limestone: calcite inclusion is 0.4mm and subangular, and subrounded micritic limestone inclusion is 0.7mm (**103**).

*Clay pellets (textural concentration features)*: <1%. These are pale yellowish brown (xp and pp, x30), *c.* 0.5mm, neutral optical density, clear boundaries, well rounded and with high apparent sphericity. Constituents: *c.* 5–10%, predominantly quartz and commonly biotite silt set in a stipple-speckled micromass.

*'Amorphous' concentration (depletion) features*: *c.* 3%. Predominantly pure, opaque nodules, 0.35–0.075mm, mode *c.* 0.15mm.

*Crystalline concentration (depletion) features*: 0%.

## Mudstone (fine sand–extremely fine) (*Fig. 114*)

*Microstructure*: Frequent mesovughs and mesochannels, rare macrochannels (**115**). Single- to double-spaced, and rarely open-spaced, porphyric related distribution. Preferred orientation is very rarely evident, primarily in the orientation of channels.

*Groundmass*: Predominantly homogeneous, but there is some variation in the fine sand to silt content, the presence of channels (**115**), the occurrence of coarser quartz inclusions (**200**), and development of crystallitic b-fabric. Micromass is predominantly optically inactive. Crystallitic b-fabric is rarely present. Colour is yellowish green to reddish brown to greyish brown (xp, x30), pale greenish yellow to yellowish brown to greyish brown (pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 5:90:5 to 25:55:20.
The 20% void estimation is for **115**, which has common channels throughout the fabric.
**Predominant–dominant**: Mudstone: inclusions are 5.25–0.3mm, mode *c.* 1mm, grey to dark reddish brown, moderately sorted, subangular to subrounded. They very rarely contain radiolaria, quartz grains, or have dark grey rim around their circumference or reddish brown core.
**Predominant–very rare**: Breccia (or tuffite, where minute grains of volcanic glass occur): inclusions are 1.3–0.55mm, mode *c.* 0.75mm, grey to dark reddish brown, moderately sorted, and subangular to rounded. They are composed of very well sorted, grains of argillaceous material, *c.* 0.08mm, subangular to rounded pale grey to yellowish brown (pp, x100), and very rare grains of mono- and polycrystalline quartz, isotropic to anisotropic, orange (pp, x30) material which is probably volcanic glass, chert, micritic limestone and silt-sized laths possibly of mica. The breccia bears close similarities to a form of siltstone in which the orange material is a dominant inclusion. There are very rare examples of mudstone and breccia within the same inclusion, demonstrating that these sediments have a common source.
**Few–very rare**: Siltstone: inclusions are 0.75–0.15mm, mode *c.* 0.2mm, grey to dark reddish brown, moderately sorted, and angular to subrounded. Inclusions contain frequent to few, very well sorted, angular very fine sand to silt-sized grains, predominantly monocrystalline quartz and very rarely polycrystalline quartz, biotite and white mica. Polycrystalline quartz: inclusions are 1.2–0.2mm, mode *c.* 0.35mm, angular to subangular, moderately sorted, rarely with foliation (**200**).
**Very few–very rare**: Chert: inclusions are 1.9–0.1mm, mode *c.* 0.25mm, moderately sorted, angular to subangular, rarely containing radiolaria. Limestone: inclusions are 2.1–0.1mm, mode *c.* 0.25mm, micrite, moderately sorted, rounded to well rounded. Sample **200** contains frequent very fine sand-sized micrite. Monocrystalline quartz: inclusions are 0.2–0.03mm, mode *c.* 0.03.

*Clay-pellets (textural concentration features)*: 1–30%.
Reddish brown (xp and pp, x30), 0.85–0.15mm, mode *c.* 0.35mm (77), high optical density, clear to diffuse boundaries, and rounded to well rounded with high apparent sphericity. Constituents: 0–30%, predominantly biotite silt. Larger examples have faint traces of preferred orientation. These tcfs may be mudstone, but their wide grain size range and similarity to clay-pellets in smaller examples means that they are classed as clay-pellets at present. They predominantly occur in **239**.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure, opaque nodules, 0.15–0.075mm, mode *c.* 0.1mm.

*Crystalline concentration (depletion) features*: 0–30%. These are predominantly crystallitic segregations, 1.65–0.2mm, mode *c.* 0.6mm, weakly to strongly impregnated and with clear boundaries.

## Sandstone (red clay pellets—sandy) (*Fig. 115*)

*Microstructure*: Predominant mesovughs and common macro- to mesochannels. Fabrics have double- to single-spaced porphyric related distributions. Preferred orientation is not evident.

*Groundmass*: The fabric class is homogeneous. Micromass: predominantly optically inactive, where slightly active there are traces of stipple-speckled b-fabric. All samples have weak to moderately impregnated crystallitic b-fabric. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 20:75:5.
**Frequent**: Monocrystalline quartz: inclusions are 0.5–0.03mm, mode *c.* 0.06mm, angular, well sorted. Polycrystalline quartz: inclusions are 0.3–0.08mm, mode *c.* 0.1mm, angular to subangular.
**Frequent–few**: Sandstone: inclusions are 2.15–0.14mm, mode *c.* 0.9mm, subangular to rounded, containing subangular, very well to well sorted grains, 0.12–0.03, mode *c.* 0.06mm, with frequent mono- and polycrystalline quartz, and very few to rare biotite. In few cases the sandstone is matrix supported with a dark reddish brown matrix (**197**).
**Few–very rare**: Limestone: inclusions are 2.1–0.06mm, mode *c.* 0.4mm, subangular to well rounded, predominantly micrite.

