THE USE OF PETROLOGY IN THE STUDY OF MEDIEVAL CERAMICS: CASE STUDIES FROM SOUTHERN ENGLAND

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Summary

The uses of the three most common petrological techniques - binocular microscope study, thin-sectioning and heavy mineral analysis - are described. Five case studies are presented in which thin-sectioning has been used to provide previously unsuspected information concerning the source of the pottery. It is nevertheless admitted that these are atypical and that in many cases the results of petrological analysis must be so tentative as to be not worth the effort of analysis.

Introduction

Petrological analysis consists of the identification of rock and mineral fragments within a pottery fabric and provides a method which can cheaply and quickly enable pottery fabrics to be compared with each other and with geological information. In this paper the principal methods used and problems encountered are outlined, together with examples of the way in which petrological analysis has been applied to various problems in southern England (Fig. 1).

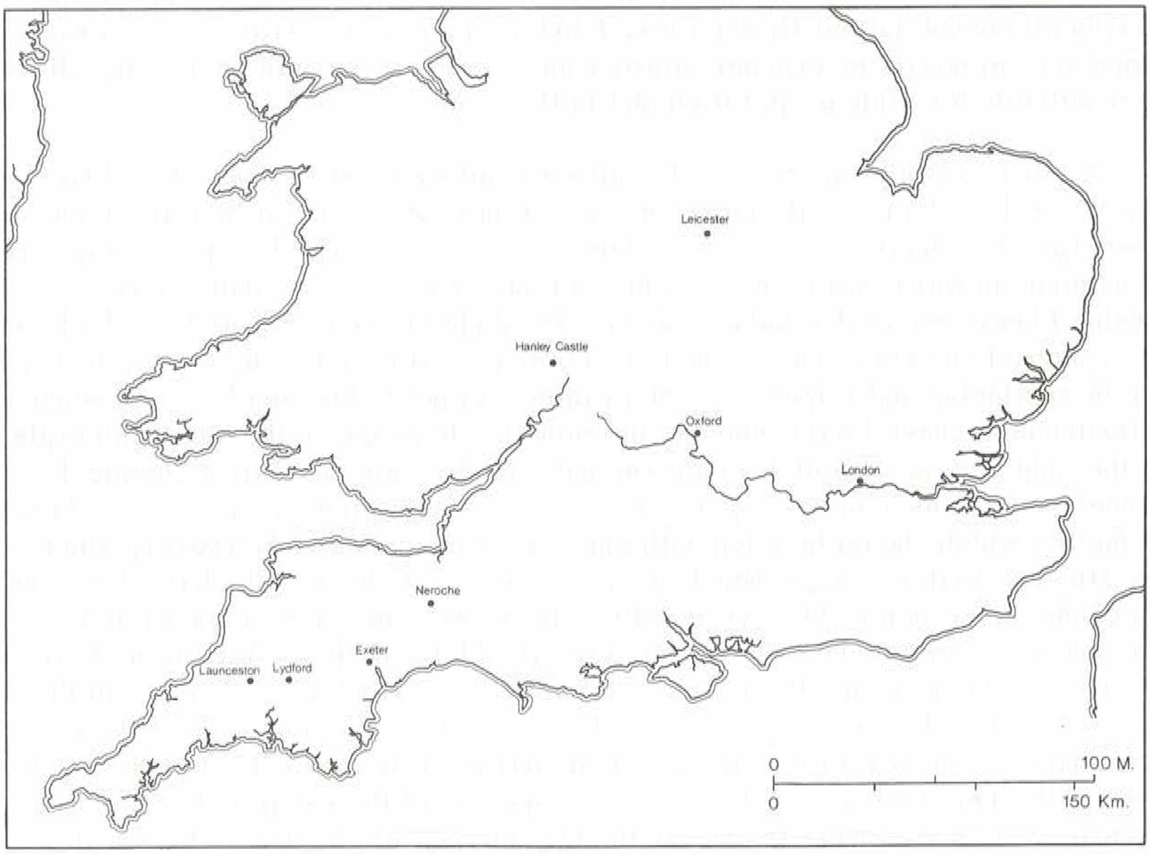


Fig. 1. Location of study areas

Three main methods of analysis exist, of which the most widely used is examination under the binocular microscope. Providing that the user has some training in petrology, the binocular microscope forms a powerful tool. The size-range, sorting and quantity of inclusions can be accurately described, especially if the microscope is fitted with a graticule (i.e. a linear graduated scale) in the eyepiece. Identification of minerals under the binocular microscope is less certain, depending on the size of the fragments, their optical and physical properties and, above all, the training of the user. The algorithm published by David Peacock is a good guide but should not be used in isolation (Peacock 1977, Table 3; see Wright & Davey 1980).

The second petrological method used is thin-section analysis. In this method, a slice of the pottery fabric is polished and mounted on a glass slide. It is then ground down to a thickness of 0.03 mm. Most of the mineral fragments present in the clay can be identified by their optical properties in thin-section, using a petrological microscope.

The technique of thin-section manufacture can be learnt in a single day and production of between 10 and 20 slides a day is typical, depending on the fragility of the fabric and, particularly, the difference in hardness between the inclusions and the clay matrix.

Thin-section analysis is more difficult to learn, and interpretation of the results is even more specialised. Many aspects of interpretation learnt in pure geology are not applicable to the study of ceramic thin-sections, mainly because of the effects of heating and clay preparation. For example, the 'straining' of quartz grains is taken to indicate a metamorphic origin for the quartz in a rock, but is normal in all but the lowest fired pottery fabric. A suitable petrological microscope is expensive, although the cheaper microscopes can be fitted with polarising filters and are suitable for slide preparation and initial study.

