The Chemical Analysis of Ceramic Fabrics from Medieval Dorset and its Region

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Abstract

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A total of eighty sherds of the one Hermitage, and two Laverstock, wares were selected. 160 powdered ceramic samples were taken and dissolved, and the liquid samples were subjected to analysis by Atomic Absorption Spectrophotometry for a suite of ten elements. Statistical analyses confirmed that the two groups of kiln products could be separated using data from very few elements, and so a smaller suite of the four 'best discriminators' was identified.

A detailed study of the medieval ceramics found in Dorset and the surrounding counties in the last fifty years was executed. This enabled the targeting of those collections likely to prove most useful in extending an understanding, through chemical analysis, of medieval ceramic production in the region. A study of the settlements that provided the 'market place' for medieval ceramics was also executed, to aid in identifying the size and nature of ceramic distribution networks.

Chemical analyses were carried out on ceramics from twenty-two 'settlement sites' and a number of small medieval and post-medieval waster collections. Multivariate statistical analyses enabled these groups of sherds to be, either matched with the known kiln groups, or placed in 'new' groups of unknown provenance.

From the spatial and temporal distributions identified for these chemically-identified types, a much more complete picture of the ceramic producers active in the Dorset region in the medieval period has been gained.

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Chapter 1

The production site material, its derivation and context

1.1 Archaeology and ceramic analysis

The study of ancient ceramics has always been of prime importance to the archaeologist, pottery being an almost ubiquitous archaeological material found in most contexts from the late prehistoric period onwards. Traditionally the study of pottery has involved the comparison of vessel types and forms, the aim being to set up typological sequences which are well-defined, both spatially and temporally. It is now generally acknowledged that such 'pigeon-holing' exercises are often of limited use as they do not always provide answers to the questions now commonly asked by archaeologists, particularly questions concerning how and why ceramics come to be where they are found. 'Type series' are still constructed as an aid to dating of both on-site stratigraphy and the vessels themselves. This is limited, however, to cases where identifiable 'types' exist within the collection, a criterion not always satisfied when dealing with, for example, medieval coarsewares.

Over the last two decades scientific analyses by petrological, physical and chemical means have proved valuable in the elucidation of problems concerning provenance and distribution. Analysis of ceramic fabrics has given archaeologists opportunities to assign pottery types to areas of manufacture and thus to trace distributions in space and time. From this models of cultural exchange can be formulated and commercial patterns identified. Few, if any, of the techniques developed have, however, proved to be universally applicable. For example, petrological studies succeed best when an exotic rock or mineral inclusion, or proportion, can be shown to be included in the fabric of ceramics from a particular area, and not in visually similar ceramics from elsewhere. These inclusions may be added deliberately, as part of a temper, or they may occur naturally in the clay matrix. In the former case the end result is identification on the level of 'fabric' and not raw material (clay). This means that the ceramic cannot be assigned to a particular clay source, but it does at least identify the area from which the temper originates. The assumption is made that the temper was not transported far from its naturally occuring source, a fact that holds true for 85% of cases studied as ethnographic parallels (Rice 1987).

Notable successes in the field of archaeological petrology include Peacock's study of Neolithic and Iron Age material from Cornwall (Peacock 1968 & 1969)) and Vince's study of medieval Malvern wares (1977). The success of these studies can be attributed to the presence in the pottery analysed of highly diagnostic igneous inclusions. Unfortunately a large proportion of the ceramics derived from certain periods, the British Medieval in particular, contains no easily provenanced igneous inclusions; instead, the vast majority of this pottery contains materials of very common provenance, e.g. quartz sand and fragments of flint.

Heavy mineral analysis

One useful approach in such cases can be heavy mineral analysis. With this technique about twenty to thirty grammes of ceramic are crushed and floated on a liquid of specific gravity 2.9. The quartz and other light minerals and clay float whilst the heavy minerals sink, enabling them to be collected and mounted on a microscope slide. Since sands of differing geological origins can be distinguished by their heavy mineral assemblages, pottery of different origin can likewise be categorised (Peacock 1970). The main drawbacks of this technique are that the method involves the destruction of large amounts of pottery and that it is rather laborious. Thus it is not well suited to large projects with long-term routine analyses. It can, however, be useful in answering specific questions.

Grain-size statistics (textural analysis)

This is another petrological technique particularly suited to sandy wares. The basis of the technique is that different sediments, by nature of their differing formation histories, exhibit different sets and statistical groupings of grain sizes. Thus pottery tempered with sand from one source can be differentiated from pottery tempered with sand from another source. Again the clay matrix is not examined, just the inclusions -whether natural or added by man. In recent years the validity of this technique has been put in some doubt by the work of sedimentologists studying polymodal sedimentation (Law 1977). Such studies have indicated that sedimentation is a much more complex phenomenon than was first thought, and simple graphical 'fingerprints' of grain-size ranges may be a too simplistic definition for such material. Despite this, textural analysis does often work well and has provided useful results in a number of archaeological studies (Streeten 1982, Wandribba 1982, Schubert 1986).

Physical and chemical techniques of ceramic analysis

In contrast to petrological techniques, which supply geological/mineralogical definitions, are the various physical and chemical techniques which identify the elemental constitution of the sample under study.

In archaeological sciences the most heavily used of these techniques are X-ray fluorescence spectroscopy (XRF), neutron activation analysis (NAA), atomic absorption spectrophotometry (AAS) and inductively-coupled plasma spectrospcopy (ICPS). The first and last of these will not be considered here, the second is given coverage in the appendices, the third, AAS, is the technique that was chosen as the primary analytical tool for this study. A description of the methods of sample preparation and analysis can be found in Chapter 3.

The reasoning behind the selection of AAS as the primary tool for this study was wholly pragmatic, the major factors coming into play being economics and available resources. New wet-chemistry/archaeological laboratories were being set up at the Dorset Institute and money was available to purchase a limited analytical system. AAS was chosen primarily because it was the cheapest of the generally available methods, but also because it overlapped with existing expertise and research requirements in the field of soil science. AAS does have advantages over the alternative systems. For example, when using NAA, access to reactor time is required to irradiate the samples, and obviously the necessary clearance and facilities to use and store radioactive material must also be provided. Similar constraints exist with XRF, as the use of X-rays is carefully regulated. Furthermore, not only are these two techniques more expensive to set up than AAS, they are also more costly to run in terms of materials and, in the case of NAA, the need to buy reactor time. ICPS requires wet chemistry facilities like AAS for sample preparation but it is very costly indeed to set up an analytical system of this type.

A major disadvantage of AAS however is that the technique is 'specific' in the elements identified. This means that the elements that are expected to be present are identified and then attempts are made to measure their concentrations in the samples. Thus there must be a greater degree of prior knowledge concerning which elements may be present in the sample, and also which elements may prove useful in solving the problem being studied. Of course this is no great problem to an established research laboratory, which would almost certainly already have a large stock of the relevant hollow-cathode lamps. With this study, however, the choice of elements was limited as only a limited number of lamps could be purchased in the initial stage. Thus there was the possibility that potentially important elements would be overlooked due to lack of funds preventing the purchase of the appropriate facilities. To counteract this the preliminary work undertaken when deciding which elements to analyse was extensive (see Chapter 4), and back-up was provided in the form of a small study, utilising an alternative technique (NAA). No AAS project is all-encompassing, in the sense that separate studies of only about twenty elements at the very most can be carried out before the time taken becomes too excessive when set against the data received. Thus it was decided that the major AAS project would be supplemented by some work using NAA, with the aim of checking the accuracy of the concentrations measured, and identifying any elements of potential use that had been ignored. In this way the research programme was precisely tailored to cover any failings that might have arisen due to the use of AAS as the basic technique.

The initial material studied here is a selection of thirteenth-century sherds from two excavated kiln sites and a number of excavated settlement sites, all from the Wessex region. The aim of the project is to provide diagnostic chemical 'fingerprints' for pottery from each of the kiln sites, based on a small suite of elemental concentrations measured by AAS. Once these groups have been adequately defined statistically, material from the settlement sites is subjected to the same analysis in an attempt to assign some of these sherds to the kiln groups, with a good degree of statistical validity. Such evidence of 'positive provenance' can then be used to build up a picture of the likely market distributions of the different kilns and industries, within the framework of thirteenth-century Wessex.

1.2 Medieval pottery studies in Dorset

Since the1940s a large amount of work has been carried out on excavations of medieval sites in Dorset. Although not all of this work has been published, it represents a mass of stored knowledge concerning the medieval ceramic industries of Dorset and its region. Major publications relating to this work include Dorset Natural History and Archaeological Society (DNHAS) monographs on sites in Dorchester (Draper and Chaplin 1982), and Christchurch (Jarvis 1983) and papers in the Proceedings (or annual journal) of the Dorset Natural History and Archaeological Society (PDNHAS) concerning sites at Christchurch (Davies 1983), Corfe Castle (RCHM 1960), Hermitage (Field 1966), Holworth (Rahtz 1959), Shaftesbury (Jervoise 1954; Cox 1985), Sherborne Old Castle (Harrison and Williams 1979), Wareham (Renn 1960; Hinton and Hodges 1977), Wimborne (Field 1972; Woodward 1983) and Woolcombe (Poulsen 1983). Sites where much work is as yet unpublished include, Milton Abbas, Owermoigne (Dyer 1974), Poole (Jarvis pers. comm.), Shaftesbury (Moore pers. comm.), Sherborne Old Castle (Harrison and Williams 1979), Woolcombe (Spoerry forthcoming). A large number of smaller excavations have also produced medieval ceramics, for example West Stafford (Draper 1976), Fordington (Startin 1981), Oakley Down (Poulsen 1984) and Kington Magna (Ross 1985). Furthermore many small collections exist that were produced through systematic or casual fieldwalking. Information concerning these can be found in the annual notes in the proceedings of the Dorset Natural History and Archaeological Society and also in the Dorset County Museum Archive.

Excavations in the counties immediately adjacent to Dorset form a further important element in any regional medieval ceramic study. Such sites include

Southampton (Platt and Coleman-Smith 1975 and Brown pers comm.) and Winchester (Hurst in Cunliffe 1964) in Hampshire, Laverstock (Musty et al 1969), Salisbury (Hawkes pers. comm.) and Old Sarum (Musty and Rahtz 1964) in Wiltshire, and Donyatt (Coleman-Smith and Pearson 1988) and Ilchester (Pearson 1982) in Somerset.

Most of the reports concerned with Dorset sites have type series' based solely on vessel typology, accompanied by macroscopic fabric descriptions. This was perceived as perfectly adequate when most of the older reports were published but such information is not of great use to a study such as this one where identification is derived from the fabric rather than the form. Furthermore little attempt has been made to extend these series beyond the confines of each individual site. The exceptions are the work carried out by Harrison and Williams on the Sherborne, Old Castle material (1979), and that of Hinton and Hodges at Wareham (1977). In the former case Williams carried out thin-section and heavy mineral analyses on selected sherds, identifying six major fabric types. Of these, one type was closely comparable with thin sections of samples taken from the Laverstock kiln excavations and another type (fabric E) had marked similarities, in both thin section and heavy mineral analysis, to material from the Hermitage kiln. Only a limited number of sherds were examined, however, and thus no firm conclusions could be made from the work.

The work by Hinton and Hodges on material from Wareham was not a comparative study, utilising material from sites elsewhere. It did, however, assign different fabric types to possible geological sources, either immediately adjacent to the town, or further afield around Poole Harbour and the Isle of Purbeck. From the results of this initial petrological work it was suggested that a fruitful extension of the study might be to attempt to distinguish some of the previously identified fabric and site groups by means of their chemical characteristics. One of the primary problems that faces petrological workers when studying medieval English ceramics is the lack of easily provenanced geological inclusions in much of this material. This arises from a general tradition of sand-tempered wares that are found over much of England from the eleventh century through to the fifteenth century. Quartz sand temper is usually impossible to provenance by petrological means, whether it be through heavy mineral or textural analyses, both of which have proved to be only of limited use when applied to Dorset medieval ceramics. The obvious alternative is therefore to use some form of physical or chemical method of analysis on this material. Such techniques could possibly prove more successful as they involve the study of the whole ceramic fabric, as opposed to petrological methods which study only the inclusions.

The material from medieval Dorset has much to recommend it, as far as a study based on chemical analysis is concerned. Firstly there is a great deal of ceramics from a variety of excavated occupation sites (as noted earlier). Furthermore material from two identified kiln groups, Hermitage and Laverstock, is available. If these groups could be characterised satisfactorily, the distribution of the kiln products could then proceed, initially on settlement sites in Dorset, and subsequently, further afield in West Hants, East Somerset and South Wiltshire. The study could also identify other areas of probable ceramic manufacture, based on identifying occurrence-nodes for unprovenanced wares, etc. The study could also be extended, if necessary, to cover known kiln sites further afield, e.g. Nash Hill in Wilts (McCarthy 1976), or Donyatt near Ilminster (Coleman Smith and Pearson 1988).

Another facet of such a study which is of great interest is the relative status of the different 'industries' and how that affects their product distributions. Some variation would be expected between the economic niche of what is assumed to be a low-status peasant concern at Hermitage and the much larger, multi-kiln industry at Laverstock. The actual form that this may take is at present an unknown quantity. Hopefully this project sheds some light both here, and elsewhere, in the field of medieval pottery studies.

1.3 Previous regional studies of medieval ceramics

The 'region' was identified as an appropriate landscape unit for such a study, based on the quality of information provided by previous projects of this scale.

Two petrologically-based regional studies of medieval ceramics have been carried out by PhD students at Southampton University in recent years. Vince's thesis (unpub.) was concerned with pottery from a very wide area that centred on the River Severn, but extended from South Wiltshire to South West Wales. He used petrological and hand-specimen identification methods to define 'wares' and he then traced their spatial distributions by studying all available excavated collections. The study started by considering wares from the Malverns that were tempered with characteristic igneous inclusions. Most other fabrics that were studied were, however, tempered with much more common materials and thus identification by purely visual information seems to have been the more useful tool in these areas. Streeten (unpub.) used textural analysis as the basis for his study of south-eastern medieval ceramics. He, like Vince, also carried out much identification without the aid of microscopy, defining wares across the counties of Kent, East and West Sussex and Surrey. Textural analysis was used in this study, primarily because many of the medieval wares of this region were known to be sand-tempered. The success of this work must, in part, be attributed to the large number of known kiln sites present within the study region. Identification of characteristic grain-size populations for so many definable kiln groups allowed many products to be traced to their source relatively easily, and enabled detailed models of distribution to be defined and discussed.

Sandwiched between the two regions considered in Vince's and Streeten's theses are the counties of Dorset and Hampshire. The medieval ceramics of this area are not tempered with exotic rock fragments as such deposits are not locally available. The nearest igneous and metamorphic deposits are much further west. Like the material from the South-east, much of the medieval pottery of this area is tempered with quartz sand but in comparison with the South-east very few kiln sites are known. Thus the indications are that a petrologically-based study of the medieval ceramics of the region would prove difficult. This had already been suggested by the small pieces of work carried out by Hinton and Hodges (1977) and Harrison and Williams (1979) as described in 1.2.

The analytically-based study described here concentrates on the material from much of this region. As a study of this nature requires the statistical precision that derives from many samples. The indications at the outset were that a smaller area than that studied by Vince or Streeten would have to be considered if enough samples from a good proportion of the many available collections were to be considered. The region defined was therefore Dorset and its surroundings. This included parts of Somerset and Wiltshire, and the Western half of Hampshire. This encompasses much of that region known as Wessex. Despite this the results of the study have implications that have relevance far beyond the defined borders of the 'study region'.