*Clay pellets (textural concentration features)*: 5–20%.
Dark reddish brown to dark yellowish brown (xp and pp, x30), 1.05–0.15mm, mode *c.* 0.45mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. They rarely display medium striated b-fabrics. Constituents: *c.* 0–3%, very well sorted grains, 0.1–0.03mm, predominant–frequent monocrystalline quartz and frequent to very rare biotite and white mica.

*'Amorphous' concentration (depletion) features*: <1–2%. They are predominantly pure, opaque, nodules with clear to diffuse boundaries, 0.12–0.03mm, mode *c.* 0.04mm.

*Crystalline concentration (depletion) features*: 5–20%. These comprise moderate to weakly impregnated crystallitic b-fabric.

## Sandstone (sparse in very fine sand matrix) (*Fig. 116*)

*Microstructure*: Predominant to common meso- to microvughs, and predominant to common macro- to mesochannels (**19**). They have a single-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: The fabric class is homogeneous, although some variation does occur in coarse grain sizes, the proportions of well sorted very fine sand in the matrix and in proportions of limestone, but on the whole the fabrics display strong similarities. Micromass: predominantly optically inactive, where it is slightly active there are traces of stipple-speckled b-fabric. Colour: dark reddish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 10:85:5 to 30:50:20.
**Frequent**: Monocrystalline quartz: inclusions are 0.65–0.03mm, mode *c.* 0.07mm, angular, well sorted. Polycrystalline quartz: inclusions are 0.7–0.1mm, mode *c.* 0.25mm, angular to subangular.
**Common–few**: Sandstone: inclusions are 4.8–0.25mm, mode *c.* 0.7mm, subangular to well rounded, containing subangular, very well sorted grains, 0.12–0.04mm, with frequent mono- and polycrystalline quartz, and very few to rare biotite. In few cases the sandstone is matrix supported with a dark reddish brown matrix. One example, **19**, includes grains of calcite.
**Few–very rare**: Limestone: inclusions are 0.55–0.04mm, mode *c.* 0.2mm, subangular to well rounded, predominantly micrite. Mudstone: inclusions are 2.55–0.25mm, mode *c.* 0.5mm, dark brown, subangular and with striated b-fabric.
**Rare**: Mica: inclusions are 0.12–0.03mm, mode *c.* 0.06mm, angular, moderately sorted, predominantly biotite, commonly white mica.
**Very rare**: Plagioclase: it is 1.15mm, subangular and fresh (**177**). Biogenic fragments: they are arcs of thin shell, 0.4–0.08mm, mode *c.* 0.24mm (**248**), and possibly fragments with biogenic origin to judge by structure (**19**), 3.12–0.4mm.

*Clay pellets (textural concentration features)*: 0–5%.
Dark reddish brown to dark yellowish brown (xp and pp, x30), 2–0.35mm, mode *c.* 0.6mm, high to neutral optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. Constituents: *c.* 0–30%, very well sorted grains, 0.1–0.04mm, predominant–frequent monocrystalline quartz and frequent to very rare biotite and white mica.

*'Amorphous' concentration (depletion) features*: <1–2%. These are predominantly pure, opaque, nodules with clear to diffuse boundaries, 0.08–0.03mm.

*Crystalline concentration (depletion) feature*: <1%. There is a weakly impregnated crystallitic b-fabric in **179**.

## Sandstone (calcareous sandstone) (*Fig. 117*)

*Microstructure*: Dominant mesovughs and frequent mesochannels, the latter frequently curved in a manner consistent

with burnt out organic material. It has a double- to single-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: The fabric is homogeneous. Micromass: optically slightly active with traces of stipple-speckled b-fabric, it has a moderately impregnated crystallitic b-fabric. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 15:75:10.
**Frequent**: Limestone: inclusions are 2.3–0.05mm, mode *c.* 0.15mm, subangular to well rounded, predominantly micrite.
**Common**: Sandstone: the inclusion is 1.85mm, rounded, containing subangular, very well sorted grains, 0.14–0.03, mode *c.* 0.06mm, with dominant calcite and frequent monocrystalline quartz.
**Very few**: Monocrystalline quartz: inclusions are 0.14–0.03mm, mode *c.* 0.06mm, angular, well sorted. Polycrystalline quartz: inclusions are 0.08–0.06mm, angular to subangular.

*Clay pellets (textural concentration features)*: *c.* 5%.
Dark reddish brown to dark yellowish brown (xp and pp, x30), 0.85–0.2mm, mode *c.* 0.2mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. They rarely display stipple-speckled b-fabrics. Constituents: 0%.

*'Amorphous' concentration (depletion) features*: <1–2%. They are predominantly pure, opaque, nodules with clear to diffuse boundaries, 0.06–0.03mm, mode *c.* 0.03mm.

*Crystalline concentration (depletion) features*: *c.* 10%. These comprise weakly impregnated crystallitic b-fabric.