A third method of petrological analysis commonly used on pottery fabrics is Heavy Mineral Analysis. All clays contain a proportion of rare minerals which are heavier than clay, quartz, mica or calcium carbonate. These heavy minerals are most common in wares with a high quantity of quartz temper - 'sandy wares'. Analysis of heavy mineral residues can enable fabrics to be distinguished which are indistinguishable by eye. The method of sample preparation is much more destructive than thin-sectioning and requires c. 150 grammes of pot to be completely crushed and then floated on a heavy liquid, such as bromoform, to separate the heavy minerals from the light fraction. Both bromoform and its substitutes are toxic chemicals and should only be used under expert supervision using a fume cabinet. It is therefore not a method which should be tried with make-shift equipment. Moreover, since Heavy Mineral Analysis is a technique which by definition deals with characteristics which cannot be recognised by eye it suffers from the same disadvantages and advantages as chemical and physical analyses (including Neutron Activation Analysis). All of these techniques can distinguish between fabrics which look identical to the naked eye but they do not provide the 'feedback' that thin-section analysis does. Having analysed one vessel it is no easier to characterise the next. Furthermore, it is not sufficient to show that the results of analysis of the sample are within the range found within the products of a particular source. It also has to be shown that the results distinguish the sample from those from other sources.

These, then, are the options available to a ceramic researcher. The first consideration in choosing which, if any, technique to employ is to ask "What can be achieved through petrological analysis?". The answer to this question depends very much on the petrological composition of the local sources of tempering and the way in which the research is organised.

To evaluate the local petrological variability requires a knowledge of the local geology of the area, although some results are possible with only the barest of details. For example, if a sample of a vessel found in London contains abundant fragments of dark red metamorphic rock then its source cannot be in south-east England, nor in north-western France or the Low Countries. However, to discover the actual source - the Malaga region of southern Spain - using only geological methods would be extremely time-consuming and beyond the resources of most researchers. However, these vessels use a tin-opacified glaze and have lustre decoration with Islamic motifs. If archaeological knowledge is included, therefore, then the search for the source of the clay can be limited to three or four areas in Spain and the Near East (Vince 1982; Hughes & Vince forthcoming).

The discovery of such distinctive inclusions is not common, although several examples from southern Britain are given below. It is more common for the ceramic petrologist to be presented with a situation where visual analysis has been used to group sherds together into 'fabrics' and the intention is then two-fold:

1. To tell whether the fabrics are from geologically separate groups, whether they represent points in a continuum or whether they are not petrologically distinguishable.

2. To ascertain whether the petrology of the fabric can be used to determine the source area of the vessels made from it.

The ease with which the first aim can be fulfilled depends on the way in which the sherds have been sorted. If the sorting is based on colour or texture alone then there is a good chance that it will not have a petrological basis. If this is the case then the analysis of a single sample from each 'fabric group' cannot be extrapolated to the remaining sherds in the groups. However, if sorting is based on the size, sorting, and appearance of inclusions as seen under a binocular microscope then a single sample may be useful, although the more samples the better. Rare inclusions which might be flukes in a single sample can prove to be diagnostic characteristics if they are present in a number of samples of a group. For example, analysis of two sherds of sand-tempered ware from Gloucester, Type Fabric 43, showed that one contained sparse inclusions of fayalite, probably due to the addition of slag to the sand, and the other contained the same temper without the fayalite (Vince 1978). Fayalite could therefore either be a characteristic of a separate fabric within this group or just a one-off instance of accidental mixture. However, examination of five more samples showed that one of these also contained fayalite and that the two samples containing fayalite were from late Saxon contexts whereas the others were from 12th-century contexts (Vince 1983).

The discovery of the source of a ware through the petrology of its fabric depends upon the variability in the local geology and on the availability of sufficient comparative samples or literature. Analysis of medieval coarsewares from the south-west of England, undertaken by Duncan Brown and myself, shows the value of comparative data. In the first analysis we undertook it was possible to show that the wares came from the south-west of England, that they included material derived from the granite intrusions which form the spine of the peninsula but that they also contained a mixture of metamorphic and sedimentary rock fragments (Vince 1978a). Thus, the clays were tempered with a sand from rivers which drained the granite, the metamorphic aureole and the Devonian sandstones, siltstones and shales beyond. However, we have now built up a large series of thin-sections from sites in Cornwall and Devon and are beginning to recognise similarities and differences within fabrics with this single range of inclusion types (Brown and Vince 1984; Vince and Brown 1981, 1984 and forthcoming a-b). In some the granite fragments predominate and are barely worn, whilst in others it is the sedimentary rocks which predominate with only a few, subangular fragments of granitic origin. Given a sample of 5 or 6 thin-sections of a south-western coarseware we can say whether or not it can be distinguished from others which we have examined. One major late medieval fabric has been identified. It is likely, from the distribution of products and from the petrology, that this ware is the ancestor of the post-medieval North Devon pottery and indeed a medieval kiln-site has been excavated at Green Lane, Barnstable. The distribution of this North Devon medieval ware is not restricted to Devon and Cornwall. Two unglazed jugs in the National Museum of Wales from Barry Island have an identical temper, compared in thin-section (National Museum of Wales Acc. no. 36, 202/16), although the ware has yet to be found in Somerset or Dorset.

Other wares appear at present to be more localised, although we have been able to characterise the late Saxon pottery of Exeter and demonstrate some movement of pottery between south Cornwall and south Devon in the later medieval period. The number of thin-section samples needed to produce these results was relatively small in comparison with the 1,200 samples made during my post-graduate research, for example. The reason for this is that John Allan, of the Exeter Archaeological Unit, selected samples for us, using his knowledge of the local pottery to make sure that each sample could be related to a fabric group whose members were of known date and typology. Without this local knowledge the number of samples needed to produce the same information would have been much higher.

I will now turn to several studies in which the use of petrological analysis has produced archaeological results not expected beforehand and has led to a greater understanding of the distribution of medieval ceramics. Readers may suspect correctly that these examples are unusual. Thin-section analysis is like panning for gold. There is an awful lot of quartz to search through before you find the nuggets.