1.4 Medieval ceramic production in Wessex: The state of the information

The limits of the study region

When the limits of the region to be covered by this study were first considered an initial criterion was that wholesale duplication of those areas covered by Vince and Streeten would not be particularly useful. The project title defines 'Dorset and its region' as the area of study, and this phrase indicates the areas where sites would be given specific attention.

The first problem when considering Dorset as the basis for a medieval pottery study is that only one medieval kiln has been excavated within the county. This is the thirteenth century kiln at Hartley Manor Farm in Hermitage parish. A regional provenance study of great use could not easily be constructed around one known production centre. Thus sites outside of Dorset were considered as well, as candidates for the primary study of production source material. The most obvious known sites nearby were Laverstock in Wiltshire (Musty et al 1969) and Donyatt in Somerset (Coleman-Smith and Pearson 1988). As the Donyatt report had not been published at the time that this project was being initiated, and the excavated material was still being studied by the excavators, this site had to be ruled out for the time being. So the study was initiated by a chemical comparison of ceramics from the kiln at Hermitage and the industry at Laverstock.

This database was still perceived to be rather less than adequate and so attempts were made to define all known and possible medieval ceramic industries in the region, and in a large area of terrain around it. An area of approximately 130 miles east to west, by 80 miles south to north was included in this study, stretching from Devon to West Sussex, and from the South Coast to North Wiltshire. The approximate extent of this 'Greater Wessex Region' (Birch 1981) can be seen in Figures 1.1, 1.2 and 1.3. These maps also show the limits of the actual study region which includes all of Dorset, west Hampshire, south Wiltshire and south-east Somerset.

The study region

The area of the study region is approximately 1500 square miles. It is quite significantly smaller than the areas considered by both Vince and Streeten in their theses (op. cit.). This is because it was felt that there was so much medieval pottery available from excavations in Dorset and its surroundings that, to consider only material from a few of the total number of sites, but across a larger area, would not provide information of as good quality as could be gained from a less extensive, more intensive study. To realise fully the potential derived from a study of the many medieval ceramic collections available in Dorset and its surroundings, a protracted assessment of the number, magnitude and quality of these collections was carried out. Production sites identified through this survey are discussed here. The study of those sites that constituted the 'market-place' for medieval ceramics in this region is the basis of Chapter Two.

Ceramic producing sites in 'Greater Wessex'

Figures 1.1, 1.2 and 1.3 show the extent of information concerning medieval ceramic manufacture in the 'Study Region' and 'Greater Wessex' in three periods; the tenth and eleventh centuries, the late twelfth to late fourteenth centuries, and the fifteenth and sixteenth centuries. Despite the obvious incompleteness of any summary of this nature, as well as the lack of direct evidence for ceramic manufacture in the early twelfth and late fourteenth centuries, the maps do illustrate some of the developments in the English medieval ceramic industry, as described by Vince (1981 and unpub.).

Figures 1.1 and 1.2

The early periods show many fewer production sites than are known for later centuries. This must in part be a function of a paucity of documentary evidence for the period before the Norman Conquest but this must also reflect the more limited, patchy production of the tenth and earlier eleventh centuries, with some kilns being located in population centres such as Chichester (Down 1971, 1978) and Exeter (Allen 1984) and possibly Ilchester (Pearson 1982), Southampton (Brown pers. comm.) and Winchester (Biddle and Barclay 1974). Kilns did also exist in rural areas, as exemplified by Michelmersh (Addyman *et al* 1972). Kilns of this period would have regularly been of the 'clamp' type "which amounted to little more than a bonfire" (McCarthy and Brooks 1988). The archaeological remains of such 'structures' can be quite minimal, and thus it is likely that evidence for ceramic production of this type has in the past not been identified accurately. This must partly account for the lack of production sites of this period, but such a situation may also be, in part, a true representation in comparison with later centuries. The evidence for production in the early twelfth century is almost non-existent. There are no new sites identified for which evidence of manufacture starts in this period. There are, however, indications that production continued through this period in, or around, some of the towns where evidence for earlier and later production is known. Towns where production probably continued include Chichester and Southampton. Furthermore, there are suggestions of continued production in, or near to, Ilchester (Pearson *op. cit.*) and the appearance of 'Developed Winchester Ware' indicates the continuation of ceramic manufacture around that city (Biddle and Barclay *op. cit.*). Vince, however, (1981) indicates that the late eleventh and early twelfth centuries were generally a period a great expansion in pottery manufacture, at least in terms of the number of production sites.

Vince identifies many producers as being active in this period in north Wessex and the Welsh borders. He uses the presence of identifiably local wares in excavated collections as the basis for locating many of these manufacturers. Fig 1.2 identifies these producers, as outlined by Vince (1981), and additionally indicates similar potential producers from excavated evidence in Dorset and Hampshire. The indications are that there were many more ceramic producers in the late eleventh and early twelfth centuries than there is at present direct evidence for. Although this is probably true for any period, the lack of evidence of manufacture here is quite striking in comparison to the number of different wares known. There also is a general trend for the number of these wares to lessen towards the south west, perhaps mirroring, although to a lesser extent, the lack of local ceramics apparent in Wales in this period (Vince *op. cit.*).

Figure 1.3

Direct evidence for late twelfth, and early thirteenth, century production is also rather thin and patchy. Occasional documentary references indicate the existence of potters in Batcombe, Somerset (Le Patourel 1969), and Crockerton, Wilts (Vince 1983), whilst Pearson continues to indicate an Ilchester/Yeo valley production source until the mid-thirteenth century (op. cit.). The closeness of these sites, alongside the possible continuation of the Westbury industry suggests that ceramic producers may well have been more common in this period in Wessex than has previously been thought; the lack of known sites elsewhere being perhaps attributable to a rather limited study of the documentary evidence in areas such as Dorset and north and east Hampshire. This is obviously only guesswork, but such possibilities cannot be discounted without further study in these areas being attempted.

The later thirteenth and early fourteenth centuries witness a large increase in the number of potteries known, for much of 'Greater Wessex', with twenty possible sites attested from archaeological or documentary evidence. Only two of these sites are, however, in Dorset, and only five others are located within the rest of the study region. The known pottery producers in Dorset are the excavated thirteenth century kiln at Hermitage (Field 1966) and kilns at Alderholt, known to have been active from at least the early fourteenth century onwards (Algar et al 1987). The Alderholt references are the first indications of the beginnings of the

Verwood and District industry, that became so prominent in later centuries. The documentary reference from Damerham (Le Patourel 1969) indicates exploitation of the same raw materials that formed the basis of the Verwood industry, that being Reading beds derived clay, London clay and the wood and water of the New Forest fringe. The location of this site is however in Hampshire, and it indicates a continuation of production into that county which has not been identified before. Unfortunately the earliest identifiable Verwood industry products are of seventeenth century date, thus placing the study of these production centres initially outside the brief of this research project.

The well known medieval industry at Laverstock (Musty et al 1969) produced evidence for ten kilns, all of thirteenth century date. Excavated sherds found in two of these ten kilns were used in the analytical study described in the forthcoming chapters. Wasters also exist from an excavation on Culver Street in Salisbury. Unfortunately these proved difficult to locate and thus could not be studied analytically in the project, but visual classification of some of them suggested that they were very similar to Laverstock products, although chemical confirmation remains at present unavailable. The Culver Street sherds have been dated by typological methods to the second half of the thirteenth century (D. Algar pers. comm.) and in this aspect they also match the products from the Laverstock industry. A few probable wasters have also been discovered in a sand pit at West Grimstead, a village a few miles south east of Salisbury. These are again visually similar to some Laverstock products, although their date may be somewhat later. It is certainly possible that this material, and the Culver Street wasters might only represent the dumping of waste material by the potters from Laverstock. Wasters from Southampton are also attributed to this period (D. Brown pers. comm.), the style being partially in imitation of French imports. A few wasters of a possible thirteenth century sandy ware also exist from the town.

The production sites of the late twelfth to early fourteenth centuries tend to be situated in rural communities (e.g. Hermitage, Lacock and Donyatt) occasionally located near to towns or cities (e.g. Ham Green and Laverstock). Exceptions to the rule do exist, however, notably the wasters from Southampton and Bristol, and the kilns at Chichester.

Figure 1.4

Evidence for fifteenth and sixteenth century production is sparse. Isolated sites exist, but there is much evidence to suggest the growth of rural 'industries' on a larger scale supplying ceramics to much wider areas than previously. Examples of this include Donyatt and the Verwood area kilns. The only other producers at present known in the study region are in Holnest parish, near the medieval kiln at Hermitage. Documentary evidence identifies potters here, and in Hermitage, from the late 16th century onwards. In other parts of Wessex a total of nine manufacturers of ceramic vessels are known for this period. These are all located in rural or semi-rural contexts.

Further documentary evidence for ceramic manufacture in Dorset (Figure 1.5)

A detailed study of documentary references to ceramic manufacture in medieval and post-medieval Dorset has been carried out by P. Spoerry and V. Hart. The results of this study were published recently (Spoerry 1989) and are again discussed here. The actual data, in the form of a gazetteer, is located in Appendix 1. Information was taken from various documentary sources, mainly lay subsidy rolls, clay rentals, manorial court rolls, wills, and tithe maps and apportionments. These documents were searched for personal and field names of the 'potter' or 'crocker/crock' type, the significance of which are discussed by le Patourel (1969). Mr. Jeremy Harte kindly added other names drawn fromsuits of court (Pope n.d.), and drew our attention to some names mentioned by Hutchins (1863, 1870). Subsequently both these sources were searched more thoroughly to provide further information. Other references were supplied by Jo Draper from Austen (1852) and Stevenson (1815). In addition to the gazetteer, the principal data are summarised on a distribution map locating the relevant information within the post-1893 Dorset parish boundaries (Figure 1.5).

Five levels of evidence for the presence of a pottery production site have been identified. These are set out in ascending order of significance.

Level 1: a "potter" or "crocker" personal name in 13th-14th-century documents, with no explicit identification of the person's occupation.
Level 2: a site identified by field name or (more loosely, perhaps) by road name, e.g. Potter's Field; Crock Lane.
Level 3: a potter identified by name and explicitly designated a potter, in a medieval or post-medieval documentary source.
Level 4: a site identified or confirmed by the recovery of wasters and/or kiln furniture, either by excavation or surface collection, or a kiln-mound identified on the site of a kiln known from documentary evidence.
Level 5: the excavation of all or part of a pottery production site (i.e. kiln/s, associated buildings, associated debris).

A pottery production site should be confidently identified only when attested by evidence at levels 4 or 5. In our investigation evidence at level 1 was used only to select those parishes whose tithe maps were to be examined for diagnostic field names. A 'potter' surname alone cannot be taken as evidence for pottery manufacture.

The gazetteer lists alphabetically the parishes where relavent references have been discovered. Each parish has a reference number which is used as an identifying index on Figure 1.5. The approximate location of "crocker" or "potter" place names referred to in the text are identified by national grid references where these are known. In cases where a number of known kiln sites exist in a parish, all the relevant locations and grid references have been recorded. The parish boundaries used for all references are those found on the 1901 edition of the Ordnance Survey County Series maps. The terms medieval and post-medieval used in Figure 1.5 and in the subsequent discussion, are approximately identified as *circa* 1100 to 1500 and 1500 to 1800, respectively. This latter cut-off point is flexible as some later kilns in the east of the county show continuity well into this century (Algar *et al* 1987). The end point is merely used so as to exclude 'art' potteries from the list.

Discussion (of the distributions apparent in Figure 1.5, in relation to the geological deposits shown in Figure 1.6)

The Blackmore Vale

In the north and northwest of the county the is a quite distinct cluster of eight parishes exhibiting some evidence for medieval ceramic production. This includes the excavated thirteenth century kiln at Hermitage. There is also evidence for post-medieval ceramic manufacture in three parishes in this same area, Holnest being the best documented example. These parishes are all located on the Oxford clay at the southeast edge of the Blackmore vale. Further parishes showing some documentary evidence exist in the vale, notably to the west on the Great Oolite deposits (Halstock and East Chelborough) and in the northeast on Oxford or Corallian-derived clays (Fifehead Magdalen and West Stour). Taking all these references together, an arc of evidence for pottery production is identified, running the complete length of the Blackmore vale. This area certainly has an abundance of natural resources for ceramic manufacture. The large expanses of Oxford, and perhaps Kimmeridge, clay deposits provide a basis for potting, with temper in the form of greensands or crushed flint easily available. Domesday book certainly indicates that there was much woodland here in the eleventh century (Darby and Welldon-Finn 1967), especially to the south on the north west scarp-slope of the chalk massif. This is also an area of abundant surface water, unlike the chalklands where the streams are often seasonal. The excavations at Hermitage (Field 1966) revealed probably one thirteenth century kiln and possibly some evidence for later medieval ceramic manufacture. The pottery from this site is a distinctive orange sandy ware, examples of which can be found at, for example Sherborne Old Castle, where it is defined as 'Fabric E' (Harrison and Williams 1979). This fabric, and a developed, harder-fired version of it, is found in forms dating from the thirteenth to at least the fifteenth century at Sherborne. This suggests that the Hermitage kiln is only one part of a much longer tradition of sandy-ware manufacture in the area and the most likely location for this extended period of production must surely be in Hermitage and Holnest parishes, bearing in mind the documentary evidence available.

The Central Chalklands

To the southeast of this arc of documentary references is an area which is totally blank on Figure 1.5, which relates directly to the chalk massif of central Dorset. Geology, topography and vegetation are not good for ceramic manufacture here, with negligible clay resources, little water and few trees. This area was, however, settled in the medieval period and these residents must have needed ceramic vessels like everyone else. Thus the pottery must have been brought in from outside, with areas such as the Blackmore vale to the northwest, and the heathland fringe to the southeast, providing the likely sources of these items. The only area of chalkland where some evidence of ceramic manufacture is apparent is at the western extremity of the Frome and its tributaries, where deep river valleys have cut through the chalk deposits revealing pockets of Gault and Wealden clays. Here, in the parishes of Frampton, Maiden Newton, Sydling St, Nicholas and West Compton, ceramic manufacture would have been possible, providing enough fuel was available on the lower slopes of the downs and in the valleys.

The Marshwood Vale and the West

The far west of the county is almost totally lacking in documentary evidence of a useful nature. The Marshwood Vale is a rich agricultural area with a high population density at Domesday (Darby and Welldon-Finn *op. cit.*), and presumably thereafter, and this, together with the thriving medieval ports of Bridport and Lyme Regis, must have provided an important market for ceramics throughout the medieval and post-medieval periods. One must therefore assume that, either the methods of study employed have not identified the actual ceramic producers of the medieval period in this region, or that this area was supplied with its ceramics from outside. This latter is certainly a possibility from the 14th century onwards, when the 'industry' at Donyatt in Somerset could conceivably have supplied the area with much of its ceramic needs. Unfortunately so few excavations of medieval sites of any kind have been carried out in Dorset west of the chalk, that there is no database for medieval pottery studies in this area at all. In the post-medieval period there seems to be at least one kiln active in the eighteenth century at Hole Common near Lyme Regis (Draper 1982), but no other documentary evidence exists in that area, except for one place name in Corscombe parish. Again it is possible that the industries of South Somerset and, later, Devon may have provided ceramics for those living in the western part of Dorset but this is not certain. The raw materials required for ceramic manufacture are easily available in much of this area. There is plenty of woodland and water, and a variety of Jurassic clay types plus some outcrops of Gault and Oxford clays. Thus the potential for local ceramic manufacture is present, although no evidence for this is available.