## Sandstone (siltstone mudstone) (*Fig. 118*)

*Microstructure*: Predominant mesochannels. It has a single-spaced porphyric related distribution. Preferred orientation is well developed in subparallel channels.

*Groundmass*: The fabric is homogeneous. Micromass: optically active with stipple-specked b-fabric. Colour: dark yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 30:60:10.
**Common:** Sandstone: inclusions are 2.4–0.25mm, mode *c.* 0.95mm, rounded, containing subangular, well sorted, fine sand, with frequent mono- and polycrystalline quartz, few biotite and muscovite mica, and rare plagioclase, with silica cement. Siltstone: inclusions are 2.1–0.45mm, mode *c.* 1.75mm, moderately sorted, rounded. Mudstone: inclusions are 1.4–0.45mm, moderately sorted, rounded, optically active with striated b-fabric and few well sorted biotite and white mica silt.
**Few**: Monocrystalline quartz: inclusions are 0.14–0.03mm, mode *c.* 0.1mm, angular, well sorted.
**Very few**: Polycrystalline quartz: inclusions are 0.3–0.04mm, mode *c.* 0.1mm, angular to subangular. Chert: inclusions are 1.1–0.35mm, subrounded.
**Rare**: Mica: inclusions are 0.08–0.03mm, mode *c.* 0.04mm, angular, moderately sorted, predominantly biotite, commonly white mica.

*Clay pellets (textural concentration features)*: 0%.

*'Amorphous' concentration (depletion) features*: <1%.
These are predominantly pure, opaque, nodules with clear to diffuse boundaries, 0.06–0.03mm.

*Crystalline concentration (depletion) features*: 0%.

## Clay pellet (highly calcareous) (*Fig. 119*)

*Microstructure*: Predominant macro- and mesochannels. Channels may be the result of burnt out organic matter. They have a double- to open-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: The fabrics are homogeneous. Micromass: optically inactive. Crystallitic b-fabric is dominant. Colour: yellowish green (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 5:75:20.
**Common**: Monocrystalline quartz: inclusions are 0.14–0.03mm, mode *c.* 0.08mm, moderately sorted, angular to subangular. Polycrystalline quartz: inclusions are 0.36–0.12mm, mode *c.* 0.2mm, angular to subangular, well sorted. Chert: inclusions are 0.82–0.12mm, mode *c.* 0.28mm, subangular to subrounded, moderately sorted.
**Common–few**: Limestone: inclusions are 0.9–0.03mm, mode *c.* 0.08mm, predominantly micrite and common to few sparite, poorly sorted, subangular to well rounded.

*Clay pellets (textural concentration features)*: 5–20%.
Dark yellowish brown (xp and pp, x30), 2.5–0.08mm, mode *c.* 0.3mm, poorly sorted, high to neutral optical density, sharp to clear boundaries, rounded to well rounded and with moderate to high apparent sphericity. Constituents: 0–5%, grains are *c.* 0.03mm, predominantly limestone and quartz with very few to rare white mica and biotite.

*'Amorphous' concentration (depletion) features*: 0%.

*Crystalline concentration (depletion) features*: 10–20%. Frequently occurs as moderately impregnated crystallitic b-fab-

ric, and frequently as crystallitic coatings on void surfaces and around the edges of grains.

## Clay pellet (red silty clay pellets) (*Fig. 120*)

*Microstructure*: Dominant mesovughs and frequent mesochannels. They have a single- to open-spaced porphyric related distribution. Preferred orientation is rarely evident in channels and mica (**178**).

*Groundmass*: There is a degree of homogeneity to the class, but there is some variation in the quantity of inclusions, the proportions of limestone (high in **173**, low in **167** and **178**), and optical activity of the micromass. Micromass: optically inactive to slightly active, with stipple-speckled (**178**) and striated (**167**) b-fabric. Crystallitic b-fabric is few to very rare. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 3:92:5 to 20:70:10.
**Frequent–common**: Monocrystalline quartz: inclusions are 0.14–0.03mm, mode *c.* 0.08mm, well sorted (**178**).
**Frequent–very few**: Polycrystalline quartz: inclusions are 1.1–0.14mm, mode *c.* 0.22mm, subangular to subrounded, well sorted (**178**).
**Frequent–very rare**: Limestone: inclusions are 1.9–0.03mm, mode *c.* 0.1mm, micrite, poorly sorted, well rounded (**173** and **120**). Chert: inclusions are 0.3–0.08mm, mode *c.* 0.1mm, well sorted, subangular (**173**).
**Very few–very rare**: Mica: inclusions are 0.2–0.03mm, mode *c.* 0.1mm, angular, moderately sorted, frequent biotite and white mica (**178**).
**Very rare**: Quartz biotite rock fragment: inclusion is 1.84mm, subrounded, quartz with dominant intergranular biotite and common white mica (**167**).

*Clay pellets (textural concentration features)*: *c.* 10–20%.
Dark reddish brown (xp and pp, x30), 3.1–0.03mm, mode *c.* 0.16mm, well to poorly sorted, high optical density, sharp to clear boundaries, well rounded and with high to medium apparent sphericity. They are rarely optically active with striated b-fabric in fine, grained examples (**178**). Constituents: 0–20%, 0.32–0.03mm, mode *c.* 0.04mm, well to moderately sorted (**167** and **173**), predominantly subrounded to angular, monocrystalline quartz, few polycrystalline quartz and white mica.