1. London in the pre-Conquest period

Although London is one of the most important towns of England in the late Saxon period, a town whose mint output dwarfed those of other late Saxon mints, its pre-Conquest pottery has not yet received the attention in print that it deserves. During 1982-3 Barbara Hurman, Rita Rattray and myself tried to correct this omission. Three stratified sequences have been excavated by the DUA: Peninsular House, Milk Street and New Fresh Wharf (Milne 1980; Roskams and Schofield 1978; Miller 1977). Several other sites have produced contexts or small sequences in which Late Saxon pottery is associated with coins or is related to datable structures.

Five separate phases of pottery use are recognisable in the city. In the earliest, none of which is represented by a stratified assemblage, only chaff-tempered pottery is present. The source of this ware has not been determined since not enough sherds are available to spare any for petrological analysis. Outside the City of London, several groups of handmade pottery containing wholly or mostly chaff-tempered fabrics have been excavated, the most notable of which is that at Rectory Grove, Clapham (Densem and Seeley 1982). This pottery has been analysed using the binocular microscope but no indication of its source was found, nor positive evidence for the use of more than one clay source.

The second phase of Saxon pottery use in London is dated somewhere between the late 9th and late 10th centuries (Vince 1984a). Despite being represented by large quantities of stratified pottery, both from pits and occupation surfaces, only one ware, Late Saxon Shelly ware, has been found.

The DUA fabric reference collection included over 30 sherds of late Saxon Shelly ware from sites all over the city and covering the whole range of inclusion types, frequencies and sizes (Orton 1978). All these sherds were thin-sectioned by Rita Rattray, who was therefore able to show that all the samples contained fragments of the same shelly limestone, a distinctive feature of which is the presence of well-sorted angular quartz in the muddy calcite matrix. It is therefore quite certain that all of the London Late Saxon shelly ware came from a single source. The precise location of this source is unknown but a sample of Late Saxon shelly wares from Oxford, made available by Maureen Mellor, shows that most of the late 8th to early 11th century shelly wares there contain the same shelly limestone temper (Fig. 2). The shelly

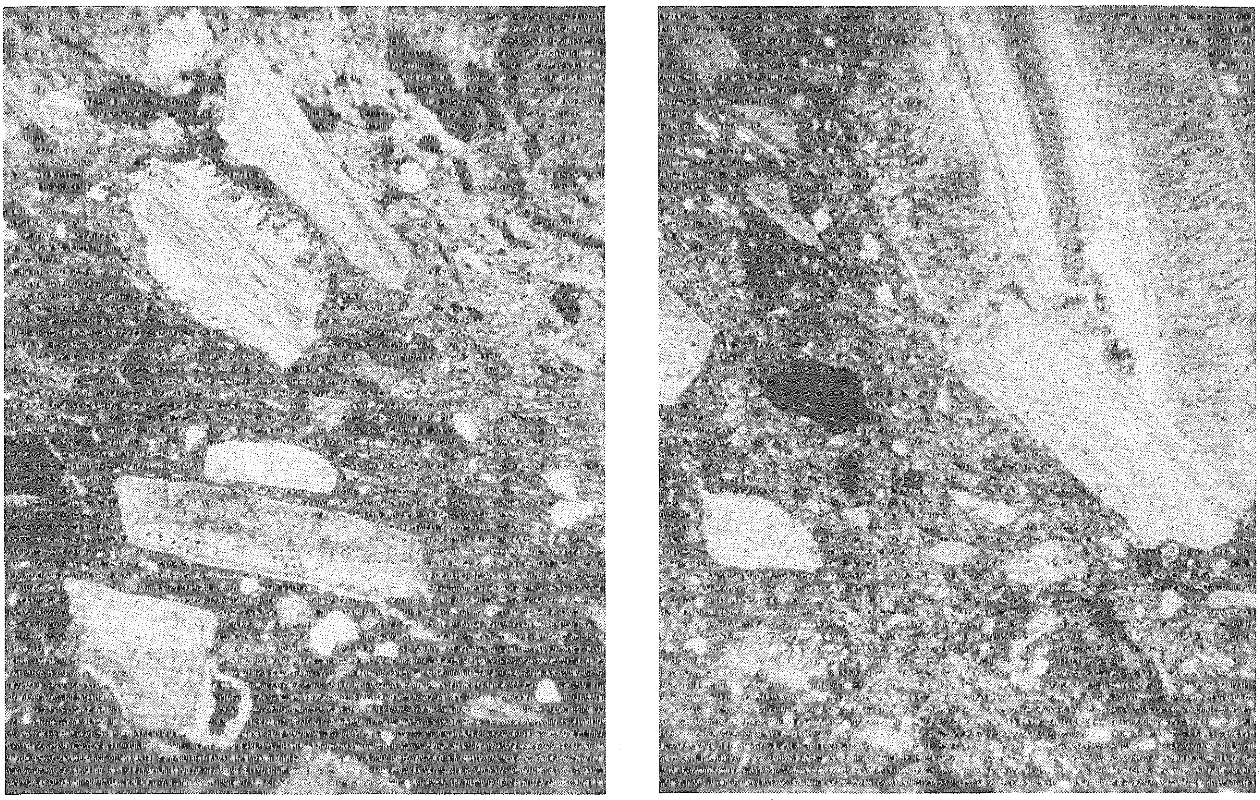


Fig. 2. Samples of Late Saxon Shelly ware from Oxford (left) and London (right)

fabrics found in Oxford in the early 11th century - St Neots-type ware - and a hand-made shelly limestone-tempered ware from London - DUA code SHEL - are distinguishable in thin-section. The Jurassic measures of the Oxford region include a number of outcrops of shelly limestone which would repay comparison with London LSS whereas the lower Thames valley has few if any comparable outcrops and can therefore be assumed not to be the source area of the ware.

Obviously, the implications of this work are wide-ranging and conflicting. On the one hand, the pottery was not being made locally which suggests commercial links with the upper Thames valley (Fig. 3). On the other hand, there are no examples of the other well-known and easily recognisable wheelthrown wares of East Anglia and the Midlands from the city, nor are there any examples of late 9th to 10th century continental imports. Such wares are found at Oxford associated with the same Late Saxon shelly ware and this must indicate that the continental connections of Oxford, despite its political connections with London (both being within that part of Mercia taken into Wessex upon the death of Aethelred), were to the south, through Southampton. The historical evidence for the importance of London as a trading centre in the 10th century, recently summarised (Dyson and Schofield 1984), cannot be doubted. It is surprising, to say the least, that petrological study of the pottery fails to complement this evidence.