South Dorset

Little evidence for ceramic manufacture in the medieval, or post-medieval, periods can be found for much of South Dorset, west of the Reading beds. Isolated personal names of medieval date have been found for Dorchester and Portesham, with field names of some interest being identified ar Broadway and Osmington. There are abundant supplies of the necessary raw materials for ceramic manufacture in this area, although they tend to appear in more isolated pockets than elsewhere. This leads to the suggestion that there must have been medieval ceramic manufacturers here, because there seems to be no reason for them not to be present. The boroughs of Dorchester, Melcombe Regis and Weymouth and the monastery and market at Abbotsbury must have represented an important concentration of consumers of durables such as ceramics throughout the period from the eleventh century to the present day. In Domesday book this area is shown to be the most populous in Dorset (Darby and Welldon-Finn *op. cit.*) and the population could only have increased with the establishment of the medieval boroughs, the growth of Weymouth as a port and the increased extraction of Portland stone for national and local building projects. Ceramics could have been transported to Weymouth by sea from kilns elsewhere along the south coast, in the manner of Scarborough ware in the east of the country (Farmer and Farmer 1982). This could only have been worthwhile, however, with the finer wares and it therefore does not account for the majority of the ceramics in use. Our knowledge of the medieval and post-medieval ceramic assemblages of this area is, however, not good, with excavations inland at

Dorchester providing the only recent groups. Thus, until further work is carried out here, the picture concerning ceramic production and distribution will remain vague.

East Dorset

South and east of the dip-slope of the chalk massif lie the 'acid heathlands' that extend into the New Forest and beyond. At the interface of these two natural zones outcrop the Reading Beds and London Clay in bands ranging from tens of metres, to four kilometres, across. This area has provided the natural basis for ceramic manufacture over many centuries, especially in the far east of the county between Wimborne and Fordingbridge, where abundant supplies of water and fuel are also available. These natural raw materials formed the basis for the Verwood and district industry (Young 1979, Algar *et al* 1979), which lasted from at least the fourteenth century until the 1950's. It is evident from Figure 1.5 that there is an abundance of information concerning the post-medieval industry in this area, and more is being accrued constantly thanks to the efforts of members of the Verwood and District Potteries Trust. Some references to medieval production have also been located and it is surely only a matter of time before some of these early sites come to light. By tracing the extent of the Reading Beds and Oxford Clays from Figure 1.6 onto Figure 1.5, an almost continuous ribbon of documentary and other evidence for ceramic production is apparent, following these deposits in a 'dog-leg' from Verwood to Puddletown and back to Lulworth. It is surely no coincidence that so many vague medieval references that relate to ceramic production appear for parishes on this arc. East of this band no references that can be related to ceramic manufacture have so far been found. This is perhaps surprising as the post-medieval extraction of pipe and potting clays from around Wareham, Norden and elsewhere is well known (Page 1975, 363-4). These clays derive from deposits belonging to the Bracklesham and Bagshot beds, a complex mixture of variously coloured clays, sands and gravels. Post-medieval pottery production is known to have been carried out at Stoborough in East Holme parish (Terry 1987), the white fabric of these vessels being most distinctive. Furthermore heavy mineral analysis of medieval sherds from Wareham has indicated that at least some of the ceramics excavated at the

St. Martins House site derived from raw material deposits in the Wareham, Poole Harbour area (Hinton and Hodges 1977). Bearing in mind these indications, as well as the large quantities of distinctive, light-coloured ceramics found locally (Jarvis pers. comm.) it can be assumed that the clays of this area were extensively used in the medieval period, although no direct evidence for this has yet been found.

General Conclusions

The documentary evidence used in this study has proved both useful and puzzling. Areas or 'traditions' of manufacture in the medieval period have been tentatively identified in the Blackmore Vale, East Dorset and near Wareham. Suggestions of other, perhaps more isolated, local production centres have also come to light. It must be stressed however that much of this data, the level 1 and 2 references in particular, is of a very vague nature and should not be taken as confirmation of ceramic production. It is only when the data are presented as a distribution which can be related to natural resources and demographic information, that some importance can be attributed to such references. The information for post-medieval production is less numerous but, on the whole, more reliable. The indications are that the major 'industries' of the medieval period continued on into the later centuries, whereas the smaller, more isolated concerns ceased to function. This can be seen in the lack of any evidence after 1500 over much of the county, particularly in areas where isolated references exist for the earlier period. A situation may have developed where small-scale producers were 'pushed out' through being unable to compete against the quantity or quality of goods being made at industries such as those at Donyatt and Verwood. These two larger producers would perhaps ultimately have supplied everyday ceramics to most of Dorset outside the Poole Harbour area.

1.5 The availability, in the study region, of the raw materials necessary for ceramic manufacture

The main raw materials necessary for ceramic manufacture (excluding glazes) are; clay, tempering agents, fuel (wood) and water. This section reviews the availability of these necessary commodities in the study region.

Figure 1.6 is an interpretation of geological deposits in Wessex that can, in part or wholly, be used as clay for ceramic manufacture. Table 1.1 indicates the geological categories into which clays from these deposits can be classified, with information in the final column concerning their use, or otherwise, by potters in the medieval period.

Lias

Lias deposits only appear in the west of the study region, outcropping on the coast between Lyme Regis and Bridport and extending inland over the Marshwood Vale and over much of south Somerset. In the former area they are partly covered by recent sands and clay with flints, whereas in the latter they are overlain by some alluvial deposits. The lias contains some clays, notably Eype Clay and Down Cliff Clay. It is not known whether either of these is useful for ceramic manufacture, although the marly nature of the latter perhaps indicates it is not. Clays from the lias are known to have been used by medieval potters near Gloucester (Vince 1983) but there is no evidence to suggest ceramic manufacture in the Marshwood Vale at all (Fig. 1.5). Further north, the medieval ceramic industry in the Yeo valley (Pearson 1982) may well have utilised lias clays, the only close alternatives being the recent alluvial material that lies in the valley bottom.

Middle jurassic

Middle jurassic deposits outcrop on the coast immediately to the east of the Lias. They extend in a thin band north west to Beaminster and then north east to Sherborne. From there they follow the curve of the sout east side of the South Somerset Plain, underlying a further number of medieval towns and extend east into the Blackmore Vale. Clays from the middle jurassic include the Great Oolite series, deposits of Fullers Earth Clay, Frome Clay and Forest Marble. Of these Fullers Earth Clay is common in the Marshwood Vale, but is known to be unsuitable for 'potting' (Streeten unpub.). Vince, however, suggested that other 'oolitic' clays were used by eighth to tenth century potters at Oxford indicating that material of a similar type found here could also have been used. Despite this it is unlikely that the Forest Marble would have been seen as useful because of its very marly nature.

Upper jurassic

The upper jurassic deposits include many clays, some of quite extensive distribution. The oldest is a minor silty clay in the Kellaway Beds. It is doubtful whether this was valuable as a resource for potters. The same is certainly not true of the Oxford Clay which here immediately post-dates the Kellaway material. The Oxford Clay appears as a continuous band east and northwards from Yetminster which forms the centre of the Blackmore Vale, before constricting near Bruton and then fanning out over much of the midlands. An additional isolated member is located between Dochester and Weymouth. The Oxford clay is brown or blue, firing to orange or red-brown when not reduced. It was used as the basic raw material at the Hermitage kiln (Field 1966) and pits have been located on 'clay lane' within sight of the kiln itself. As described in section 1.4, the Oxford Clay deposits in the Blackmore Vale seem to have an associated cluster of documentary references relating to ceramic manufacture that perhaps indicates that this deposit was known as a better raw material for ceramic production than, for example, the Kimmeridge Clay to the east, or the lower and middle jurassic clays of the Marshwood Vale. Corallian deposits stratigraphically follow the Oxford Clay and these include Nothe and Sandsfoot Clays which can be found outcropping near Weymouth. It is not known whether these clays are also found in the larger Corallian deposits in the Blackmore Vale and Vale of Pewsey. Kimmeridge Clay is the second major upper jurassic clay. Despite its wide area of exposure in the Blackmore Vale there is little evidence to suggest that it was used by potters. Despite this it may well have been the basic raw material for locally produced medieval coarse wares at Shaftesbury (W. Moore pers. comm.).

Cretaceous

Lower cretaceous beds contain the Wealden series which includes variegated clays which are freshwater derived. Faulting has exposed the Wealden beds in the Isles of Purbeck and Wight which are the only deposits of this material west of Sussex. In the Weald area this clay does not seem to have been used by medieval potters, preferences being instead for Gault Clay and deposits from the Reading Beds (Streeten 1981). It is therefore unlikely that it was used here, bearing in mind the alternatives on offer. The same is probably true of the Speeton Clay and others found in the Lower Greensand. Above this, however, lies the Upper Greensand and Gault Clay. These outcrop below the scarp of the chalk which, in this region, means to the west of the 'massif'. The latter tends to be a blue-grey sandy clay, which is known to have been used by medieval potters in Sussex (Streeten op. cit.). Immediately to the east of this lies the chalk. This covers much of central Dorset and the Salisbury Plain and is devoid of useful clay except where river valleys have exposed the Gault beneath.

Tertiary

The oldest tertiary deposits in this region are the Reading Beds which lie on top of the southern, dip-slope of the chalk and are exposed in a thin band from the Dorset Frome valley eastwards to Sussex. The London clay is stratigraphically above the Reading Beds and follows the same distribution, except that it usually lies further to the south. Reading Beds-derived light coloured clays and the redder London clay are known to have been used as the basic raw material for the medieval and post-medieval industry in east Dorset (Algar *et al* 1987). The former was also favoured by potters in the south east (Streeten *op. cit.*) and is believed to have been the basic raw material used at Laverstock (Musty et al 1969). The Barton Bracklesham and Bagshot Beds are located south of the London Clay. These deposits are of very mixed stratigraphy and include gravels ,sands and clays. In the Avon valley they are obscured by river gravels and near the south coast they are covered by sands of indeterminate origin. In the Bracklesham series are white pipe-clays which are best known on the Isle of Purbeck and at a number of points around the shores of Poole Harbour. These have been used for pipe-clay manufacture over the last four hundred years, but may have had a longer period of use, as suggested by the white fabric of many medieval sherds from sites in this area.

Pleistocene and recent

Clay with flints is located over parts of the chalk. It appears as a reddish brown accumulation of clay, flint pebbles and sand. The source of this material is thought to be decomposing chalk and in some cases the Reading Beds (Melville and Freshney 1982). Clay with flints is known to be of little use as a potting clay (Streeten op. cit.)

Brickearth is a largely unstratified mixture of fine-grained quartz sand or flint sand with clay and chalk fragments. It derives from several mechanisms including solifluction, flooding and wind-action and in this region is confined to small pockets near Southampton. There are indications that it was used as a raw material for medieval ceramic production at Southampton (Brown pers. comm.)

The location of clay deposits in relation to other raw materials necessary for ceramic production.

The indications are therefore that most of the Dorset region, except for the central chalk massif and parts of the Marshwood Vale in the west, and the heathland in the east, is provided with clays that could form the basis of a ceramic industry. Those deposits identified in section 1.4 as being most favoured by medieval potters seem to be the Reading Beds Clay and the Oxford Clay, with the London Clay and Pipe-Clays also being used. This can be seen if a comparison is made between an interpretative map of the geology (Fig. 1.6) and data representing evidence for ceramic manufacture (Fig. 1.5), as described in section 1.4. It must be assumed that ceramic manufacture was carried out over these deposits in particular, partly because they were known to be clays sympathetic to the needs of a potter. There must of course have been other reasons why potters chose specific localities to practice their craft. Some of the heavy clay land over the Reading and London deposits was probably too wet and heavy to be very useful for other purposes, the populace of these areas therefore requiring a supplement to pure agriculture. Clay lands also tend to support large amounts of woodland and this was certainly true of the area of London clay in east Dorset at Domesday. A map of the extent of woodland attached to Domesday settlements (Darby and Welldon-Finn 1967) clearly illustrates the tendency for clay lands to be wooded. It is probable that the pattern of woodland did not vary greatly through the subsequent centuries, making such a distribution still valid when considering thirteenth century ceramic production.

Wood was perhaps almost as valuable a commodity as clay to a medieval potter as it was the most commonly used fuel supply. In other parts of the country furze, peat and coal were sometimes used (McCarthy and Brookes 1988, 46). In Wessex, however, there is no evidence for other fuels being used, although it is known that gorse was commonly used as a fuel for other purposes in the heathland areas. At the Laverstock excavations analysis of the remains of fuel from a kiln stoke-pit identified fragments of oak, willow, hazel and birch (Musty *et al* 1969, 90). Other areas that were well-wooded at Domesday are the south east of the Blackmore Vale and, to a lesser extent, parts of the Marshwood Vale. The location of evidence for ceramic manufacture on clay deposits in the Blackmore Vale has already been discussed. The woodland at Domesday was particularly dense over both the Oxford and Kimmeridge clay deposits, although whether the latter was used for ceramic manufacture is a matter for conjecture.

Most of the study region is well served by surface water, the exceptions being the chalklands and parts of the heathland. Even in these areas there are still valleys, particularly those of the larger water-courses, where continuous streams flow. It is unlikely that the availability of water would have been a serious limiting factor for medieval potters in Dorset as those areas that possess useful clay deposits also tend to be served with much running water. The same can be said of the availability of woodland. Darby's distribution map (Darby and Welldon-Finn 1967) suggests that those areas of Dorset with large clay deposits were precisely those areas with the greatest woodland resources.

The availability of temper does not seem to be a limiting factor in determining the location of kiln sites either. Most temper in medieval pottery from the Dorset region is quartz sand, with crushed flint also frequently occurring. There are few places in the region where quartz sand does not occur. River valleys produce fluvial deposits, whilst the tertiary deposits of the south and east included many sands of different grades. Good temper can also be found in the greensands that lie below the north west scarp of the chalk.

The main natural limiting factor relating to the location of medieval ceramic manufacture in the Dorset region must therefore be the location of sympathetic clay deposits. Wherever clay is found in quantity there also seems to be wood, water and temper close at hand. In areas like the Marshwood Vale where all the raw materials necessary for ceramic production exist, but no evidence for an industry can be found, if the data are a true representation of fact then the explanation must be either that the clays themselves were not suitable, or that economic and cultural factors limited the need or ability to produce ceramics locally. The siting of the Verwood and district industry, specifically to take advantage of the Reading Beds and London Clay, is perhaps a good example of how the presence of the necessary raw materials was the first consideration. Hand in hand with such decisions, however, must have been economic considerations. Streeten (1981) states that the medieval ceramic producers of the south east were regularly located on the Reading Beds or Gault deposits. This took advantage, not only of the raw materials, but also of the large market of settlement sites on the chalklands which possessed no clays with which to make their own pottery. Such statements could equally be made about the Verwood and district industry, which could have supplied many sites on the chalk and heathland from a position between the two. In other parts of the region, however, the geological changes are not so obvious and abrupt and it is likely that other economic factors came into play. The next chapter includes a study of the medieval towns in the region. The presence of these large concentrations of population would have often been the sort of stimulus necessary for the establishment of a successful pottery production site, particularly where they also supplied a 'frontier zone' market for the exchange of products between regions. The large market at Shaftesbury, lying between the grain-producing chalklands and the heavier pasture lands of the clay vales might be an example of this last type of centre (Bettey 1986).

The social, legal and tenurial factors regulating ceramic production are certainly worth considering. The amount of work involved in a study of documentary references relating to these factors is liable to be great, however, and the actual information that is easily available is perhaps rather small. These areas of study will not therefore be considered at present but further discussion of the subject of production site location will undoubtedly arise whilst considering the analytical results. It is worth pointing out, however, that such factors could only work within the framework of the raw materials that were available in the first place.