*'Amorphous' concentration (depletion) features*: <1%.
These are predominantly pure, opaque nodules with sharp to clear boundaries, *c.* 0.09mm.

*Crystalline concentration (depletion) features*: 0–10%.
Predominantly occur as weakly impregnated crystallitic b-fabric (**120**).

## Clay pellet (red clay pellets in silty matrix) (*Fig. 121*)

*Microstructure*: Rare meso- microvughs and mesochannels. They have an open-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: The fabric class is homogeneous. Micromass: optically inactive. Crystallitic b-fabric is few. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 5:85:10.
**Predominant–common**: Limestone: inclusions are 0.9–0.03mm, mode *c.* 0.06mm, predominantly micrite, very rarely sparite, moderately sorted, well rounded (**138** and **139**). Monocrystalline quartz: inclusions are 0.3–0.03mm, mode *c.* 0.06mm, well sorted.
**Very rare**: Polycrystalline quartz: inclusions are 0.28–0.15mm, subangular to subrounded, well sorted. MICA. Inclusions are 0.14–0.03mm, mode *c.* 0.06mm, angular, moderately sorted, frequent biotite and white mica (**110**).

*Clay pellets (textural concentration features)*: *c.* 10–20%.
Dark reddish brown to yellowish brown (xp, x30), bright reddish brown (**139**) to dark brown (pp, x30), 0.56–0.03mm, mode *c.* 0.06mm, well sorted, high to neutral optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. Few examples are optically active with stipple-speckled b-fabric. Constituents: predominantly 0%, but very rarely with rare monocrystalline quartz and biotite silt.

Very rare is a dark greenish grey (xp, x30) and very pale brown (pp, x30) clay-pellet (**110**), 1.16mm, low optical density, sharp to clear boundaries, rounded and with moderate apparent sphericity. It has moderately impregnated crystallitic b-fabric, and rare monocrystalline quartz, *c.* 0.08mm.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure, opaque, nodules with sharp to clear boundaries, 0.1–0.03mm, mode *c.* 0.03mm.

*Crystalline concentration (depletion) features*: 3–20%. Predominantly occurs as weakly to moderately impregnated (**110**) crystallitic b-fabric, few occur as thin coatings on voids.

## Clay pellet (large fine clay pellets) (*Fig. 122*)

*Microstructure*: Rare mesovughs. They have an open-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: The fabrics are homogeneous. Micromass: optically inactive. Crystallitic b-fabric is dominant to few. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 5:90:5.
**Predominant–very rare**: Limestone: inclusions are 5.5–0.03mm, mode *c.* 0.24mm, predominantly micrite, poorly sorted, well rounded (**161**), rarely with well sorted, angular monocrystalline quartz, *c.* 0.06–0.03mm.
**Predominant–common**: Monocrystalline quartz: inclusions are 0.14–0.03mm, mode *c.* 0.03mm, well sorted.
**Very rare**: Biotite: inclusions are 0.14–0.03mm, mode *c.* 0.03mm, angular, moderately sorted (**161**). Polycrystalline quartz: inclusions are *c.* 0.18mm, angular to subangular, well sorted.

*Clay pellets (textural concentration features)*: *c.* 25%.
Dark reddish brown to yellowish brown (xp and pp, x30), 1.7–0.04mm, poorly sorted, high to neutral optical density, sharp to merging boundaries, well rounded and with high apparent sphericity. Constituents: predominantly *c.* 0%, very rarely *c.* 2–10%, well sorted, monocrystalline quartz or biotite silt.

Pale yellowish brown (xp and pp, x30), 2.4–0.08mm, moderately sorted, neutral to low optical density, clear boundaries, rounded but frequently with low apparent sphericity. These clay-pellets appear to have been deformed, implying that they were plastic when the vessel was formed. Constituents: predominantly strongly impregnated crystallitic b-fabric.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure, opaque, nodules with sharp to clear boundaries, *c.* 0.03mm.

*Crystalline concentration (depletion) features*: 10–50%. These predominantly occur as weakly to moderately impregnated crystallitic b-fabric.

## Volcanic (cryptocrystalline with phenocrysts) (*Fig. 123*)

*Microstructure*: Predominantly mesovughs. It has an open-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: The fabric is homogeneous. Micromass: optically very slightly active with stipple-speckled b-fabric. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 20:75:5.
**Predominant:** Volcanic rock fragments: inclusions are 2–0.32mm, mode *c.* 1.2mm, well sorted, subangular to subrounded, brown volcanic glass containing frequent to few plagioclase and rare hornblende phenocrysts.
**Very few**: Chert: inclusions are 0.56–0.14mm, mode *c.* 0.28mm, subangular to subrounded. Limestone: inclusions are 0.56–0.04mm, mode *c.* 0.14mm, predominantly micrite, rarely sparite, subangular to well rounded.
**Rare:** Monocrystalline quartz: they are *c.* 0.1–0.03mm, mode *c.* 0.06mm, subangular. olycrystalline quartz: they are 0.26–0.06mm, mode *c.* 0.1mm, subangular to subrounded.
**Very rare**: Mica: these are *c.* 0.1–0.06mm, subangular, predominantly white mica. Biogenic fragments: these are very thin, calcareous, arcuate shell fragments, *c.* 0.12mm. Plagioclase: it is 0.14mm, angular, fresh and twinned.