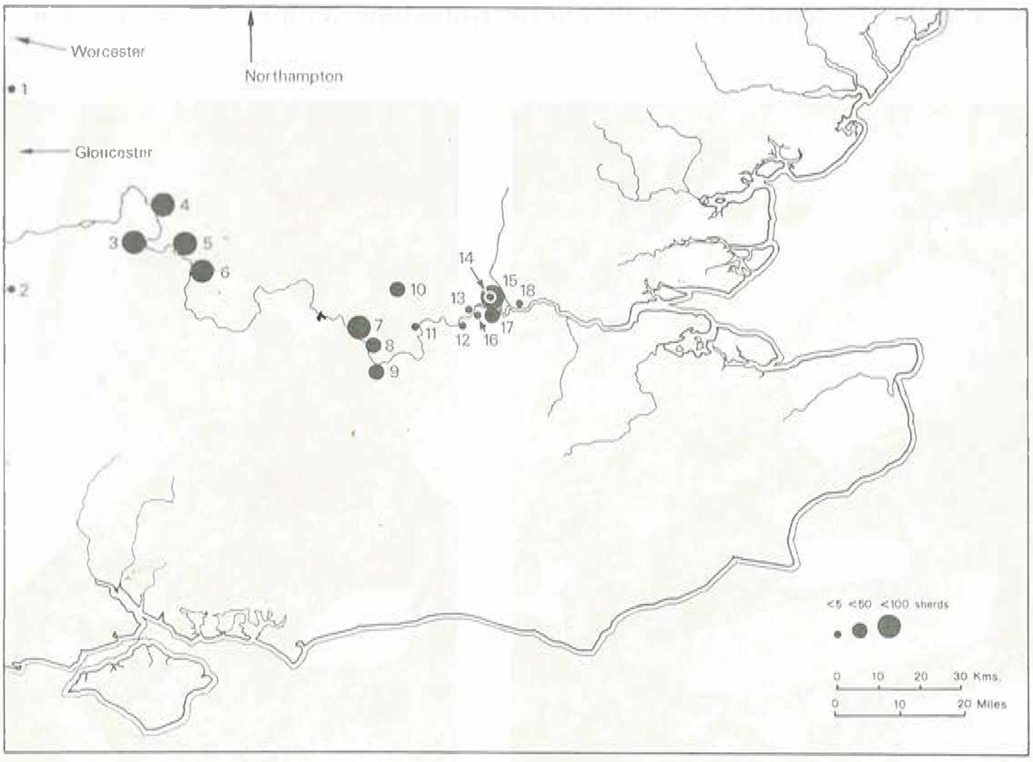


Fig. 3. Distribution of Late Saxon Shelly ware (for key to sites see Vince 1984a, 435) (illustration by N. Griffiths)

2. <u>The south-west in the early medieval period</u>

I have already mentioned the work that Duncan Brown and myself have done on the pottery of the south-west but perhaps the most interesting aspect is that some of the earliest medieval pottery from the peninsula can be shown by petrological analysis to be imported to the region from Somerset. Only at Exeter is there any evidence for pre-Conquest pottery manufacture in the counties of Devon or Cornwall, except for the bar-lug pottery of the extreme western tip of Cornwall (Thomas 1968; Allan 1984). The Exeter pottery, Bedford Garage ware, was kiln-made and wheel-thrown. A few sherds even have a splashed glaze (Fox and Dunning 1957). The fabric of this ware is distinctive and has been identified in thin-section not only at Exeter but also at Lydford (Vince and Brown 1981).

Dendrochronology and stratigraphy combine at Exeter to show that the introduction of Bedford Garage ware is earlier than <u>c</u>. 1020. In most assemblages this wheelthrown ware is associated with handmade, chert-tempered 'early medieval' cooking pots (Allan 1984). This type of cooking pot, in other fabrics, has been shown by Rahtz to be introduced to Cheddar <u>c</u>.1000 and a similar date is likely over the whole of southern and south-eastern England (Rahtz 1979). The later 11th and early 12th century pottery found in Exeter, as well as the late 11th to 12th century pottery at Lydford, Okehampton and Launceston also contains a mixed temper of chert and quartz sand (Fig. 4). This is quite distinct from any of the later medieval wares from the south-west that we have analysed but is typical of the pottery of south Somerset. At Exeter it can be shown that chert-tempered pottery pre-dates the Norman Conquest and it is therefore interesting to re-examine the sequence revealed by Davison at Castle Neroche (Davison 1972). In the earliest phases of this castle, which occupies a strategic position at the neck of the peninsula, no pottery was found at all. Davison interprets this first ring-work phase as being either a Late Saxon or