1.6 Methods of sherd classification; Form and Function

The groups the pottery was divided into to classify form were:

a) cooking pots
b) jugs and jars
c) bowls and dishes
d) roofing materials

These groups are broad enough to cover most of the medieval ceramic types commonly found in the region. Rare or perculiar forms do occur on other sites in Wessex in the medieval period but by avoiding the specific classification of these 'oddities', such as lamps, and curfews, they remain as a fifth group of 'other types'. If found in the site assemblages under study, such items would obviously be included in any statistical assessment of the number of vessels or sherds, but would not be selected for chemical analysis, as the nature of their specialisation may actually dictate a different fabric composition from the general body of kiln products.

In Musty's classification of medieval pottery (Unpub. MA thesis), cooking pots are identified as class A1, with cauldrons, skillets, pipkins, ladles, dishes and bowls as the other A types. The classification system used here, thus cuts across Musty's scheme, by separating out open cooking vessels A6 and A7 (dishes and bowls) into a separate grouping (Group C). If this new system was designed to be complete, then perhaps A3, skillets, would also come under Group C. These classifications are not, however, intended to compete with or replace Musty's system. The basis of the new scheme is primarily short term pragmatism. With many of the excavated and fieldwalking collections that were eventually studied in this thesis, many of the sherds were very small, and therefore difficult to assign to very specific formal groups. The protracted work that would be involved in using a complex system would be acceptable whilst writing an actual site report, but was not deemed to be the most productive way of utilising the time available in this project. Thus a quick categorisation of each sherd into closed cooking vessels (cooking pots) and open (cooking) vessels (dishes and bowls), was a necessary expedient to allow time for the main analytical thrust of the project to be pursued adequately. With upwards of thirty ceramic collections eventually being examined, the simplicity of this classification system was much appreciated. A further alteration of Musty's scheme was the eventual definition of Group B as jugs *and jars*, thus including all of Musty's Group C1 jug and pitcher categories, plus the three B2 forms; amphorae, jars and cisterns. This was again an expedient, in this case to group together all the non-cooking items believed to have carried liquids, that is, the jugs and cisterns. No actual jars or amphora were specifically identified by the author in any of the collections studied, but many bung-holes from cisterns were found, particularly in sites from central and west Dorset. Unfortunately, 'bung-hole' sherds from well-dated contexts are rare in the region. Examples of this type do exist, for example, at Holworth (Rahtz 1959, No. 33, 144) and Hermitage (Field 1966, No. 40, 173), but both of these examples derive from contexts that would have been classified as thirteenth century if it was not for the presence of the bung-hole sherds. The indications are therefore, perhaps, that in Wessex this form is not confined to the period from the fifteenth century onwards, but it is in fact present in some areas from the late thirteenth century.

The fourth of the categories specified here was d) roofing materials. This includes Musty's E1 to E6. These items were included in the study, despite the possibility that at least some of these types were marketed in a different fashion to the ceramic vessels. The reason why they were not left out of the classification altogether is precisely because of the presence of items of these types at both the initial kiln sites studied.

At Hermitage approximately 16% of the pieces of kiln products retrieved by excavation were ridge-tile fragments. These were made in exactly the same fabric as the vessels, although the tiles were more often reduced than the vessels. The implications of this are described in section 1.8. The presence of so many ridge-tile fragments must surely indicate the importance of these items for the Hermitage kilns success, at least in the latter years of its life. It must be indicated, however, that items such as ridge-tiles, generally required in some bulk, would quite possibly have been a product that was specifically requested of the Hermitage potter(s), rather than one that was made to be hawked or transported to market. It cannot have been worthwhile to transport large numbers of such bulky items on the off-chance that they might be bought, unless some form of depot was available for their storage away from the kiln site. It is possible that Hermitage roofing materials may have been used in the abbey and town at Cerne, as well as possibly on buildings in Dorchester and Sherborne.

At Laverstock ridge and corner, tiles, tiles with finials, drain-pipes, chimney pots and louvers were all manufactured. Most of these types are only represented by a few examples in the excavated collection. There are many ridge-tiles, however, the excavators indicating that examples were found "in abundance in most of the kilns and in some of the pits" (Musty et al 1969, 139). These were of a uniform pattern with five knife-trimmed crests and glaze in a variety of shades. The excavators suggest that there was a ready market for Laverstock roof furniture with the various rebuildings of Clarendon Palace and also state that building materials may also have been supplied to Wilton Abbey and Old Sarum Castle. "The move of Salisbury from Old Sarum to the valley below would also have led to a considerable demand for ridge-tiles" (Musty et al 1969, 139).

No flat roof tiles were found in kilns at Laverstock, although 15 fragments were recovered from a pit. These may have been made on site but it is at the moment impossible to confirm or refute this. The existence of three hip-tiles (one in pit three, two in kiln three) again hints at the production of other types of roof furniture besides the more elaborate ridge-tiles and finials, louvers etc. It is possible that these simpler types of product were made elsewhere, perhaps alongside the floor-tile production at Clarendon, or maybe in unexcavated kilns near those excavated at Laverstock. The latter possibility cannot be ruled out as there are strong indications that a number of excavated kilns do exist close by (Algar pers. comm.).

Floor Tiles

Each of the two kiln sites initially studied yielded fragments of one floor tile. The Laverstock example was not glazed and was particularly thick. The excavators do not indicate whether they consider it to be an actual Laverstock product or not, with only one brief mention of its "red sandy fabric". Such a description could fit many Laverstock products but could possibly also describe material from any other kiln in the Salisbury area.

The floor-tile recovered during the excavations at Hermitage was decorated with a white clay inlay and a pale green glaze. Its fabric is soft, but not softer than a number of other sherds from the site. If it is actually a product of the excavated kiln then it is a tantalisingly small piece of evidence for what must have been a bulk production item. In the excavation report (Field 1966), G. D. Squibb identified it as dating from the reign of Edward I (1272-1307), and Mrs E. Eames indicates its closest parallels as being at Cleeve Abbey in Somerset. Cleeve is at least 60 miles by road from Hermitage, thus making the possibility that tiles were transported there from Hermitage rather unlikely. The question must therefore remain, if the Hermitage potters did produce quantities of decorated floor tiles; then who and where for? A potential source would be the Abbey at Cerne, but as yet no similar tiles have been found there. Because the evidence for floor-tile production at both of these sites is so slender, and directly comparable material 'in situ' is at present unknown, the decision has been made to ignore this facet of the ceramic industry until more data are available. The assumption has been made that any decorated floor-tile production is likely to have been specifically commissioned and was thus perhaps not strictly a part of the regular marketing of ceramic vessels, or even ridge-tiles, in medieval Wessex.

Fabric Classification

From the outset all fabric classification was kept very simple. As with the form categories, this was partly because there was not enough time to spend too many hours studying the minutae of fabric variation in all the assemblages considered, when the point of the project was to carry out analytical work.

A short consideration of the Trust for Wessex Archaeology fabric description method (Davies and Hawkes 1985) identified the basic format that was adopted. An early decision was that very little effort would be expended in providing very specific descriptions of the fabric colour. General colour is undoubtedly in part a function of the chemical constitution of the parent clay(s), as well as being strongly affected by the firing conditions experienced by the ceramic. The latter is constrained by the former with clays of low iron and, to a lesser extent, manganese content generally exhibiting much lighter hues than other examples rich in these elements. The organic content of a clay can also affect its colour on firing. If a ceramic has a high organic content this tends to carbonise on firing producing a darker colouration than might otherwise occur. Alongside this, carbon from the fuel can be adsorbed onto the ceramic causing black or grey patches (Kilmurry 1980).

Most clays contain iron in the form of haematite (alpha Fe_2O_3). Occasional igneous-derived deposits contain iron oxides that are still in the form of magnetite (Fe_3O_4), the commonest form in igneous rocks. Magnetite generally converts to haematite under the action of air and water, and thus sedimentary deposits tend to contain iron almost exclusively in the form of haematite. If a ceramic is fired under oxidising conditions, iron present in the clay as haematite is most likely to remain in that form. Furthermore, any maghemite (gamma Fe_2O_3) present converts to haematite at temperatures of 450^oC to 650^oC under oxidising conditions. When ceramics are fired under reducing conditions, the iron present as haematite reduces to magnetite. Haematite is usually reddish and magnetite is grey or black. Thus the fabric of ceramics changes colour with firing as a result of the action of heat, and the presence or absence of oxygen, upon the iron minerals present. This combines with the effects described resulting from the presence of organic matter to produce the grey/black colouration in reduced pottery and the red/brown colouration in oxidised material. Colour changes through oxidation when firing were observed by the author whilst carrying out work on an undergraduate dissertation (Spoerry unpub.)

The overall implications of these factors are that any fabric classification that uses colour as a major identifying criterion must give a range of possible hues for each fabric to account for its appearance as a result of firing in a variety of redox atmospheres. Many wares are fired to produce a distinctive colour but the firing does not always work as required and ceramics of an unintentional colour may be produced. These untypically fired vessels can remain intact in the kiln and subsequently enter the market-place as with normally fired items. Furthermore many vessels fired in simple kilns, not necessarily just of the clamp or bonfire form, appear in a variety of colours which result from the vessel's positioning in the kiln. Other vessels are produced which exhibit many distinct hues across the whole of the pot, again deriving from position in the kiln, but also resulting from carbon adsorption.

With all these factors in mind, categorisation of ceramics by colour was thus deliberately 'played down'. Broad descriptions were used, such as 'white ware' implying a ware that could be anything from light grey through white to light pink. Descriptions specifically identifying Munsell codes were avoided, as were simpler colour chart methods, such as that devised by the Study Group for Romano-British Coarse Pottery.

Hardness and inclusions

Descriptions of inclusions visible by eye and with a low power binocular microscope were used as the most important fabric identifier. This was, of course, coupled with the general colour range description and a simple hardness test was also included. This latter was based on three categories: 1) Fabric scratched by fingernail; 2) fabric scratched by blade; 3) fabric not scratched by blade. These corresponded to the terms soft, hard and very hard. Once again caution has to be exhibited, even with a scheme as simple as this one. This is because of the possibility that the kiln waste studied is not a true representation of the required finished product, by nature of it being the failed portion of the kiln's output. This problem applies to all descriptions of wasters, but is particularly important when concerned with the colour or hardness of the fabric, which can vary greatly depending on firing temperature and conditions.

Discussion of the inclusions present in the ceramic appeared to be the most useful method of visual description and classification. The type, size, quantity and shape of inclusions were ascertained for the material derived from the kilns, using a low-power binocular microscope. The categories used for this description were those outlined by Davies and Hawkes (1985). With much of the material from 'market place' site collections it was not possible to use a binocular microscope because of the lack of facilities where the ceramics were stored, or because of the prohibitive lengths of time a large study using this visual aid would take. In such cases a quick fabric description and identification of similarity with known broad fabric groups was made using a hand lens, or by eye. This was found to be perfectly adequate to categorise most material into the broad ware groups used in this study.

1.7 Fabric groups/wares identified

Initially site-specific fabric groups were envisaged as the natural units of classification. It soon became apparent, however, that due to the rather intensive nature of this project, in terms of the number of site collections studied per unit area, that most of the fabrics described occurred in a number of collections spread across quite large areas of the landscape. These cross-site distributions could either indicate the great dominance of one large producer in a given region, or perhaps result from large 'traditions' of ceramic manufacture, involving a number of production sites within a given area, producing pottery from the same basic raw materials, with the same intended finished product. The existence of slight variations in terms of amount and size of temper, or the hardness or general colour of the clay matrix, suggested that the latter possibility of local 'traditions' of manufacture might be more appropriate in some cases, with slight variations existing between the products of members of the 'tradition'. This argument could be seen to be supported by the documentary evidence collated in Fig. 1.5. The existence of indications that the kiln at Hermitage was only one of several medieval producers on the southern edge of the Blackmore vale, and the suggestions that the medieval origins of the Verwood and District industry are in more than one parish (Alderholt, Cranborne and Damerham), perhaps lends weight to this theory.

The identification scheme that was finally used describes only these broad 'wares', leaving the separation of subdivisions in these categories to the analytical study that forms the core of this research project. Table 1.4 identifies the wares used in the whole study. The classification of the kiln site material and groups of wasters that were analysed is in the final column.

1.8 The kiln at Hermitage and its products

An assessment of the whole of the excavated ceramic material from the Hermitage kiln indicated a total collection of something in excess of 1,000 sherds and tile fragments. Of these over 90% were of one broad fabric group. The other 10% or so were a varied collection of post-medieval material which, on the basis of their generally peripheral location within the excavation, can be attributed to later activity within the same field. The excavator identified this possibility in the site report (Field 1966) and even postulated that there may have been post-medieval kilns operating here as well. This later material has no obvious stylistic similarities to the medieval assemblage and only a few later sherds exhibit fabrics of a broadly similar type to the medieval ware. Thus it can be assumed that there was one definite period of medieval ceramic manufacture, followed by a gap of three hundred years or so, and then a possible second period of kiln activity for which we have, as yet, no known excavated features. The medieval fabric is soft and sandy containing large amounts of quartz inclusions of a small size (less than 0.5mm). There are no other regular inclusions that can be seen to be deliberate temper. The occasional flint, piece of chalk, or soft grain of limonite (haematite) does occur, but these can be regarded as accidental if added by man, or 'erratic' if occurring naturally.

The clay matrix of this fabric (known here as HM FabA) varies in colour from an occasional buff-brown, through orange-red and red-brown, to a reduced dark grey. The majority of the sherds are at least partially oxidised and this can regarded as probably the desired end result. Of the 900 or so medieval pieces about 16% are roof-tile fragments, probably all from crested ridge-tiles. Many of these (over 60%) are a reduced dark grey and are much harder fired than the vessel sherds. This probably occurred as a result of one or more of the following possibilities.

a) There was a deliberate attempt by the potter(s) to give the ridge-tiles a harder, more reduced fabric, involving more care of firing and greater amounts of fuel than for vessels.
b) Less care was taken over the firing of ridge-tiles as their aesthetic appeal was less critical.
c) One of the last firings in the life of the kiln was a batch of ridge-tiles which were accidentally over-fired. These items remained unsold and were discarded nearby.

Of these three possibilities, a) seems the least likely , although it is true that roof tiles are generally thicker than vessels, and so perhaps require more strength which could be produced through harder firing. Obviously ridge-tiles need a degree of strength to survive the ravages of the English weather and they are, of course, not purely decorative items as they are designed to prevent leakage at the apex of roofs, whether thatched or completely tiled. Such needs can of course be fullfilled by normally fired ceramics, as is evident from the many examples with oxidised fabrics known from elsewhere.

The second possibility outlined above suggests that maybe less care was taken over the firing of ridge-tiles when compared to ceramic vessels. Why would this be so? Unlike pottery vessels ridge-tiles do not have to act as non-porous containers, nor do they have to stand up to the rigours of repeated heating. They are, in reality, only lumps of fired clay performing their function by virtue of their positioning and by their shape. Obviously aesthetics play some part in the visual appearance of such pieces. This accounts for the characteristic decorated ridges which make a pleasing formal design along a rooftop. Colour cannot, however, have been too critical in objects which were normally viewed from a distance. Furthermore ridge-tiles are not singular items; they are used in bulk and presumably they were bought in bulk. Therefore it is likely that the individual worth of these items was low when compared to pottery vessels and it is thus possible that there was less need to regulate the firing conditions carefully. This must not be overstated, however, as it is obvious that the large amount of time, fuel and raw materials that were invested in a 'load' of tiles would not be lightly dismissed.

The third of the possibilities already mentioned suggests that one of the last firings of the kiln included a 'load' of ridge-tiles that were accidentally over-fired and thus remained unsold and discarded nearby. This explanation cannot be ruled out. If alternative b) is suggested as the most likely course of events, then one can envisage c) as no more than a symptom of this less critical need for the precise firing of ridge tiles, when compared to ceramic vessels. This argument is supported by several known instances in the medieval period where tile kilns were established by individuals with no known involvement in the pottery industry, to provide roof furniture for specific building projects (e.g. at Clarendon).