*Clay pellets (textural concentration features)*: *c.* 5%.
Dark reddish to yellowish brown (xp and pp, x30), 0.56–0.08mm, mode *c.* 0.1mm, high to neutral optical density, sharp to clear boundaries, rounded with high apparent sphericity, and optically inactive. Constituents: 0–5%, frequent monocrystalline quartz and mica silt.

Yellowish brown (xp and pp, x30), 0.4–0.12mm, mode *c.* 0.23mm, high to neutral optical density, sharp to merging boundaries, rounded to subrounded, with high to low apparent sphericity, and optically inactive with common to very few crystallitic b-fabric. Constituents: 0%.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure, opaque, nodules with clear boundaries, 0.1–0.03mm.

*Crystalline concentration (depletion) features*: *c.* 20%. These are predominantly present as moderately impregnated crystallitic b-fabric.

## Volcanic (silicified?) (*Fig. 124*)

*Microstructure*: Predominantly mesovughs. They have a single-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: Two samples, **13** and **36**, are homogeneous in character. Sample **20** is similar in the presence of silicified? volcanic inclusions, but also bears some similarity to the fabric of sample **33** Volcanic (cryptocrystalline with phenocrysts). Micromass: optically active to slightly active with stipple-speckled b-fabric. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 20:75:5.
**Predominant:** Volcanic rock fragments: inclusions are 2.12–0.18mm, mode *c.* 0.94mm, moderately sorted, subangular to subrounded. They occur as brown volcanic glass containing frequent to very rare plagioclase phenocrysts, rare quartz (rounded) phenocrysts and very rare black and reddish brown opaque material (**20**), plagioclase in silicified? matrix, commonly with yellowish brown alteration products (zeolites?) (**13** and **36**) and very rarely with calcium carbonate

(**20**). Few of these silicified? rock fragments display banded structures, possibly reflecting pyroclastic deposition.
**Common–very rare:** Limestone: inclusions are 1.02–0.03mm, mode *c.* 0.4mm, predominantly micrite, well rounded to subangular. Plagioclase: inclusions are 1.38–0.03mm, mode *c.* 0.26mm, polysynthetic twinning, fresh to slightly altered, subangular to subrounded.
**Very few**: Chert: inclusions are 1.86–0.2mm, subangular, commonly with very fine yellowish brown crystals (zeolites?). Monocrystalline quartz: inclusions are *c.* 0.2–0.03mm, mode *c.* 0.04mm, angular to subangular.

*Clay pellets (textural concentration features)*: *c.* 2–5%.
Dark reddish to yellowish brown (xp and pp, x30), 0.86–0.3mm, high to neutral optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. Few have traces of stipple-speckled b-fabric. Constituents: 0–5%, frequent monocrystalline quartz silt or sand-sized chert.

Dark yellowish brown (xp and pp, x30), *c.* 2.8mm (**20**), it has neutral optical density, clear boundaries, rounded and with moderate apparent sphericity. Constituents: *c.* 10%, frequent monocrystalline quartz and white mica silt, moderately impregnated crystallitic b-fabric.

*'Amorphous' concentration (depletion) features*: <2%. They are predominantly pure, opaque, nodules with clear boundaries, 0.3–0.03mm, mode *c.* 0.14mm.

*Crystalline concentration (depletion) features*: 0%.

## Volcanic (fresh well sorted) (*Fig. 125*)

*Microstructure*: Predominant mesochannels. The fabric has a single-spaced porphyric related distribution. Preferred orientation is well developed in subparallel channels and b-fabric.

*Groundmass*: The fabric is homogeneous. Micromass: optically active with striated b-fabric. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 25:70:5.
**Frequent:** Plagioclase: inclusions are 0.9–0.08mm, mode *c.* 0.28mm, well sorted, subangular, fresh, twinned and zoned. Hornblende: inclusions are 0.96–0.06mm, mode *c.* 0.32mm, subangular, moderately sorted, fresh, strongly pleochroic pale yellowish green to dark reddish brown.
**Common:** Volcanic rock fragments: inclusions are 1.44–0.16mm, mode *c.* 0.32mm, moderately sorted, rounded, predominantly fresh, containing frequent to few plagioclase laths, few to very rare black opaque grains, and very rare hornblende, in very pale brown glass.
**Very few:** Monocrystalline quartz: inclusions are 0.32–0.03mm, mode *c.* 0.14mm, subangular.
**Rare**: Biotite: inclusions are 0.9–0.03mm, mode *c.* 0.12mm, angular, moderately sorted.
**Very rare**: Chert: it is 0.36mm, rounded. Biogenic fragment: it is a circular, calcareous test, 0.22mm. Limestone: it is 0.3mm, micrite, well rounded.

*Clay pellets (textural concentration features)*: *c.* 5%.
Dark reddish brown (xp and pp, x30), 0.8–0.12mm, mode *c.* 0.2mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity and rare stipple-speckled b-fabric. Constituents: 0–5%, with common plagioclase, quartz and hornblende.