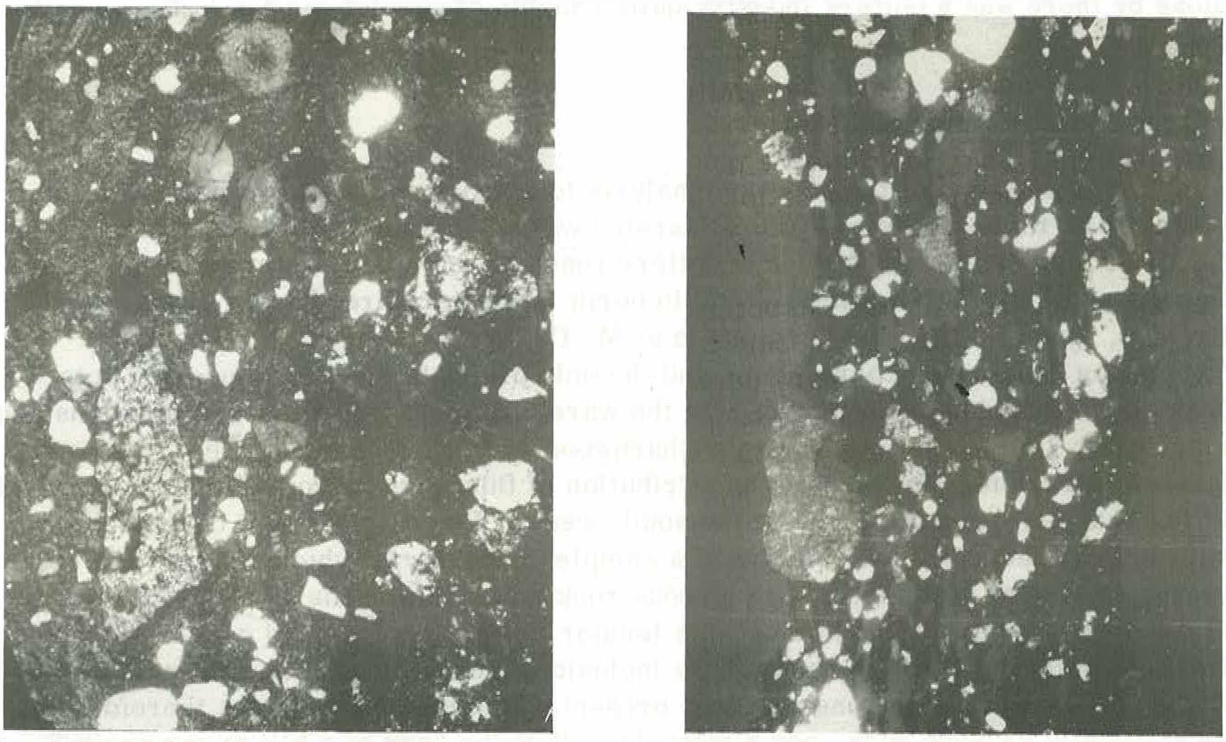


Fig. 4. Samples of chert-tempered cooking pots from Lydford (left) and Exeter (right)

Iron Age structure (Davison 1972, 23, Period 1). In the second phase, interpreted by Davison as a Norman Motte and Bailey of the late 1060 s, chert-tempered pottery was found, including some distinctive collared rim vessels and storage jars with strap handles with applied strips down the back of the strap. He interprets this material as being the products of French potters, or English potters working under French direction. Little of this French-style pottery has been recognised in the south-west.

Hand-made, chert-tempered pottery identical to that found in the south-west, occurs in the third phase at Castle Neroche, dated to the mid-12th century (Davison 1972, 26, Period IV). Several 12th century groups in Exeter contain little or no pottery other than chert-tempered cooking pots. By c. 1200, however, cooking pots in a number of other fabrics are found at Exeter, many of which can be shown by petrology to be of south-western origin. Apart from short-lived urban pottery manufacture at Exeter in the early 11th century, there was no network of local pottery production in the south-west in the 11th and 12th centuries, unlike that found over much of the Severn Valley and West Country (Vince 1981, Fig. 21.1 B & C). Such a different pattern of development could have been suggested on the basis of typology, although it could as easily have been explained as being a 'regional style'. Petrological analysis has shown that much of the pottery used in the 11th and 12th centuries in the south-west was made in south Somerset. Not only does this have important historical implications but raises the possibility of eventually providing a unified chronological sequence for the early medieval pottery of the south-west using dated contexts from a number of widely separated sites. Comparison of the dating schemes for Exeter and Castle Neroche, for example, show widely differing estimates for the starting date of chert-tempered ware. Without petrological analysis there is no reason why both chronologies should not be correct. If, on the other hand, the Exeter chronology is accurate then the central thesis of Davison's report requires re-examination. Why bring French potters to the site when quite close by there was a pottery industry quite capable of supplying sites in Devon with pottery?

3. Potters Marston Ware

The potential of thin-section analysis to pinpoint the area of production can be shown by the example of Potters Marston ware. In autumn 1982, at a meeting of SEMPER, the south-east Midlands pottery research group, at Peterborough, Rita Rattray and I saw some pottery found in north Leicestershire (from a site at South Croxton, examined by kind permission of Ms D. Sawday and Mrs R. Woodland). This was a handmade, coarse ware and the only products seen were cooking pots. Even to the naked eye it appeared that the ware contained igneous rock inclusions and, since north Leicestershire is within Charnwood Forest, an area of pre-Cambrian igneous intrusions, we felt that the attribution of this ware to Potters Marston, which is in south Leicestershire just to the south-west of Leicester, might be mistaken. Rita Rattray therefore thin-sectioned a sample of the ware, which did prove to be tempered almost exclusively with igneous rock fragments. The almost total absence of other rock types argued against this temper having been carried over a wide area from the outcrop, although some of the inclusions were rounded, and a single rounded fragment of oolitic limestone was also present. The temper could not therefore be an artifically crushed rock, nor a talus deposit at the base of a hill or mountain resulting from the mechanical weathering of an exposed rock face.

The next stage of this research was to take samples of 'Potters Marston' ware from Leicester and from field-walking on the site of Potters Marston. Analysis of these thin-sections revealed exactly the same range of inclusions, solving the problem of the attribution of the ware to the Potters Marston centre, but revealing another - where was the temper obtained from?

At this point we took advice from Ian Freestone of the British Museum Research Laboratory. He confirmed that the temper was of an acid or intermediate igneous rock but was not certain that it was identical to that found at Charnwood Forest as two features of the petrology were different. Firstly the grain-size of the crystals was smaller than is normal in a granite and secondly there were no examples of 'graphic intergrowth' of quartz and feldspar which is a feature of the Charnwood granites. Examination of the geological map of the area showed that Potters Marston in fact is less than a mile from an outcrop of syenite, a coarse-grained intermediate igneous rock, at Croft. This outcrop is almost certainly the source of the Potters Marston temper. To test this hypothesis a visit was made to collect rock samples from Croft. The village is situated on the side of a prominent hill of igneous rock, and a small river cuts through the rock flowing north-west towards Potters Marston. Several samples of the rock were taken from the face of a quarry and have been shown to be very similar in thin-section to the rock fragments found in the Potters Marston pottery fabric.