The ridge-tile component is only 16% of the total collection that derives from the kiln itself. The one sherd of glazed floor-tile hints at the possible exploitation of another market. Floor-tiles are also bulk items and could have been a more significant product than their presence in the waste material suggests. Certainly,there are known tile kilns elsewhere that produce both the roof and floor varieties, e.g. Nash Nill (McCarthy, 1974). Although it may seem unlikely that a small-scale rural kiln, such as the one at Hermitage, should be involved in specialist tile production, as well as in making the full range of household vessel types, there is some evidence for a shift in the function of the kiln, initially producing ceramic vessels and later specialising towards the tile market. It was noted by Field in his report on the Hermitage excavations that there were, "some strongly archaistic features" (Field 1966, 168), in the forms of many vessels from the kiln, when compared with the expected date for the tiles. These latter were of, "undeniably thirteenth-century date" due to their characteristic slashed and knife-trimmed decoration. Field then attributes these discrepancies to the general conservatism to be found in such an isolated rural area as west Dorset, creating a climate whereby twelfth-century pottery forms could continue well into the thirteenth-century. This does not, however, explain the comparative modernity of the tiles. In the same report Musty postulates that the kiln had two phases of construction, causing Field to suggest that this indicates a long period of use. He then states that as a result of this some of his 'contemporary material' may not be contemporary after all, although he does not specify which material he means. On close inspection it is apparent that the only material definitely of late thirteenth-century date is the floor-tile and the ridge-tiles. Everything else, apart from a few bung-hole sherds, which is in fact the majority of the vessel forms, has its closest parallels in the late twelfth or early-thirteenth centuries. If this evidence for two separate assemblages is combined with Musty's suggestion that there were in actual fact two kilns at Hermitage, in use at different times, then the greatly extended survival of twelfth-century forms can be explained as resulting from the confusion of two separate sets of products.

More recent ceramic reports, for example Pearson (1982) and Allen (1984), do, however, show that this phenomenon of west country conservatism in pottery styles was very marked in the thirteenth century, particularly with regards to cooking pot forms. This lends weight to Fields original argument that the vessels and tiles might after all be contemporary and it is therefore possible that, if two phases of ceramic production at Hermitage did exist, then the time period between them might well have been very brief.

The answer to this problem probably does not lie with the chemical analysis. An identifiable difference in the chemistry of the vessels and tiles could suggest a different clay source, perhaps resulting from the digging of different parts of the clay beds at different times. The alternative suggestion, however, is that such a difference may result from different clays, or mixtures of clays, being used for the vessels and tiles at any one time.

In summary then there are two possible explanations of the origin of the differing products identifed at Hermitage. One possibility is that the Hermitage medieval ceramic industry had two separate phases, each repesented by a separate kiln, with the later example producing a wider range of products. The first kiln came into service sometime between the late twelfth century and the mid-thirteenth century, although a date later in this period is more likely if the two phases represent part of a single progression. At some point in the mid-thirteenth century there was a rebuilding of the kiln and a change of production to include tiles. The two are not necessarily concurrent although I would suggest that this is likely, especially if there had been a period of inactivity between the working lives of the two kilns. The reason for such an abandonment of exclusive vessel production may have had something to do with the general shift in pottery styles around 1250. As indicated by Le Patourel (1969), the mid-thirteenth century in England saw a shift towards finer,highly decorated and glazed wares. Alternatively, if the tiles and all the vessels were produced concurrently, then, due to some form of 'cultural inertia', the vessels were still produced in styles that had been abandoned elsewhere in the country. This is supported by recent work on other medieval ceramic collections from the south west. The tiles were not made in these earlier styles, perhaps because they were a more 'job specific' product, made on demand and therefore not being constrained by the cultural factors that governed routine vessel production. This is obviously to a great extent speculation and will probably remain so until some Hermitage products are identified in well dated contexts elsewhere.

Material selected for analysis

As noted earlier the Hermitage material contained approximately 900 medieval pieces, all of one fabric type but exhibiting a wide range of colours and degrees of hardness. This variation can mostly be attributed to differing firing conditions. In his original site report Field classified this material into five functional groups, these being:

a) Cooking pots
b) Jugs
c) Bowls pans and dishes
d) Crested ridge-tiles
e) Kiln furniture.

Only the first four of these categories have direct relevance to this study, kiln furniture being assumed to be a non-market-distributed item. The other four groups were used as the basis for classifying the function and basic form of all the pottery subsequently studied. These groups were partially re-defined to include a slightly wider range of products and the actual definition of the groups was sharpened a little. It can be seen, however, from table 1.2 that the fundamental categories suggested by Field ultimately proved very comprehensive. A full explanation of the process by which these form groups were ultimately defined can be found in section 1.6.

Forty sherds were selected, ten of each of the four form categories. Twenty of these sherds had one sample taken from them. The other twenty were subjected to multiple sampling (three samples per sherd), the aim being to identify the extent of intra-sherd variability of elemental concentrations.

1.9 The Laverstock kilns and their products

The Laverstock collection poses several problems that did not arise in the study of the Hermitage material, perhaps the most important of these differences resulting from the much greater number of sherds found at Laverstock. The excavations at Laverstock in the1950s (Musty et al 1969) were very extensive and revealed a total of ten kilns plus assorted pits and buildings. It is also likely that there are further kilns close by (D. Algar pers. comm.). The operations being carried out here in the medieval period easily assume the title of an 'industry', something that cannot really be said of the low-key, one or two kiln, evidence so far known at Hermitage. The Laverstock industry may owe its origin to the needs of the royal palace at Clarendon, but this was not its only market and it is evident that Laverstock products reached Salisbury and Winchester (Le Patourel 1969), although few sherds of this material has been found in the latter city. It may well be the case that the Laverstock fine ware products were not usually transported to Winchester, except through royal patronage. Their marketing may well have been through Salisbury and thence to other smaller market towns and villages in the economic territory of this city. The marketing of ceramics into the hinterland of a particular large centre in such a manner has been suggested before in archaeological contexts (e.g. Hodder 1974, Renfrew 1977)

The kilns at Laverstock are generally larger and more complex than the Hermitage example, but the projected time-span of their use overlaps considerably with that suggested for Hermitage. Musty suggests that the ten Laverstock kilns operated over a time-span of approximately fifty years between 1230 and 1275 A.D. The earliest example is probably Kiln 7, followed by Kiln 1 and Kiln 8; the latest being Kiln 6. This sequence is based on stylistic considerations but also takes into account some magnetic dating evidence.

Most of the pottery, ("forty sackfuls"-10,000+ sherds in all), came from infilling of the kiln pits. Generally it would seem that this occurred as part of the initial abandonment of the kiln and the pottery used for such purposes is likely to have been originally fired in the same kiln as it was dumped, or in a succeeding kiln and not result from residual deposition. This is not a water-tight supposition, but it can be accepted that the excavators are right when they assume that the discarded pottery derives from approximately the usage date of the structure in which it was found. The only kiln where this evidence is definite, however, is kiln 6. Here a partial kiln-load was still 'in situ' and it seems probable that many of the broken sherds found here derive from this final firing as well.

Thus, on approaching a study of the Laverstock collection, it had first to be decided which elements of the excavated material were vitally important for a provenance study and which, if any, could be ignored. The obvious first step was to avoid all the ceramics found outside the kilns themselves. Most of these were probably of Laverstock origin but some of the pits did contain twelfth century material clearly of non-local origin. Thus the possibility that other pieces in these contexts were of non-local origin, but visually similar, had to be considered -so the decision was made to ignore this material when selecting sherds for analysis. Even ignoring the sherds not found within the actual kilns, the collection was still too unwieldy to work through systematically. It was therefore decided that two of the ten kilns would be sampled, which would allow the assemblages from both of the kilns to be studied in detail and these would hopefully prove chemically representative of all the clays used at Laverstock. If great inter-kiln variability became apparent at an early stage then this decision would be modified. As this problem did not in fact occur the other eight kilns were left unsampled for the time being and the assumption was made that the clays used here were chemically, as well as visually, similar to those in kilns 1 and 6.

These two particular kilns were selected for a number of reasons, which became apparent after a preliminary assessment of both the published report and the stored ceramic collection. First of all, both these kilns yielded collections of several hundred sherds, enough to give adequate variability of form and fabric, as well as being manageable units. An initial examination of material from all ten kilns had roughly identified the broad scope of forms and wares present and it was felt that these were covered by the material from the two kilns selected. Furthermore it was decided to study material that was as chronologically distant as possible thus maximising the chances of detecting changes in raw material usage over time. These two kilns fitted in with such a plan, kiln 1 being second in the chronological progression and kiln 6 last.

These therefore were the criteria by which kilns 1 and 6 were selected for analysis, the latter being of obvious special interest anyway as it was most likely to contain sherds fired in that actual kiln. This was due to the partial load excavated 'in situ' and also because, being possibly the last kiln to operate on the site, it may have had no replacement from which wasters could be dumped into it at a later date.

It must be stated here that, although the possibility of chemical discrimination between groups of sherds from different kilns within the Laverstock industry was of some interest, that was not a primary aim of this study, which was the differentiation between sherds of different 'industries'. The extent of inter-kiln variability within Laverstock had, however, to be known in case it was significant. Furthermore, the maximum likely chemical difference between Laverstock sherds had to be quantified.

As with the Hermitage pottery the sherds chosen from the Laverstock collection represented the greatest visual differences in fabric type and also contained examples of all the major functional groups identified. Two general fabrics were identified within the Laverstock material; these were not restricted to particular kilns but did have relevance to vessel function. In the site report Musty et al (1969) identified five general functional groups, these being:

a) Unglazed cooking pots and bowls.
b) Glazed bowls, skillets, dishes etc.
c) Jugs.
d) Special types.
e) Building materials.

In this study material from category d) was not used in the analytical work, the other four being roughly comparable with those categories Field used to define the Hermitage material. The final descriptions of form that were applied to all the pottery subsequently studied, regardless of site of origin, were derived from these two sets of groups from Laverstock and Hermitage. The discussion of these groups and their relationship with Musty's typology can be found in section 1.7. Two fabrics are represented in the sherds studied from the Laverstock collection. Fabric LV FabA is a coarse ware found only in cooking pot forms. It has 'abundant' sub-angular quartz inclusions of a medium size (generally 0.5mm to 1.0mm). The other fabric is LV FabB which is a fine ware found in both pottery vessels, excluding cooking pots, and also in roof furniture such as ridge-tiles and chimney pots. This fabric is soft and 'dusty' with fine to medium sub-angular quartz inclusions as with the cooking ware. However there are always fewer of these inclusions and they are never more than common and more usually rare (terms based on the T.W.A. pottery recording system). Other inclusions in this pottery include varying amounts of grog, of all sizes, and sparse, fine (less than 0.2mm) flecks of mica. Other examples contain very coarse (2mm plus), but sparse pieces of chalk.

Material selected for analysis

From the lengthy study outlined above forty sherds were selected for sampling in the initial stage, with the aim of chemically characterising the Laverstock material and differentiating it from the sherds from Hermitage. Twenty sherds were taken from each of Kiln 1 and Kiln 6. Due to a lack of examples of some functional types in the assemblages from each kiln, the selection taken was 'non-symmetrical' (see table 1.4). This was made seemingly more complex by the presence of two fabric types. On examination, however, it was found that there was mutual exclusion between some fabrics and forms. The coarse fabric (LV FabA) only occurred in cooking pots and no examples were found of cooking pots in the other, finer, fabric (LV FabB). This makes obvious sense as, out of the four functional groups, only the cooking pots have to undergo repeated heating and thus require large amounts of temper to prevent breakage. Once it had been proved that there were only minor chemical differences between the material from the two kiln sites, another twenty sherds from each site were analysed. In this way the chemical identification of the kiln site group could be better defined and the statistical validity of the work improved.

It was unfortunate that those kiln groups selected for study did not contain a larger number of roof furniture fragments. The two examples from kiln 6 do not serve as a very good sample in a statistical sense. It was therefore postulated that, if these two sherds showed significant chemical differences to the main body of Laverstock products, then more tiles and chimney pots would be sampled, from other kiln fills if necessary. In the event this did not prove necessary, as these two sherds produced samples that were chemically consistent with the vessels.

It must be noted here that one sherd from a cooking pot in Laverstock, Kiln 1 (LV K1 10) was of a flint-gritted fabric not seen elsewhere. It was therefore postulated that this piece could prove to be not of local origin. After analysis it was found that the chemical make-up of this sherd was sufficiently different from anything else analysed to confirm its intrusive nature.

1.10 Material from other kiln sites

After the pilot study (Chapter 4) had been completed, sherds from a number of other possible medieval production sites were included in the analysis programme. The collections that were included in this additional characterisation step are outlined in table 1.5. In addition to these sites medieval material from the kilns at Donyatt and also sherds of local fabrics from Ilchester would ideally have been studied. The collections from these sites were, however, being worked on by the excavators and museum staff during the period when such a study could have been carried out.

Wasters in two wares from one site in Southampton (SOU 105) were analysed. These were of late thirteenth, or early fourteenth, century date and some vessels appeared to imitate contemporary French forms (D. Brown pers. comm.). The five sherds in Southampton Museums Fabric 1230 were very similar to the sandy ware produced at Hermitage, although they had an additional crushed- flint temper not found at the latter site. The other twelve sherds were in Southampton Museums Fabrics 1044 and 1053. These sherds were highly decorated and showed some stylistic similarities with material found at Laverstock. The Southampton wasters were, however, generally smoother and harder, with less sand temper, in comparison to Laverstock products.

Three possible wasters from a sand-pit at the village of West Grimstead were also studied. These sherds were tempered with a fine quartz sand and were produced in a fabric reminiscent of some of the Laverstock fine ware products. The sherds were, perhaps, a little more brown in colouration than many of those seen at Laverstock and may also have been a little later in date. This last was suggested by the existence of one beak-spouted vessel reminiscent of early fourteenth century forms from France.

Documentary evidence suggests that production of ceramics was already under way by the late thirteenth century (Le Patourel1969) or the early fourteenth century (Algar et al 1987) in the area later to witness the growth of the so- called Verwood and District Potteries Industry. Unfortunately no wasters of a medieval date exist from any sites in this area, thus making a direct comparison of wasters and contemporary distributed products impossible. Despite this the medieval ceramic production in this area remains the only example in Dorset, besides Hermitage, for which there is definite evidence. It is therefore potentially a most significant part of the subject matter of this study and it was thus deemed necessary to include the industry in the analytical work, even if sherds of a somewhat later date had to be used as 'dummy' medieval material. The geographical siting of the later industry was specifically to take advantage of London Clay and the Reading Beds and it must therefore be assumed that the medieval potters would have been utilising these same macro-geological deposits. Thus there is the possibility of some chemical similarity between post-medieval and the medieval products of kilns from villages in this area, although the likelihood that these could be perfectly matched was undoubtedly rather small. It is very likely that potters of the medieval and post-medieval period, even if they were using the same clay pits and working in the same villages, would produce wares that were chemically somewhat different. Factors contributing to such variation of products derived from the same parent clay would include the use of differing types and amounts of temper, different clay purification procedures and different mixtures of the same clays. Added to this would be any variation resulting from changes in the composition of the clay deposits, as greater and greater amounts were extracted.