*'Amorphous' concentration (depletion) features*: *c.* 5%. These are predominantly pure, opaque, nodules with clear boundaries, 0.38–0.03mm, mode *c.* 0.1mm.

*Crystalline concentration (depletion) features*: 0%.

## Calcareous sand (calcareous sand) (*Fig. 126*)

*Microstructure*: Frequent meso- to microvughs and mesochannels. Channels rarely appear to be the result of burnt out organic matter (**242**). They have single- to double-spaced porphyric related distributions. Preferred orientation is rarely evident in channels and mica.

*Groundmass*: The fabrics are generally homogeneous, although some are more micaceous than others. Micromass: optically inactive to slightly active with a stipple-speckled b-fabric. Crystallitic b-fabric is common to few. Colour: yellowish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 10:80:10.
**Frequent**: Limestone: inclusions are 2.46–0.03mm, mode *c.* 0.14mm, predominantly micrite and common to few sparite, very well to poorly (**185**) sorted, subangular to well rounded.
**Common**: Monocrystalline quartz: inclusions are 0.34–0.03mm, mode *c.* 0.1mm, well sorted, subangular. Polycrystalline quartz: inclusions are 0.6–0.08mm, mode *c.* 0.14mm, rounded to subangular, well sorted.
**Very few–very rare**: Mica: inclusions are 0.22–0.03mm, mode *c.* 0.1mm, angular, moderately sorted, predominantly biotite.
**Rare**: Chert: inclusions are 0.42–0.08mm, mode *c.* 0.1mm, angular to subangular, well to poorly (**45**) sorted, rarely with radiolaria (**45**) or biotite (**185**).

*Clay pellets (textural concentration features)*: <2%.
Dark reddish brown (xp and pp, x30), *c.* 0.14mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. Constituents: 0%.

'*Amorphous' concentration (depletion) features*: <1%. These are predominantly pure, opaque, nodules with sharp to clear boundaries, *c.* 0.06mm.

*Crystalline concentration (depletion) features*: 2–5%. Predominantly occurs as weakly to moderately impregnated crystallitic b-fabric, rarely as traces of crystallitic coatings on void surfaces.

## Calcareous sand (chaff) (*Fig. 127*)

*Microstructure*: Frequent macro–mesovughs and macro- to mesochannels. They have a single-spaced porphyric related distribution. Preferred orientation is not evident.

*Groundmass*: The fabrics are homogeneous. Micromass: optically inactive. Crystallitic b-fabric is common to few. Colour: yellowish brown to yellowish green (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 10:70:20.
**Dominant–frequent**: Monocrystalline quartz: inclusions are 0.22–0.03mm, mode *c.* 0.08mm, well sorted, angular to subangular. Limestone: inclusions are 0.5–0.03mm, mode *c.* 0.1mm, micrite, well to moderately sorted, rounded.
**Common**: Polycrystalline quartz: inclusions are 0.18–0.08mm, mode *c.* 0.08mm, angular to subangular, well sorted.

*Clay pellets (textural concentration features)*: *c.* 10%.
Dark reddish brown (xp and pp, x30), 1.5–0.08mm, mode *c.* 0.36mm, poorly sorted, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. Constituents: *c.* 1%, minute yellowish brown (xp) inclusions.

*'Amorphous' concentration (depletion) features*: <1%. These are predominantly pure, opaque, nodules, *c.* 0.06mm.

*Crystalline concentration (depletion) features*: 10–20%. These predominantly occur as weakly to moderately impregnated crystallitic b-fabric and thin crystallitic coatings on voids.

## Grog (*Fig. 128*)

*Microstructure*: Predominantly mesovughs and rare mesochannels. They have a single-spaced porphyric related distribution. Preferred orientation is present in b-fabric and channels.

*Groundmass*: The samples are broadly homogeneous in character. Micromass: optically slightly active with stipple-speckled and striated b-fabrics. Colour: greyish brown (xp and pp, x30).

*Inclusions*: c:f:$v_{10\mu}$ = *c.* 15:75:10 to 25:65:10.