It cannot be claimed that it was petrological analysis that revealed the source of Potters Marston ware, as it was already adequately characterised by visual comparison with sherds obtained from Potters Marston by field-walking. Thin-section analysis, however, has shown that the ware is extremely distinctive and can only have been made at this one site. This, therefore, elevates the potential archaeological importance of the ware. Once the duration of the industry is established it will be possible to use sherds of this ware as a marker in excavated sequences. Furthermore, because the ware can be characterised solely by fabric analysis even undecorated body sherds can be positively identified. Plotting the distribution of this ware is therefore a means of checking the accuracy of distribution studies based on less definitely characterised wares, where the possibility of production over a wide area exists.

4. Medieval roof furniture

The counties of Hereford and Worcester, Gloucestershire and the northern part of Wiltshire did not use flat roof tiles in the medieval period; the earliest examples are of late 16th century date. However, glazed ridge tiles are found from the late 12th century onwards. As part of my thesis I examined the fabric of these tiles and of associated roof furniture, such as finials and louvers.

The petrological analysis of these tiles produced two valuable conclusions. Firstly, although documentary evidence suggests that tiles were ordered direct from the tilery rather than bought in the markets or fairs (which may have been used to distribute pottery), it could be demonstrated that ridge tiles were transported over as great a distance as contemporary glazed jugs. Secondly, a comparison of ridge tile fabrics with those of contemporary pots shows that from the late 13th century onwards every major glazed pottery industry also produced ridge tiles. Before this date only one industry, at Worcester, produced ridge tiles, while the late 12th century tiles found, for example, at Gloucester, were not made in a pottery fabric (Gloucester Type Fabric 89).

In London, where a flat roof tile industry was in existence from the mid-12th century, ridge tiles were made in tile fabric but louvers and finials were made in a pottery fabric (Armitage, Pearce & Vince 1982). This indicates a division in the production of roof tiles and helps to explain why ridge tiles and flat roof tiles are often separately itemised in medieval building accounts. This is apparently typical of tile-using areas and the same pattern is found in Essex (Carol Cunningham, pers. comm.).

A detailed comparison of Severn Valley ridge tile and pottery fabrics reveals a further pattern. Some, but not all, of the tile fabrics are noticeably coarser than their pottery counterparts (Fig. 5). Many reasons for this difference can be suggested, such as the need to add more temper to tiles than pots in order that they dry out quickly and evenly. A choice between these theories can be made since the industries in which no difference is found are those in which the clay was used 'as dug' whereas those in which the ridge tiles occur in a coarser fabric are those in which tempering was added to both tiles and pots. The reason for tile fabrics being coarser is probably not that extra temper was an advantage in the tiles but that less care was taken over the quantity and size of temper in tiles than in pots.

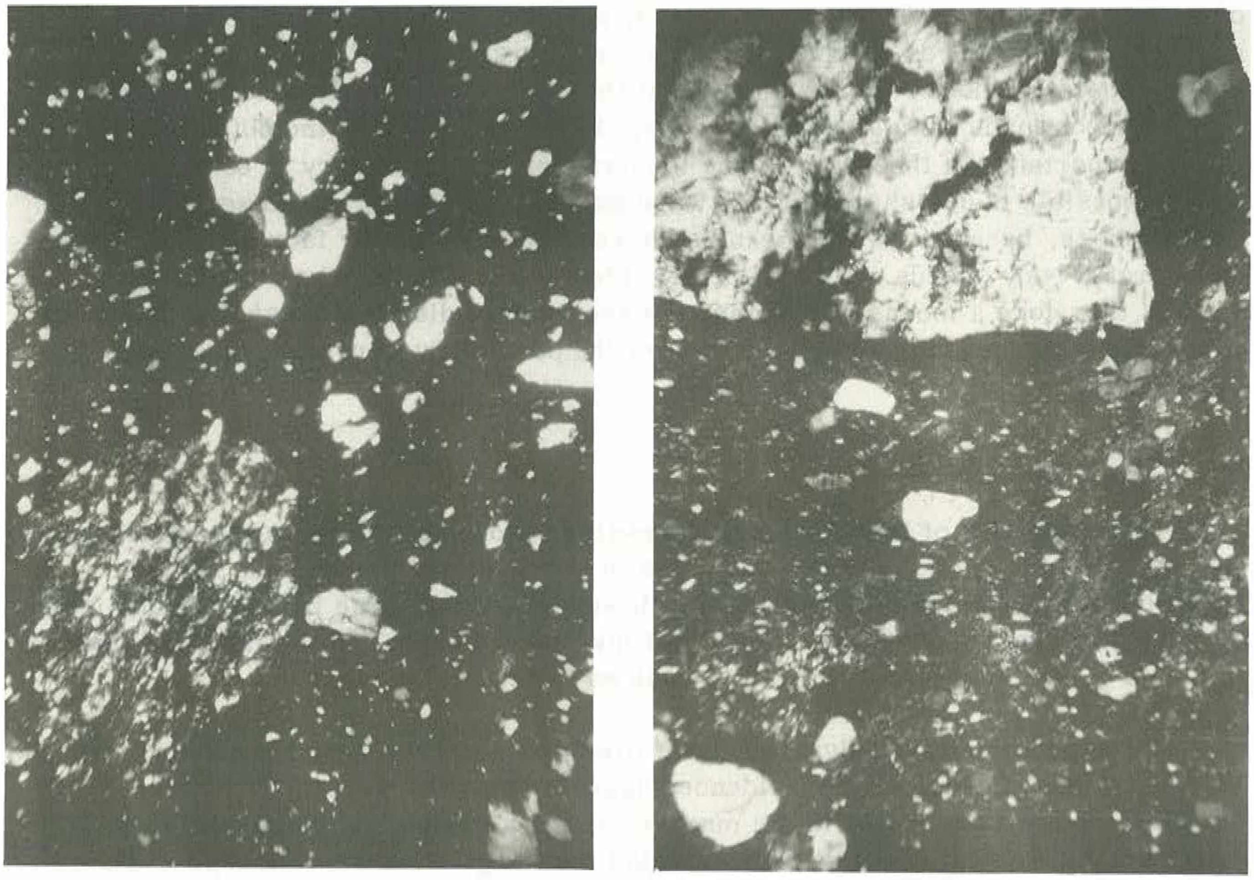


Fig. 5. Samples of a ridge tile (left) and jar (right) of 16th century Malvern Chase ware showing the difference in texture