Despite all these factors, potentially making a study of later material redundant when compared to medieval products, a small number of sherds were studied from known post-medieval kiln sites in East Dorset. Fifteen sherds from Kiln Site 2 at Horton (seventeenth century) and fifteen sherds from Kiln Site 10 at Alderholt (seventeenth or eighteenth century) (Algar et al 1987) were included in the analytical work. The Alderholt site was specifically chosen because a fourteenth century documentary reference to potters is known for this parish. The Horton material was also studied to give a comparison from a geographically distant part of the industry. Although no kilns are known to have existed at Horton before the late sixteenth century, the village was probably one of the most prosperous in the area in the medieval period, possessing a Benedictine Priory (Abbey until 1122) and being situated on better quality land than most of those villages that later became potting centres. If the industry extended south of Alderholt in the medieval period, a production centre near Horton seems very likely.

Similar considerations prompted the analysis of fifteen sherds from the known seventeenth century kiln site at East Holme near Wareham (Terry 1987). Although no explicit references to medieval ceramic manufacture are known for this area, the parish and its surroundings have been known to produce characteristic white-firing pipe-clays for over four hundred years. Excavated medieval collections from sites around Poole Harbour have produced many off-white sherds that presumably were made from pipe-clays. A production source for this material is again not known ,but the possibility that the known East Holme industry was continuation of an earlier medieval industry, located somewhere in the immediate area, cannot be overlooked. The comparison of seventeenth century wasters from East Holme with thirteenth and fourteenth century pottery from Corfe, Christchurch, Holworth, Poole and Wareham was therefore deemed to be a worthwhile exercise.

The material from all these post-medieval kiln sites can be seen listed on Table 1.5.

Chapter 2
The settlement site material, its derivation and context

2.1 The market place for ceramics in thirteenth-century Wessex

Any ceramic production site in medieval Wessex would have to have some method of marketing its products. This could be by one or more modes.

1. Direct sale to consumers at the production site.
2. Direct sale to consumers at their home settlement.
3. Sale to consumers at a market centre.
4. Sale to middleman (e.g. itinerant hawker), either at the production site, or at a market centre.

Of these, mode two would be the most time-consuming for the potter and would therefore be unlikely to be carried out by potters working alone. Groups of potters would be more likely to have spare labour which could be utilised for such purposes, although it is possible that most potters would also have kin who could carry out such tasks, whether on an informal or regular basis. This last is documented as occurring in nineteenth, and early twentieth-century Wessex (Algar, Light and Copland-Griffiths,1987). In this case the younger brothers of potters in the Verwood area often became travelling hawkers, supplying remote settlements directly and taking the wares to markets over quite wide areas. There is no reason why a similar situation should have not occurred some centuries earlier in the same region. A comparative study of the family names of potters and market-stall holders in the immediate post-medieval period may shed some light on the intermediate centuries, but the author sees no obvious way of taking such a study back any further. Whether related to the potters or not, the sale to hawkers would be an efficient way of distributing kiln products over a wide area, requiring minimal effort on the potters' part.

Mode one, direct sale at the kiln site, is probably only likely in certain circumstances. The Laverstock industry was located just outside the thriving city of Salisbury and would therefore have been within easy reach of many potential customers. By contrast, in the case of a relatively isolated rural kiln, such as that found at Hermitage, the effort expended to travel to the production site may well have prohibited many potential customers from considering direct purchase there. The kiln was, however, located near to the main road from Dorchester to Sherborne, by way of Cerne Abbas, and this may have brought custom. This location, however, is more likely to derive from the potters need to have easy access to the markets at these centres and thus could be seen to be a function of mode three rather than mode one.

Of all the possible methods of distribution of kiln products, mode three, sale at market centres, is the most easy to study. This is because documentary and archaeological information is readily available concerning the location, size and duration of virtually all markets operating in thirteenth-century Wessex. In contrast, other than occasional oblique references and illustrations, there is little information regarding the lifestyle and operations of itinerant medieval salesmen. It may be assumed that they existed, and supplied many settlements outside the 'market-place' system, but proving this is very difficult. One way may be through identifying differing distributions of particular wares in different status and differently located settlements. In this way it may be possible to show that, for example, the products of a kiln might have a distribution mainly centred on a market centre, except in upland chalk areas, where the remoter settlements show a wider distribution, which could relate to the actions of travelling middlemen. It is probable that the marketing of medieval ceramics was regularly of this multi-modal form and, bearing this in mind, the four distribution methods outlined at the start of this section should not be seen as mutually exclusive.

Whatever the methods of distribution, before any concrete statements can be made, a study must be carried out of all those centres that provided a 'market-place' for ceramics, in both senses of the phrase. These are the 'urban' centres and other large concentrations of individuals. A complementary total study of all the smaller agricultural settlements in the study area is obviously beyond the scope of this project. An assessment will, however, be made of all the 'natural regions' occurring in the area and this will hopefully help differentiate between groups of such settlements.

2.2 The status of larger settlements: A definition of 'urbanism'

Any definition of urbanism or other indication of the status of nucleated settlements must derive from a broad conceptual base. A classification based on only one or two criteria is meaningless for many reasons, not the least of which is the incomplete nature of most archaeological or historical data. Beresford and Finberg (1973) defined a medieval borough as any place that passes one of the following tests:

Had it a borough charter?
Had it burgage plots?
Was it called 'burgus' in the assize rolls?
Was it separately taxed as a borough?
Did it send members to parliament?

This classification system identifies boroughs recognised as such in the thirteenth century admirably. It does not, however, indicate which settlements were the most prosperous urban centres in the landscape, nor does it identify those that were failures. Newton Studland, for example, qualifies as a borough under these criteria and yet, as Beresford and Finberg quite rightly point out, it was a complete failure. If urbanism in general in the thirteenth century is being described, the information must be polythetic for the results to be meaningful. Heighway (1972) used a 'bundle of criteria' approach to define urban settlements. The information was gained from both documentary sources (historical) and also from archaeological publications.

The nature of archaeological evidence is such that it is impartial to biases dictated by the social or political enviroment present at the time the evidence was formed. The historical record is prone to these inaccuracies, however, which are derived from the perception of the scribe. Archaeological information, on the other hand, is interpreted according to the theoretical paradigm present at the time of discovery, with the primary data being lost through excavation. Thus modern concepts may be forced upon an 'unwilling' data set. Historical evidence, however, remains unchanged for reinterpretation at a later date. By utilising both types of evidence in a complementary fashion, many of the failings of the data, and of interpretation, should be avoided.

Heighway defined her 'bundle of criteria', derived from both archaeological and historical data, as follows:

1. Defences.
2. A planned street system.
3. A market.
4. A mint.
5. Legal autonomy.
6. A role as a central place.
7. A relatively large and dense population.
8. A diversified economic base.
9. Plots and houses of urban type.
10. Social differentiation.
11. Complex religious organization.
12. A judicial centre.

Despite the comprehensive nature of this list Heighway did not rank the criteria in any way. Thus there is no way of indicating that some criteria, such as possession of a market, are fundamental to the formation and functioning of a medieval town, whereas other criteria, such as possession of a mint or defences, are only peripheral in importance. Such factors are more likely to indicate levels of stratification within a group of towns, rather than serve solely as indicators of urbanism. With such matters in mind an attempt was made to formulate a 'bundle of criteria' defining medieval urbanism, which weighted those factors vital for urban status, and gave less importance to factors of a peripheral or additional nature.

A scheme identifying urbanism and levels of urban status for medieval centres in the study region

To be included in this scheme a centre had to qualify in either section 1 or section 2 below. The identification of virtually all the relevant centres was made simple by the availability of publications concerned with planning in historic towns for all the counties in the study area (Aston and Leech 1977, Haslam 1976, Hughes 1976 and Penn 1980). Thus the majority of information was easily available and the study of primary documentary evidence was not carried out. A review of recent archaeological work was needed, however, to bring the information on some centres up to date. This was carried out as part of the wider study of archaeological evidence that forms 2.3.

The scheme that was finally adopted was as follows:

1	Possession of a borough charter,	4 points
	or	or
	references to burgesses.	2 points
	Identification of burgage plots.	2 points
2	Possession of market charter(s)	2 points
	or	or
	other reference to med. market.	1 point
	Identified med. market place.	1 point
3	Evidence for craft specialisation,	1 point each
	industry or non-agricultural	max. of 3
	professions. in section	
4	Documented as admin. centre.	1 point
	Documented as judicial centre.	1 point
	Presence of mint.	1 point
	Presence of gaol.	1 point
5	Presence of cathedral.	3 points
6	Presence of Abbey.	2 points
	Presence of priory, friary or	1 point
	hospital.	each
	Maximum of 3 points in whole section.	

7	Presence of town fortifications. Presence of castle in, or adjacent to, centre.	2 points 2 points
8	Evidence of planned development.	1 point
9	Active as a port	1 point
Maximum point total possible		25 points

This scheme was then applied to all centres in the study area that had been identified as towns by AD1300 in previous publications. The points scores derived from this exercise can be seen in Table 2.1.

Discussion of results

After some initial trial studies, bracketed areas, based on points scores, were created to indicate various levels of urban attainment. These were:

3 to 5 points	A market village (not necessarily urban), or decaying or recently formed town.
6 to 11 points	A small town, probably only supplying local market needs (unless a port).
12 to 17 points	A large town of importance as a regional centre.
18 to 25 points	A very large town or city of national importance.

The numbers of settlements by 1300 in the study region, in each category, were as follows. The actual sites and their status in this scheme are located on Figure 2.1.

Group 1 (18 to 24 points)	1 settlement
Group 2 (12 to 17 points)	11 settlements

Group 3 (6 to 11 points)	32 settlements
Group 4 (3 to 5 points)	8 settlements
Total	52 settlements

The only group 1 centre is Winchester. This is understandable because as well as being one of only two cathedral cities in the study area (the other is Salisbury) Winchester was a major royal centre, second only to London in political importance before circa 1150, and thereafter regionally pre-eminent.

There are eleven centres in group 2. These include Salisbury, a thriving new city, and Ilchester and Dorchester. The latter was, and is, county town of Dorset and owes its status to this role as much as any other. Ilchester had been a thriving early medieval centre, but its importance was on the wane by the end of the thirteenth century. Its position in this group is fair, although the points total is perhaps more a reflection of a more prestigious past, and a large number of published excavations, than its role by 1300. There are also a number of Saxon monastic centres in this group, all of which saw expansion in the twelfth and thirteenth centuries. These are Shaftesbury, Sherborne and Wimborne. Wilton was also a Saxon monastic and royal centre, but it was in decline as a result of competition with, first Old Sarum, and later from the new city of Salibury. Bridport, Southampton and Wareham were also Saxon centres, in this case 'burhs', and all three continued to thrive due to their role as ports. Wareham was soon to decline, however, probably due to the silting up of its harbour and the use of bigger ships from the thirteenth century onwards. It was slowly replaced locally as a port by Poole (Penn 1980). Christchurch, another Saxon burh and port, also appears in this category, but may well be wrongly classified. Recent excavations have suggested that it was only a very minor port and that there were many open areas within the bounds of the medieval town (Davies 1983 and Jarvis 1983). It may well have gained more points than it deserved, due to its previous importance as a Saxon centre and as a result of the wealth of archaeological information available from the town.

Of the centres in group 4, Ilminster was a Saxon centre in decline. Beaulieu was, at this stage, only a small settlement outside the abbey which did not receive its charter until the fifteenth century (Hughes 1976). Ringwood and Fordingbridge may both have been impoverished due to a lack of good agricultural land, acting only as centres for those who lived, or worked, in the New Forest. Alternatively, the sparse documentary evidence concerning these towns and the total lack of recent archaeological work, may be causing an unnatural depression of the points scores. Hindon was a thirteenth century foundation by the Bishop of Winchester which did not gain much momentum in development until the fourteenth century (Haslam 1976). Beaminster was a "small but thriving place" (Penn 1980, 15), which did not receive a market grant until 1274-5. Its place in group 4 is somewhat doubtful and is perhaps due, more to a lack of information, than a lack of economic activity in the thirteenth century. Stalbridge was a late foundation (1286) and does not seem to have expanded greatly until the fourteenth century. This may have been due to the proximity of more established towns such a Milborne Port, Sherborne and Sturminster Newton. Charmouth was not established as a borough until 1320, and even then it was a failure. This was almost entirely due to the closeness of Lyme Regis, by then a thriving port and market town.

All the other centres were classified in group 3 as 'small towns'. None are totally undeserving of this title, except maybe a number of small settlements outside monastic centres or baronial castles (e.g. Castle Cary, Mere). Centres such as Poole, Weymouth/Melcombe Regis and Yeovil, although much more prosperous a century later, were at this time in the early stages of their development.

This classification system, despite being based on a rather limited and unsatisfactory data base, has produced a progression that seems to match general perceptions concerning the status of the better known medieval 'towns' in the study region. Some clarification of the relative position of these centres has been achieved, and suggestions to the status of a number of the less well known, or less well documented, sites have been made. In the context of studies of medieval urbanism an exercise of this type is, perhaps, rather sterile, as it seeks to make static statements about complex economic and social units which were constantly changing. Despite this, the information produced here seems to be very informative, even if rather incomplete data have been used to provide a 'snapshot' perspective. As an exercise to indicate the relative importance and economic 'gravity' of population centres in medieval Wessex, with the intention of using this information to construct policies to understand ceramic use and distribution, the results are most definitely of value.

Other centres of population that provided a market for goods in medieval Dorset and the surrounding region

Besides the urban centres of various forms a number of other settlements may also have provided concentrated 'markets' for goods such as ceramics. These centres are of two types, rural monastic communities and rural 'castles'. A list of the larger rural monasteries in Dorset and the surrounding region by the end of the thirteenth century is given below; the location of these sites can be seen on Figure 2.2. The greatest and most important of Dorset's monastic houses were undoubtedly the Benedictine Abbeys of Abbotsbury, Cerne, Milton, Shaftesbury and Sherborne. These were, however, all within, or associated with, medieval towns and have therefore already been identified as centres of population. A number of minor cells of alien houses and hospitals also existed but these have not been included in the list below. This is because they were not very large and probably did not represent population centres greater than the average hamlet. Rural 'castles' are not a common phenomenon in Wessex at the end of the thirteenth century. Most of the royal and baronial castles, like the larger monasteries, were associated with settlements that had by this stage developed into towns. Of the dozen late thirteenth century castles in the Dorset region only two are in rural contexts, these being Sturminster in Dorset and Wardour in Wiltshire. A number of fortified manor sites or 'moated sites' are known to have been in existence in the region by the late thirteenth century. This class of settlement includes examples at Chideock and Nunney in Dorset and Milton in Hampshire. Excavated examples of this type of settlement are rare in the region, the only published example so far being at Milton. Excavations have also taken place on moated sites at Lodge Farm and Owermoigne in Dorset, although neither excavation has yet been fully published and uncertainties remain as to the status of these settlements at the time of interest. Sites of this category are not large enough to represent great population concentrations, many being no more than fortified farms. They can thus be perceived as part of the general rural landscape and will be not considered individually for the purposes of this work.

Larger rural monastic communities in Dorset and surroundings by the end of the thirteenth century

Dorset	Bindon, Horton and Tarrant Crawford
East Hampshire	Breamore, Mottisfont, Netley and St. Denys
South Somerset	Muchelney, Stavordale and Witham
South Wiltshire	Ivychurch and Maiden Bradley
East Devon	Newenham

2.3 Excavations in the Dorset region producing medieval ceramics.

Abbreviations used in this section

CRAAGS	Committee for Rescue Archaeology in Avon, Gloucester and Somerset.
DCM	Dorset County Museum.
DIHE	Dorset Institute of Higher Education.
DNHAS	Dorset Natural History and Archaeological Society.
Med. Arch.	Medieval Archaeology.
PDNHAS	Proceedings of the Dorset Natural History and Archaeological Society.
PHFC	Proceedings of the Hampshire Field Club.
PSANHS	Proceedings of the Somerset Archaeology and Natural History Society.
RCHM	Royal Commission on Historic Monuments.
SMARG	Salisbury Museum Archaeological Research Group
TWA	The Trust for Wessex Archaeology
WAM	Wiltshire Archaeological Magazine.