**Predominant–very few**: Polycrystalline quartz: inclusions are 2.04–0.12mm, mode *c.* 0.4mm, subangular to subrounded, moderately sorted, rarely with intergranular biotite (**17**).
**Frequent–common**: Grog: fragments are 1.62–0.2mm, mode *c.* 0.56mm, poorly sorted, subangular to subrounded. Grog fragments in the two samples have different fabrics, although within each sample the fragments are predominantly similar in character. Fragments are frequent in **24**, with a higher optical density. Optical activity varies between inactive and active, with stipple speckled and striated b-fabrics. Groundmass inclusions are similar in size to the host given the size of the grog fragments, 0.44–0.03mm, mode *c.* 0.12 mm, moderately sorted, subrounded to angular. There are *c.* 2–10% inclusions, predominant to few monocrystalline quartz and limestone, rare to very rare polycrystalline quartz, chert, white mica and dark reddish brown acfs. Fragments are common in **17**, where they have a neutral to greater optical density and contrast particularly in their lack of optical activity. The groundmass is finer than the host, with inclusions *c.* 5%, 0.14–0.03mm, well sorted, subangular to angular, predominantly monocrystalline quartz, few chert and rare biotite. Chert: inclusions are 4–0.08mm, mode *c.* 0.84mm, moderately sorted, subangular to subrounded, rarely with radiolaria or quartz veins. They are frequent in **24** and common in **17**.
**Common–very few**: Monocrystalline quartz: inclusions are 0.34–0.03, mode *c.* 0.08mm, well sorted (**17**). Polycrystalline quartz: inclusions are 1.16–0.16mm, mode *c.* 0.26mm, moderately sorted, subangular, commonly with crenulated grain boundaries and rarely with intergranular white mica.
**Rare**: Limestone: inclusions are 0.56–0.03mm, mode *c.* 0.16mm, predominantly micrite and rarely sparite, well sorted, subangular to rounded.
**Very rare**: Mica: inclusions are 0.2–0.03mm, mode *c.* 0.1mm, angular, moderately sorted, frequent biotite and white mica. Biogenic fragment: the inclusion is 0.24mm, a thin arcuate shell fragment (**17**).

*Clay pellets (textural concentration features)*: 5–10%.
Dark reddish brown (xp and pp, x30) inclusions, 0.7–0.03mm, high optical density, sharp to clear boundaries, well rounded and with high apparent sphericity. Constituents: 0–5%, well sorted silt-sized inclusions, predominantly monocrystalline quartz, few polycrystalline quartz and white mica. Clearly it can be difficult to distinguish this material from grog, but these tcfs are more rounded and lack void structure. With their optically dense character they could also be classed as strongly to moderately impregnated acfs.

*'Amorphous' concentration (depletion) features*: 1–3%. These are predominantly hypocoatings around voids (**17**) reflecting the burn out of organic matter. Few occur as pure, opaque

nodules with sharp to clear boundaries, 0.2–0.03mm, mode *c.* 0.1mm.

*Crystalline concentration (depletion) features*: 0%.

## Conclusions

There are many problems in exploring patterns of ceramic fabric occurrence over a time period as extensive as the Neolithic to Modern day.[15] Limited sampling means that the data set is unlikely to include all fabrics present in the valley, and the relative frequencies of different fabrics will only broadly mirror their actual use. Vessel shapes and functions differ considerably by period, as does our archaeological knowledge about the ceramics. It is important to recognise these limitations and distortions, but they should not undermine the importance of this study, the value of which lies in its overview. In particular, it offers insight into patterns of raw materials exploitation in the Berbati Valley, a comparative resource for fabric characterisation and variation in the region, and a reference point for exploring specific issues of ceramic production and distribution in this and other regions of southern Greece.

Perhaps most fundamental is the identification of a range of fabric classes, some of which are quite distinct, given the relatively small size of the Berbati Valley and the sedimentary nature of its geology. Arnold found that potters travelled up to 7 km for clays in 84% of 111 ethnographic cases.[16] The Berbati-Limnes survey covered a region measuring approximately 6 × 12, which suggests that any given potter could, in theory, have exploited much of the valley for raw materials. Of course, there may have been various preferences and restrictions in access at different times. Apart from the evidence of the fabrics themselves we cannot easily detect such limitations. Mapping the spatial distribution of fabric findspots does, however, show that there is no clear pattern of deposition with respect to the underlying geology. Where spatially specific structure is evident it seems to be a function of sampling from findspots and sites that are strongly represented in particular periods. This is illustrated by the concentration of Middle Neolithic samples in Sandstone (sparse in very fine sand matrix) at FS400 (*Table 6*), and the prominence of Mudstone (fine sand–extremely fine matrix) from the Mastos and Pyrgouthi (*Table 5*). Such structuring of the data can develop from a complex interaction of factors including sample selection, findspot recognition and sampling strategy, and the greater availability of material from excavations, aside from any underlying trends in settlement patterns and raw materials exploitation. Given these factors the data set has been taken to represent the valley as a whole.

Taking a broader perspective on spatial issues, the geology of the Berbati Valley is unexceptional for the northeast Peloponnese and all of the fabrics could probably be produced in neighbouring regions.[17] The presence of kiln sites in the valley does show that local production took place but, with the exception of volcanic fabrics, the problem of identifying potential imports from their fabric properties remains an issue for further research.

Temporal patterning of the fabrics is far more evident than spatial distribution.[18] This can be seen in the dominance of Felsic and Sandstone group fabrics in Neolithic samples (*Tables 1* and *6*), the preference for yellow-refired clays in the Late Helladic (*Table 3*), and the almost exclusive occurrence of Felsic (chert limestone garnet) in Roman and Late Antique wares (*Table 1*). Again, this patterning is subject to the limitations of the data set and therefore would benefit from further exploration. For example, the chronological range of Sandstone (sparse in very fine sand matrix) (*Table 6*) may in part be dependent on the use of other raw materials and the methods of processing them. The fabric class is well represented in ceramics dating earlier than the Middle Helladic. Middle and Late Helladic examples of the class are absent, which may reflect the preference for yellow-refired clays in these periods. Absence of the class in Geometric, Archaic and Classical samples may be due to the use of, potentially related, Felsic (very fine sand) fabrics. A similar absence in Roman and Late Antique samples may be due to a preference for Felsic (chert limestone garnet) fabrics.