5. The Severn Valley in the 16th and 17th centuries

In the counties of Hereford and Worcester, Gwent and Gloucestershire, early to mid-16th century pottery assemblages are typified by a red earthenware with a distinctive fabric and range of forms, for example conical bowls with inturned, flanged rims and jars with everted rims with thumbed bands around the neck. This is termed 'Malvern Chase ware' and its manufacture was centred in the neighbourhood of Hanley Castle, near Upton-on-Severn in Hereford and Worcester (Vince 1977).

Malvern Chase ware was replaced during the late 16th to early 17th centuries by another distinctive ware, with a very fine red fabric and a different set of forms, such as 'T' shaped-rim bowls and cylindrical, handled jars.

Petrological analysis confirms this split into two distinctive groups but in this case it is misleading, since it does not show that the second group is actually the product of numerous small potteries scattered throughout the Welsh borderland (Fig. 6).

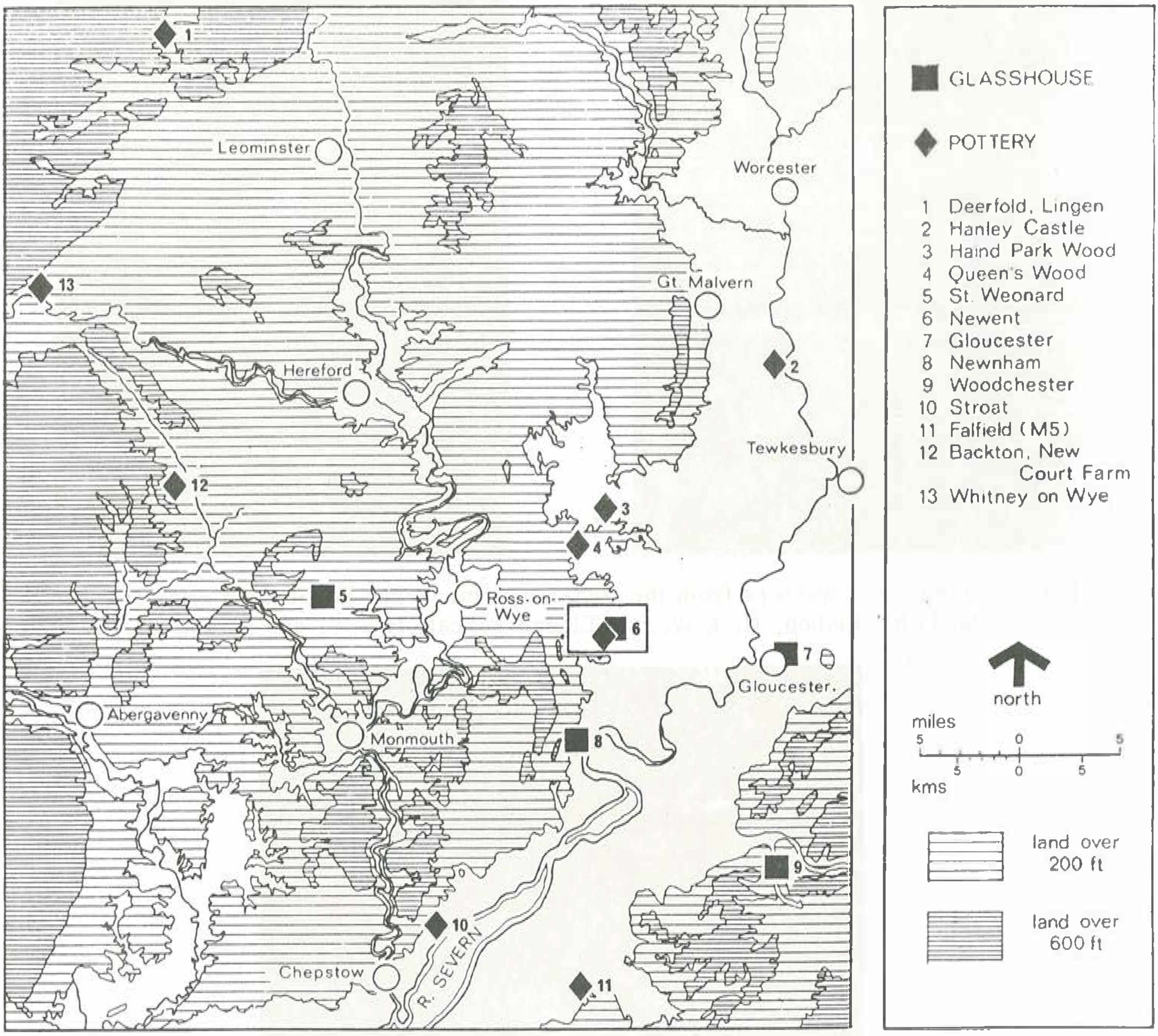
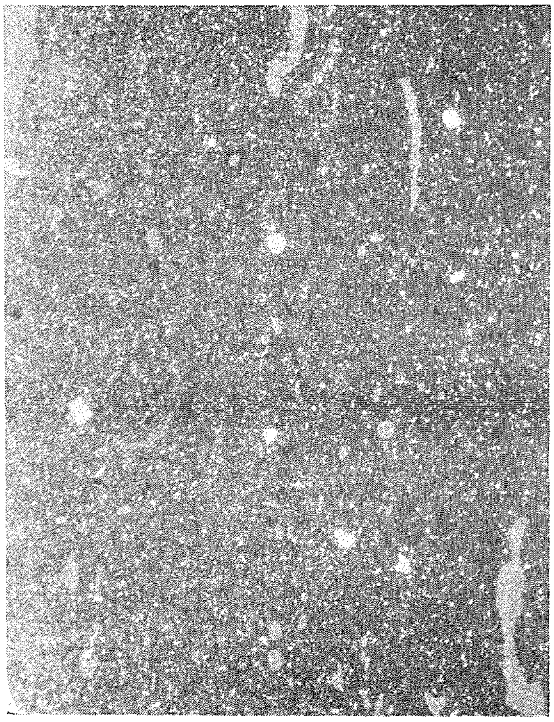