Urban contexts

Sites in Dorset

In late thirteenth century Dorset there were 21 centres that could in some way be described as urban (Penn,1980 and Chapter 2.1, this volume). Of these 21 centres, eleven have experienced excavations of some form over the last forty years. These centres are listed alphabetically below along with information and references concerning all known excavations.

1. Abbotsbury
"Excavations in the Abbey Church, Abbotsbury." *Med. Arch.* volXVI (1972), 173. Excavations revealed the north wall of the abbey church. Although no ceramic material was mentioned in the note, some may have been found although its location is unknown.

2. Bridport
"Excavations in the Glebe, Bridport,1975." J. Bailey,*PDNHAS* vol 98 (1976). Star Garage, Bridport,1986. DIHE unpublished excavation. No definitely medieval features were found at either of these excavations, and the 1986 excavation did not produce large amounts of medieval pottery either. A number of sherds of twelfth to fourteenth century date were found at the Glebe site, but all the material came from cultivation or disturbed levels.

3. Christchurch
There are published reports concerning twenty one sites excavated in Christchurch between 1969 and 1983. These can be found in two publications.
"Excavations in Christchurch 1969-1980." K.S. Jarvis, *DNHAS* monograph 5, 1983.
"Excavations in Christchurch, Dorset, 1981-83." S.M. Davies, *PDNHAS* vol 106, (1983).
Of the twenty-one sites, one was a pagan Saxon cemetery of seventh to eighth century date. Most of the other twenty contained medieval features of some form. Over 450kg of pottery was recovered, much of it of medieval date.

4. Corfe Castle

No excavations have so far been carried out in the town itself, but a number of sites within the castle have been studied, and limited publication produced. In 1960 a report on excavations in the west bailey was published, with a pottery report. More recent excavations in 1986, carried out by the National Trust, have produced more pottery which has been studied by the author. Although much of this material is medieval most of it comes from disturbed contexts.

"Excavations in the West Bailey of Corfe Castle." RCHM, *Med Arch* vol 4, (1960).

"Finds from the excavations at Corfe Castle 1986." N. Grace, unpublished report for The National Trust.

5. Dorchester

Many excavations have been carried out within the bounds of medieval Dorchester. Most of these have been primarily Roman period sites, although medieval material usually occurred in small quantities as well. Some excavations were intended to study facets of the medieval settlement, but mainly within the area of the castle as opposed to the town proper. Those excavations revealing most medieval material are listed below.

Dorchester Prison, 1970.
Dorchester Prison, 1975.
Dorchester Prison, 1978.

These reports can all be found in one volume;

Dorchester Excavations Volume 1. J. Draper and C. Chaplin, *DNHAS* monograph 2, 1982.

Another excavation of medieval date is that of a small chapel in South Street;"St. Rowalds Chapel, South Street, Dorchester." J. Draper, *PDNHAS* vol. 102, (1980).

A large amount of medieval pottery has been found in a number of more recent excavations, including:

"Excavations at the Greyhound Yard Car Park, Dorchester, 1984." P. Woodward, S. Davies and A. Graham, *PDNHAS* vol. 106 (1984).

6. Milton Abbas

Excavations were carried out at the Abbey by RCHM in the1950s and also in 1972. No excavations, however, have occurred on the site of the abandoned town itself. Pottery from the1972 excavations is available for study in DCM.

7. Poole

Many excavations have taken place in Poole over the last decade and a half, under the guidance of the Archaeology Section of Poole Museums Service. They have revealed timber and stone buildings, refuse features, and industrial areas associated with the medieval port. Much medieval pottery has been discovered, four per cent of it being imports (Jarvis, 1983). Although no full reports are yet published, notes for several sites excavated in the early 1970s appear in *PDNHAS* vol 96 (1974).

8. Shaftesbury

A number of small excavations producing some medieval pottery have been carried out in Shaftesbury over the last forty years or so; these are shown below. A volume of recent work in and around the town has not yet been studied by the author, but should provide information concerning sites and finds of the 1980s.

"Castle Hill, Shaftesbury." S.E. Rigold, *PDNHAS* vol 71 (1949).

Includes excavations in the Castle Hill earthwork, of twelfth to thirteenth century date, and also on the site of Old Brow House, a probable fortified farmhouse. Both these sites are on the edge of the medieval town.

"Cockrams Field" E. Jervoise, *PDNHAS* vol 76 (1954).

Features associated with Barton Manor House.

"Excavations within No.8 Gold Hill, Shaftesbury." M. Cox, *PDNHAS* vol 107 (1985).

Unpublished excavations also took place in 'The Commons', at 6 Bimport and at 22 High Street. At the latter site pits containing medieval ceramics were found (Moore pers. comm.) which have been studied by the author.

9. Sherborne

Most of the excavations carried out in Sherborne over the last forty years have been located around the site of the Old Castle, which lies just to the east of the medieval town. During the 1940s and 1950s the late C.E. Bean carried out several seasons work there, as well as excavating a small pit in Durrant Close in the town itself. Pottery from the latter was published in 1951, but no publication of the material from the castle is known of by the author.

Further excavations were carried out at the Old Castle in the 1970,s and a report on the pottery fabrics appeared in 1979 (Harrison and Williams). However, the bulk of these excavations are also unpublished, although work is progressing on this front.

"Excavations at Sherborne Old Castle." C.E. Bean, *PDNHAS* vol 73 (1951).

"Excavations at Durrant Close, Sherborne." C.E. Bean, *PDNHAS* vol 73 (1951).

"Sherborne Old Castle, Dorset; Medieval Pottery Fabrics." B.P.Harrison and D.F. Williams, *PDNHAS* vol 101 (1979).

10. Wareham

There have been several excavations producing medieval pottery carried out in Wareham over the last forty years. Excavations in the 1950s concentrated on the towns fortifications, notably the West Wall and the keep of Wareham Castle. Excavations in 1974-5 in the north-west quarter of the town found occupation from the tenth century up to the late twelfth, and possibly the fourteenth centuries (Hinton and Hodges, 1977).

"Wareham, West Walls." RCHM, *Med. Arch.* vol III (1959).

"The Keep of Wareham Castle." D.F. Renn, *Med. Arch.* vol IV(1960).

"Excavations in Wareham, 1974-5." D. Hinton and R. Hodges, *PDNHAS* vol 99 (1977).

"Excavations in East Street, Wareham." D. Hinton and I. Horsey, *PDNHAS* vol 101 (1979).

11. Wimborne Minster

Excavations producing Medieval pottery have been carried out in the old town centre of Wimborne (Woodward, 1983) and also in a deserted medieval suburb (Field, 1972). More recently observation of builders trenches at the grammer school has identified further medieval features and produced pottery.

"The Leaze, Wimborne, excavations in a deserted medieval quarter of the town." N. Field, *PDNHAS* vol 94 (1972).

"Wimborne Minster, Dorset-Excavations in the Town Centre 1975-80." P.J. Woodward, *PDNHAS* vol 105 (1983).

Sites in East Hampshire

The part of Hampshire covered by this survey is the area south of Andover, as seen on Figure 2.1.

12. Beaulieu

There have been excavations on the site of the Abbey, both recently and in the pre-war period. The most recent excavations have been carried out by Southampton University. No published pottery has been identified.

"Excavations at Beaulieu Abbey 1977 D. A. Hinton *Proc. Hants. Field Club*, 33 (1978).

13. Romsey

"Excavations in the chapel of the Benedictine Abbey" (SU351213), *Med. Arch.* 18 (1974).

Excavations at 29/31 Church Street revealed rubbish pits and industrial structures probably derived from cloth-making. These were of 13th century date, *Med. Arch.* 29 (1985) and 30 (1986).

14. Southampton

Numerous excavations have been carried out since the war on a variety of sites in the town, including merchants' houses, storage areas, the castle and town defences, the friary and industrial tenements.

Many notes recorded in *Med. Arch.* e.g. volumes 27, 30 and 31 (1983, 1985 and 1986) along with several volumes of excavation and finds reports and a number of papers. These include:

Excavations in medieval Southampton 1953-69, volumes 1 and 2 C. Platt and R. Coleman-Smith Leicester University Press, 1975.

Excavations at Southampton Castle John Oxley (ed.) Southampton City Museums, 1986.

"Excavations in medieval tenements on the Quilters Vault site in Southampton" J. S. H. Walker *PHFC* 35, 183-217 (1978).

Sites in East Hampshire

The part of Hampshire covered by this survey is the area south of Andover, as seen on Figure 2.1.

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Excavations at Southampton Castle John Oxley (ed.) Southampton City Museums, 1986.
"Excavations in medieval tenements on the Quilters Vault site in Southampton" J. S. H. Walker *PHFC* 35, 183-217 (1978).

15. Winchester

Numerous excavations since the war including major work on the Cathedral, Wolvesey Palace, Hyde Abbey, St. Mary's Abbey, many churches and tenements, some of which were industrial.

Many notes in *Med. Arch.* e.g. volumes 17, 18 and 26 (1973, 1974 and 1982).

Major published work in Winchester Excavations reports, particularly;

Winchester excavations 1949-60 Vol. 1 B. Cunliffe City of Winchester Museums and Libraries Committee, 1964.

Sites in South East Somerset

The area included is that part of Somerset south east of Glastonbury shown in Figure 2.1.

16. Bruton

Unpublished excavations have been carreid out by Kings School, Bruton, on the site of the Abbey and at Holywater Copse, Pitcombe. The location of the finds or records is unknown (Aston and Leech 1977).

17. Castle Cary

Nineteenth century excavations were carried out by Meade and J. H. Frances , and also by Rev. J. A. Bennett. These revealed the plan of the Norman keep and identified it as earlier than the southerly of the two earthworks to the east (Aston and Leech op. cit.)

18. Ilchester

From the 1940s to the 1960s much research and many excavations were undertaken by J. Stevens-Cox. More recently a number of excavations, in advance of construction, have been carried out and some have been published. Buildings and refuse deposits were found and the medeival pottery was studied by T. Pearson and is published in Leach (1982)

Ilchester excavations 1974-5, vol. 1 P. Leach, WAT 1982.

19. Langport

In 1969 two small excavations were cut across the probable line of the burh defences. Over 200 sherds were found, most of which were of 12th to 15th century date (Aston and Leech op. cit.).

20. Wincanton

Groups of medieval pottery from topsoil contexts, and field scatters, were found during work in advance of road construction.

The Wincanton Bypass Ann Ellison and T. Pearson, CRAAGS occ. paper no. 8 1981.

Sites in South Wiltshire

The area studied is shown on Figure 2.1

21. Downton

Trial excavations have revealed evidence of medieval structures south of the castle and at the site of the old hundred court meeting place, which probably relates to the headquarters of the Bishop of Winchester's manor of Downton.

"Saxon and medieval features at Downton" P. A. Rahtz, *WAM* 59 (1964), 124-9.

"Old Court Downton and the Moot earthworks" J. Musty, *WAM* 61 (1966), 99.

22. Old Sarum

Earlier excavations concentrated on elucidating the plan of the cathedral and castle. In the last thirty years, however, other work has identified the principal foci of civilian settlement as being outside the defended area, next to the East Gate and along The Portway.

"A pipe-line near Old Sarum - finds" J. Musty *WAM* 56 (1961), 179-191.

"Excavations at Old Sarum 1967" P. A. Rahtz and J. Musty *WAM* 57 (1962) 353-70.

"The suburbs of Old Sarum" P. A. Rahtz and J. Musty *WAM* 59 (1964), 130-154.

23. Salibury

In the 1970's a number of excavations were carried out by SMARG including those of a bell-foundry and a possible pottery kiln in Culver Street.

Med. Arch. 17 (1973).

More recently a number of excavations have been carreid out by the TWA revealing 13th-14th century buildings and pits.

Med. Arch. 29 (1985).

Med. Arch. 31 (1987).

24. Wilton

A few small excavations have been carried out in the medieval borough of Wilton. Published evidence of these is, however, rather brief. In the 1970s a number of prime sites were developed, without archaeological investigation, which was much lamented by archaeologists (Haslam 1976).

Excavations at sites in rural contexts

The data for this section are very comprehensive for the county of Dorset. For the other counties the literature search has not been totally exhaustive and there may be some omissions.

Sites in Dorset

1. Daw's Mill.

"Excavations at Daw's Mill." R. Hodges, *PDNHAS* vol 96 (1974). Site of medieval mill. Some pottery.

2. Old Vicarage, Fordington.

"Excavations at The Old Vicarage, Fordington, 1971." D.W.A. Startin, *PDNHAS* vol 103 (1981).

Site in suburb of Dorchester revealed ditches, rubble, walls and chalk spreads with associated medieval pottery. The site was above a Roman cemetery.

3. Hamworthy.

"Excavations at Hamworthy."(By Poole Museums.) K. Jarvis, *PDNHAS* vol 101 (1979). Three small trenches were dug. Thirteenth to fifteenth century ditches were found in one and pits of a similar date in another. Some pottery was recovered (K. Jarvis, pers. comm.)

4. Hermitage Kiln.

"A Thirteenth Century Kiln at Hermitage, Dorset. N.H. Field, *PDNHAS* vol 88 (1966).

Two kilns built back to back and of probable consecutive use were excavated. Sandy ware pottery and ridge-tiles of mid-late thirteenth century date were recovered. No other areas of the site were studied, although surface scatters suggested ceramics were produced in the sixteenth century as well (Field, 1966).

5. Holworth DMV.

"Holworth medieval village excavation." P.A. Rahtz, *PDNHAS* vol 81 (1959).

Excavation of house platforms and associated enclosures revealed rubble-built stuctures and large amounts of pottery of twelfth to fifteenth century date.

6. Manor Farm, Kington Magna.

"Kington Magna, A Parish Survey." M.S. Ross, *PDNHAS* vol 10 (1985)."Recent work by Shaftesbury and District Archaeological Society 1980-1983'.

A trial trench next to the church and medieval royal manor farm revealed few features but over 2,000 sherds of medieval pottery.

7. Lodge Farm, Pamphill.

Excavations were carried out by the National Trust in 1986 and 1987 on the site of this moated manor on the Kingston Lacey Estate. Evidence of occupation from the thirteenth century onwards was revealed (M. Papworth, pers comm).

8. Portland, St. Andrews Old Church.

"A study of medieval pottery from Portland St. Andrews, Dorset." J.S. Burrows, unpublished dissertation, DIHE, 1986.

Excavations on the site of this ruined parish church were carried out by DIHE between 1978 and 1982. Evidence for a pre-twelfth century stucture was found, and twelfth century phases in the existing building were identified. Well stratified twelfth century pottery was found along with residual material from later in the medieval period.

9. Milton (formerly in Hants.).

"Excavations of two moated sites: Milton, Hampshire, and Ashwell, Hertfordshire." D. Gillian Hurst and John G. Hurst, *Journal of the British Archaeological Association* vol 30 (1967).

An early fourteenth century moated site was excavated on the site of three late Saxon and early medeival timber enclosures. Six pottery types were found. Three were of 11th to 12th century date, two of 13th or 14th century date, and one of 14th to 15th century date.

10. Oakley Down.

"A medieval site at Long Ground, Oakley Down, Wimborne St. Giles." J. Poulsen, *PDNHAS* vol 106 (1984).

Trial trenches in the early 1950s revealed flint and sandstone wall foundations and thirteenth century pottery.

11. Owermoigne DMV.

In *Medieval Village Research Group Report No. 20/21* C.Dyer (ed.), 1974.

Excavations were carried out on this DMV and moated site complex in the early1970,s. Evidence for stone-built and wooden structures was found along with refuse material and late-medieval to post-medieval pottery.