The data set also highlights specific issues of a technological and functional nature, though these cannot be pursued far without further sampling. It may seem self-evident, but still worthwhile noting, that fine-grained fabrics predominate in samples from drinking vessels; particularly Felsic (very fine sand) (*Table 2*) in the Archaic period and Felsic (silt–extremely fine) (*Table 3*) in the Late Helladic and Classical periods, for example. At the other end of the scale, samples of large storage vessels, pithoi, mainly fall into Mudstone classes; notably Mudstone (limestone) and (fine sand–extremely fine matrix) (*Tables 4* and *5*).

The use of chaff (or similar material) as organic temper in Late Helladic drainage channels is a more specific example of technological choice. Four of the six drainage channels sampled occur in Mudstone (chaff) and Calcareous sand (chaff) (*Tables 4* and *7*). The addition of chaff may have been a Late Helladic tradition when using particular yellow-refired clays to make thick-walled ceramics. One exception is drainage

[15] Whitbread, Ponting & Wells 2007.
[16] Arnold 1985, 50.
[17] E.g. Whitbread 1995, 293–295; Myer, Betancourt & Vaughan 1995.
[18] Whitbread, Ponting & Wells 2007.

channel **76** in Felsic (extremely fine), which also refired yellow (*Table 3*). In this case, the absence of sinuous channels could mean that chaff was not added to the clay body, but the fabric has an optically inactive micromass and a vesicular microstructure (numerous well sorted circular voids), which indicate over-firing and partial melting of the ceramic. The development of this microstructure may have eradicated any voids initially developed from burning out organic matter. The remaining drainage channel, **237**, belongs to Mudstone (fine sand to extremely fine matrix) but, perhaps significantly, this is made of red-refired clay (*Table 5*) that may not have been regarded as requiring chaff temper.

A couple of distinctive fabrics are noted in cooking ware vessels: Felsic (packed quartz) and Mudstone (quartz sand and breccia) (*Tables 3* and *4*). The dense packing of inclusions may have been intended to dissipate stress caused by thermal shock when these vessels were subjected to rapid changes in temperature. If so, then these may constitute functionally specialised fabrics. The limited number of samples does not allow us to examine the use of these particular fabrics any further in terms of vessel shapes and functions. In contrast, cooking wares occur in fabrics that had wider application, such as Felsic (quartz limestone), Felsic (chert limestone garnet) (*Table 1*) and Felsic (fine sand) (*Table 2*). Felsic (quartz limestone) occurs in a Classical cooking pot and a louterion, or wash basin, but in the Roman period it was used for an amphora, spacer-pin and drain pipe. Felsic (chert limestone garnet) was used for cooking pots, various bowls, jars and amphorae in the Roman and Late Antique periods. Felsic (fine sand) occurs in cooking pots, lekane, a dish, basin, amphora and loom weight. These fabrics appear to have been used for a variety of functions but, perhaps, were recognised as being equally viable for cooking when necessary. These distinctions, or lack thereof, raise questions as to whether the potters and consumers in certain periods considered cooking wares to be defined, at least in part, by fabric. If suitable clays were in general use then was this class of vessel purely a consideration of shape and functional suitability?

Despite the diverse use of Felsic (chert limestone garnet) fabrics in the Late Antique period they are noticeably absent from the tile samples. Apart from one each of Felsic (very fine sand) and Calcareous sand (calcareous sand), all of the Late Antique tiles were made from yellow-refired clay. The fabric classes represented are Sandstone (red clay pellets–sandy), Clay pellet (red silty clay pellets) and (large fine clay pellets), and Mudstone (limestone) and (fine sand–extremely fine matrix), the latter a fabric class widely used in the Classical period, notably for tile (*Table 5*). With only ten samples, the number of Late Antique tile fabrics characterised by clay pellets may be coincidental. Nevertheless, it could mark a preference for clay sources that were distinct from those used for general utilitarian wares. This is echoed in the two building materials sampled, with the Classical daub? classed as Clay pellet (highly calcareous) and mudbrick as Clay pellet (red clay pellets in silty matrix).

Finally, what can we say about the output of Berbati potters themselves? Here the evidence from kiln sites and debris is crucial. Several samples from over-fired fragments of Late Helladic fine ware found in dumps associated with the kiln show that yellow-refired Felsic (silt–extremely fine) fabrics are consistent with local output (*Table 3*). Classical kiln supports from Pyrgouthi, presumably locally made, have fabrics in yellow-refired Felsic (silt–extremely fine) (*Table 3*), Felsic (very fine sand) (*Table 2*) and Mudstone (fine sand–extremely fine matrix) (*Table 5*). Samples from construction materials in the Late Antique kiln situated in the valley, excavated by the Greek Archaeological Service, have fabrics very similar to Clay pellet (large fine clay pellets). A piece of Medieval–Modern kiln lining(?) is classed Felsic (silt–extremely fine). Finally, the striking similarity between clay samples **3**, **12** and **14** and Felsic (chert limestone garnet) (*Figs. 102–103*) provide a local reference point for Roman and Late Antique products.[19]

[19] Whitbread, Ponting & Wells 2007.