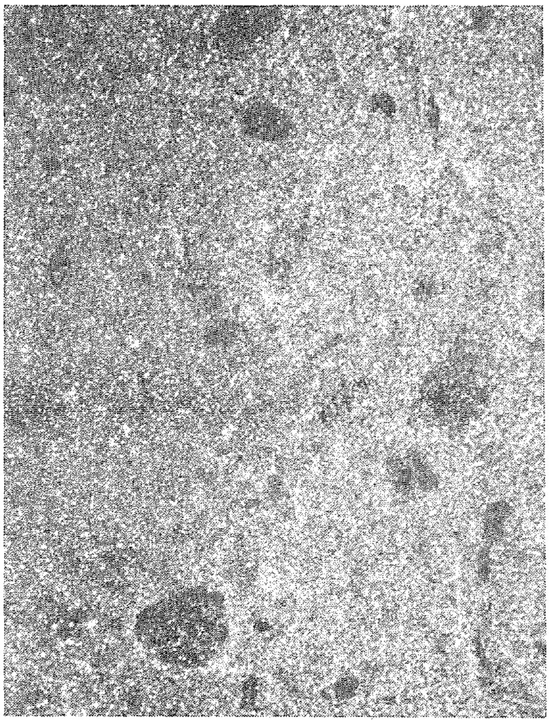
Fig. 6. The location of kilns producing post-medieval Welsh Borderland wares

Samples of pottery from kiln sites in north Herefordshire, west Herefordshire, west Gloucestershire and Gwent have been thin-sectioned and reveal exactly the same petrology, a fine textured clay containing abundant quartz and white mica silt, while clay samples from the same area show the same clay matrix but also contain sparse fragments of sandstone, calcareous nodules and iron or manganese-rich concretions (Fig. 7).

The grouping of thin-sections into 'fabric groups' should not therefore be taken as an indication that the vessels were produced in the same centre. These post-medieval Welsh Borderland (PMWB) wares do raise several problems about our use of the term 'industry', since by most definitions the potters working in these isolated centres, in places over 50 miles apart, were working in the same 'industry'. Other potters, however, for example at Stroat near Chepstow, were working in the

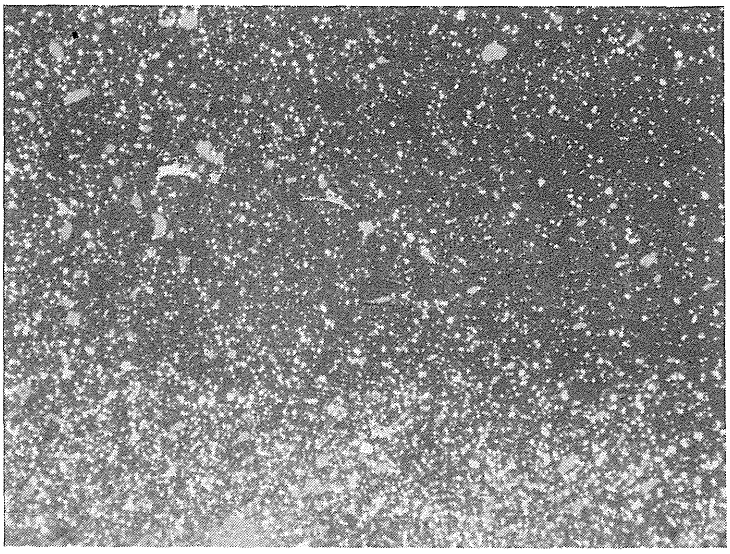


(a)



(b)

Fig. 7. Samples of wasters from the post-medieval Welsh Borderland kilns at (a) Upton Bishop, H. & W., (b) Lingen Forest, H. & W. and (c) Bacton, H. & W.



(c)

same geographical region, less than 15 miles from the nearest PMWB kiln site, yet they were definitely not working in the same 'industry', neither on petrological or typological grounds. The rim forms of their bowls, the range of forms produced and the type of ridge tiles made link this Stroat pottery with those of North Devon and south Somerset, although no decorated slipwares were produced at Stroat.

Petrology in this instance has not enabled the later pottery to be characterised but is still useful since in this case the potters must have had an 'ideal' fabric appearance which they strove to achieve wherever the kiln-site was situated. The almost complete lack of inclusions over c. 0.5 mm across when compared with the local clay samples suggests that the PMWB potters were cleaning their clays. The Malvern Chase pottery contains occasional large angular rock fragments and was probably therefore used 'as dug'. Clay samples from Malvern Chase also contain these large rock inclusions.

Conclusions

These examples are intended to show some of the ways in which the integrated use of petrological analysis can be of use in solving archaeological problems. I would not claim that petrology is a prerequisite for all pottery studies and in many cases the amount of effort needed to try and characterise a pottery fabric cannot be justified by the meagre and inconclusive results. The discovery of the source of every medieval pot found on a site is not necessarily a useful goal. It seems to me to be better to concentrate effort on producing a few certain conclusions, such as being able to demonstrate the non-local origin of the late Saxon Shelly ware in London, or, as in the case of Potters Marston ware, being able to characterise a ware with absolute certainty. Thin-sections can reveal characteristics which could not be predicted by eye and it is therefore worthwhile examining a small number of samples of even the most visually unpromising untempered or quartz sand-tempered wares. However, in most cases the use of petrological analysis in the characterisation of quartz-rich fabrics merely adds a veneer of scientific respectability to inspired archaeological guesswork.

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