12. Radipole Church and Village.

Two rescue excavations have been carried out in Radipole by DIHE.

St. Anns Church,1986. Pottery of twelfth to fourteenth entury date was discovered along with much architectural material.

Radipole DMV,1987. Rescue work in advance of road widening revealed evidence for structures on house platforms and pottery of medieval date.

13. Parish Church, Sydling St. Nicholas.

"Excavations in the naive of the parish church of Sydling St. Nicholas, Dorset." A.H. Graham, *PDNHAS* vol104 (1982).

Excavations under the floor of the church revealed earlier structural features and a pit containing bell-founding refuse of the thirteenth century.

14. West Stafford.

"A group of thirteenth century pottery from West Stafford, Dorset." J. Draper, *PDNHAS* vol 98 (1976).

Medieval pits produced thirteenth century pottery.

15. Woolcombe Farm.

"Excavations on a medieval settlement at Woolcombe Farm, Toller Porcorum 1966-1969." J. Poulsen, *PDNHAS* vol 105 (1983).

"Woolcombe Farm." A. Hunt, *PDNHAS* vol 106 (1984).

"Woolcombe Farm." A. Hunt, *PDNHAS* vol 107 (1985).

"Woolcombe Farm." A. Hunt, *PDNHAS* vol 108 (1986).

Excavations were carried out on the deserted medieval settlement at Woolcombe during the 1960s by the late G. Rybot. Pottery from these excavations was published by J. Poulsen in 1983. More recent excavations by DIHE have produced more material which has been studied in detail by the author. Medieval pottery from both excavations dates from the early twelfth to early fourteenth centuries.

Sites in East Hampshire

16. Foxcotte (SU345473)

Med. Arch. 24 (1980).

Habitation and agricultural structures of 10th to 19th centuries.

17. Wickham, Glebe (SU576114)

Med. Arch. 22 (1978).

Excavations on the site of a moated manor house. Development from 12th century aisled hall through to 16th century. 14th century 'Boarhunt type' fabrics and imports.

Sites in South East Somerset

18. Burrow Mump

"Excavations at Burrow Mump, Somerset 1939" H. St. G. Gray *PSANHS* 85, 95-133 (1939).

Fortification with chapel of probable 12th century date. Continued in use into 14th century.

19. Castle Neroche

"Castle Neroche, an abandoned Norman fortress in south Somerset" Brian K. Davison *PSANHS* 116, 16-58 (1972).

Norman fortress, initiated in late 11th century and occupied until 13th. Pottery in local and French styles. Probable that 'French pottery' was made locally by French potters, rather than imported.

20. Donyatt

Excavations in the Donyatt Potteries R. Coleman-Smith and T. Pearson, 1988.

Rural pottery industry in Forest of Neroche. Excavations of medieval and post medieval kilns. One 13th century clamp kiln and 14th century wasters in a gulley.

21. Huish Episcopi

"Romano-British and medieval settlement at Wearne, Huish Episcopi *PSANHS* 120, 45-50 (1976).

22. Stavordale Priory (ST732320)

Med. Arch. 27 (1983).

Excavations were carried out on the priory church and the fishponds in 1982.

23. Stoke sub-Hamdon Castle ST(476178)

"Excavations at Stoke sub-Hamdon Castle, Somerset", 1976 P.J. Leach *PSANHS* 124, 61-76 (1980).

Sites in South Wiltshire

24. Clarendon Palace

"Clarendon Palace" Tancred Borenius and J. Charlton *Antiquaries Journal* 16 (1936).

Clarendon Palace. The history and archaeology of a medieval palace and hunting lodge near Salisbury, Wiltshire. James T. B., and Robinson A. M., Res. Rep. Comm. Soc. Antiq., London 1988.

Large-scale excavations of much of this medieval royal palace were undertaken in the 1920s and 1930s. As well as the palace itself, a kiln was discovered which produced decorated floor tiles. In the 1960s a further small-scale excavation was undertaken to provide ceramics for comparison with Laverstock products.

25. Gomeldon

"Excavations at the deserted medieval vilage of Gomeldon, near Salisbury" D. Algar and J. Musty *WANHM* 80, 127-169 (1986).

Excavations of houses and enclosures at the deserted medieval village of Gomeldon were carried out in the 1960s. Much Laverstock-type pottery, both coarse wares and fine wares, was found.

26. Laverstock

"The medieval pottery kilns at Laverstock, near Salisbury, Wiltshire" J. Musty, D. Algar and P. Ewence *Archaeologia* 102, 83-147 (1969).

Eight pottery kilns, seventeen pits and three associated buildings were excavated in the late 1950s. The collection, held in store at Salisbury and South Wilts Museum, contains material from two more kilns as well, presumably excavated at a later date. The industry produced coarse wares and fine decorated wares. It was dated by the excavators to the period 1230-1275.

Other collections of medieval pottery from Dorset

Besides the excavated material there are a number of other collections of medieval pottery recorded as being found in Dorset. These collections range in size from several sherds, up to several hundred sherds. Because some rural areas of the county had seen little or no excavation of medieval material, it was decided that all published references to these smaller collections woud be recorded, and their provenance located. Thus in areas where no sites, or only certain classes of site, have been excavated, the gap in information could be filled by studying material derived from fieldwalking, builders trenches or watching briefs. Those collections that were recorded in the *Proceedings of the Dorset Natural History and Archaeological Society* are listed below, along with a number of collections held at the Dorset Institute. There are, of course, other collections for which no published record exists, a number of which are stored in the Dorset County Museum (DCM). These include many sites discovered during the compiling of the Dorset volumes of the Royal Commission For Historic Monuments Survey. The notebooks of the survey teams are also available at DCM for study. It has been noted recently by the author that about a dozen collections of this type from parishes in central and east Dorset, particularly from around the Winterborne Valley, are kept in DCM. These may well prove to be useful in filling gaps in collections from the eastern end of the chalk downlands.

List of small collections kept at DIHE, or noted in the *PDNHAS*.
Numbers refer to those on Figure 2.3.

1. Portesham. SY 64358423.
   Surface finds from a rural enclosure.
   PDNHAS vol 94 (1972).

2. Frome Whitfield, Stinsford. SY6917913
   Surface Finds.
   PDNHAS vol 96 (1974).

3. Toller Porcorum. SY563980.
   Sewage pipe trench in village.
   PDNHAS vol 97 (1975).

4. Darknoll Farm, Okeford Fitzpaine. ST799118.
   Surface finds from DMV.
   PDNHAS vol 97 (1975).

5. Lorton Farm, Broadwey. SY666835.
   Builders trench revealed medieval pits.
   PDNHAS vol 101 (1979).

6. Whitcombe. SY717882.
   Fieldwalking on DMV.
   Stored at DIHE (unpublished).

7. Poxwell. SY742842.
   Rescue excavation and surface finds on DMV.
   Stored at DIHE (unpublished).

8. Radipole. SY668812.
   Builders trenches and limited excavation at church and DMV.
   Stored at DIHE (unpublished).

9. Chickerell. SY645807.
   Builders trench.
   PDNHAS vol 76 (1954).

10. Southwell, Portland. SY68607006.
    Builders trench.
    PDNHAS vol 84 (1962).

11. Fifehead Magdelene. ST782216.
    Fieldwalking.
    PDNHAS vol 107 (1985).

12. Charminster. SY66679545.

Surface finds from DMV.

PDNHAS vol 103 (1981).

13. West Bexington. SY534868.

Surface finds and trial trenching on DMV.

PDNHAS vol 106 (1984). Finds kept at DIHE.

14. Gussage St. Andrew. ST976144.

Surface Finds.

PDNHAS vol 106 (1984).

15. Nallers Farm, Askerswell. SY543927.

Builders trench revealed medieval pottery and walls.

PDNHAS vol 106 (1984).

16. Quarleston, Winterborne Stickland. ST837041.

Surface finds (garden soil).

PDNHAS vol 77 (1955).

17. Yondover, Loders. SY499939.

Builders trench revealed medieval pits and buildings.

PDNHAS vol 78 (1956).

18. The New Rectory, Litton Cheney. SY55209077.

Builders trench.

PDNHAS vol 78 (1956).

19. Southover, Frampton. SY617950.

Pipe trench through shrunken MV.

PDNHAS vol 78 (1956).

20. Blashenwell, Corfe Castle. SY95078030.
Builders trench.
PDNHAS vol 82 (1960).

21. Osmington. SY728826.
Surface finds.
PDNHAS vol 84 (1962).

22. Higher Loop Farm, Lytchett Matravers. SY945955.
Trial pits in DMV.
PDNHAS vol 86 (1964).

23. South Eggardon Farm, Askerswell. SY536937.
Surface finds from deserted medieval farmstead.
PDNHAS vol 87 (1965).

24. Compton Valence. SY582943.
Surface finds from deserted medieval farmstead.
PDNHAS vol 87 (1965).

25. Modbury, Swyre. SY51558981.
Pipe trench through deserted medieval hamlet.
PDNHAS vol 87 (1965).

26. Frampton. SY63309482.
Surface finds (garden soil).
PDNHAS vol 87 (1965).

27. West Burton, Winfrith Newburgh. SY824858.
Surface finds from DMV.
PDNHAS vol 88 (1966).

2.4 Natural Regions within the study area

The area covered by this study contains a varied set of differing topographical, geographical and geological regions. The patterns and types of settlements found in any one place will be greatly influenced by these environmental factors and may well be subject to differing economic and social constraints deriving from this. For example, the pattern of low-status agricultural settlements would be expected to be different on the poor soil of an upland area to the pattern found on the good quality soil of a lowland plain. The latter could exhibit an even spread of nucleated village settlements exploiting small areas of good land, whilst the former pattern may be much less regular and show much less nucleation, with individual farmsteads tied to pockets of good land in valleys.

This simplistic example highlights one or two aspects of settlement form and distribution dictated by natural environmental factors. Obviously on a micro-regional scale potentially unique factors could be identified for the siting of every farmstead and for the distribution of settlements in every valley. Such detailed work is impossibly time consuming to consider tackling here, but the more important aspects of settlement geography must not be ignored and so a limited approach has been formulated. This is based on the identification of 'natural regions' within the study area, each of which contains a vaguely homogeneous set of geological, topographical and ecological types within its bounds. It is hoped that this scheme divides the medieval settlement of the region into a set of meaningful units that exhibit contrasting patterns and types of site.

The 'natural regions' that were defined can be seen on Figure 2.5. These were originally independently derived, but as the work progressed similar division exercises appeared in the literature. The earliest scheme of this type located is that devised by Tavener in his study of land classification in Dorset (Tavener 1937). A similar, but more wide-ranging, classification was devised by Birch (1981). The scheme devised here is similar to both these earlier attempts, but an independent description of the divisions has been included as it was felt that some justification of them was still necessary. The data used were mainly those of geology, topography and land-use capability, but additional information concerning soil type and bioclimatic zone was also considered. The relationship of these zones to the base geology can be seen by comparing Figure 2.5 with Figure 2.6 which identifies the solid geological succession for most of Wessex.

Geology

Broad periods were used, often representative of many different strata. It must be stressed, however, that a varied set of soil types exists within the area of each underlying geological group. Despite this, the broad periods that were used for identification are still valid divisions, the regions they encompass indicating general land potential and areas of differing natural vegetation.

Topography

This is mostly described as average height above sea level. Where varied upland and lowland areas exist within regions, the subdivisions are identified.

Land-use capability

This is based on data from the Soil Survey for Great Britain. The broad levels of capability described in this information have been given numbers from one to six, indicating decreasing land capability and increasing soil fragility with increasing number. The study area actually only possesses land in categories two to four.

Natural Regions

1. **The East Dorset Heath and The New Forest**
   a. Geology: Paleogene.
   b. Topography: Mostly below 200 feet, except for parts of the New Forest and area furthest inland. Most of the eastern part is very flat.
   c. Land-use capability. Moderately severe limitations requiring very careful management; level 4.

2. The Central Chalk Downs

a. Geology: Cretaceous, chalk, greensands and gault.

b. Topography: Mostly above 200 feet, rising to c.900 feet on the high downs, which are orientated linearly as a dip slope facing south-east. The river valleys of the Stour and its tributaries repesents the only major part of the region below 200 feet.

c. Land-use capability: Moderate limitations requiring careful management; level 3.

3. Purbeck and Portland

a. Geology: Upper Jurassic, Purbeck and Portland Beds.

b. Topography: In the east the Purbeck Ridge rises to c.600 feet, on an approximate E/W orientation. Portland is similarly high (c.400 feet) with only the plain south of Dorchester being lowland in character.

c. Land-Use capability: Level 3.

4. The Blackmore Vale

a. Geology: Upper to Middle Jurassic. Oolitic limestones, corallian, Oxford and Kimmeridge clays, Purbeck and Portland beds.

b. Topography: Land rises from below 200 feet in the valleys of the Stour and its tributaries, up to 500 feet on the downs around the 'bowl' of the vale.

c. Land-use capability: Level 4 on downs, level 3 in valley.

5. Coastal vales and downs

a. Geology: Plains; Liassic, clays, marls and Bridport and Yeovil sands. Downs; Cretaceous, Chalk and Greensand.

b. Topography: Plains below 200 feet and generally flat. Downs rise to a maximum of c.900 feet.

c. Land-use capability: Level 2 (minor limitations) on plains and 4 on downs.

6. The Blackdown Hills

a. Geology: Cretaceous, Upper Greensand.
b. Topography: 200 to 1000 feet.
c. Land-use capability: Level 3.

7. The Central Somerset Plain

a. Geology: Plain; Liassic. South-eastern littoral; Middle Jurassic.
b. Topography: Plain; below 200 feet and mostly flat. Littoral; up to 400 feet.
c. Land-use capabilities: A gradual increase in land quality from the Somerset Levels in the centre of the plain (2), up to the hills of the south-eastern littoral (4).

8. Salisbury Plain and The Vale of Wardour

a. Geology: Cretaceous, Chalk.
b. Topography: The valleys of the Avon and Test and their tributaries are often under 200 feet. The downs rise to as much as 1000 feet around the edges of the plain.
c. Land-use capability: 3 on plain, 4 on high ground.

Conclusions

Factors such as modern fertilisers and ploughing methods allow significant output to be gained from soils that might have been perceived as poor, or worthless, in earlier periods. Also, the changes in soil content brought about by centuries of cultivation sometimes create difficulty in establishing the past value of particular areas of land. Despite this, it is felt that the soils classification information is of some worth when considering the potential for agricultural production since the introduction of the oxen-drawn plough, provided that only broad conclusions are drawn.

The areas of best land seem to be, a. The coastal plains of the West, b. The south-eastern littoral of the Central Somerset Plain. The poorest land is on the Dorset heath and in the New Forest, and also, surprisingly, in the Blackmore

Vale. This latter is slighly misleading as the soils of this area are very fertile in the valley bottoms, although poor on much of the surrounding high ground. Other poor, fragile, soils can be found on the high downs in the west of Dorset and also in the Somerset levels on the edge of the study area. The rest of the land has good or average soils,decreasing in quality with increasing height above sea level.

Regional differences in urban site size and distribution

Table 2.2 shows the number of urban sites of each category defined in Figure 2.1, present in each 'natural region'. There are some obvious differences in site size and density between, and within, regions. The suggested reasons for this inter, and intra,-regional variation are outlined below. Due to variations in geographical size between the various regions the raw figures of 'numbers of centres per region' can be quite misleading. To account for this variation, the eight regions have been split into three size groups.

Large natural regions; 1,2 and 8

All three are of a similar order of size and contain ten, six and ten urban centres respectively. Region 2 is the Dorset chalk downs and the lesser number of centres, their comparative isolation, and their moderate size are probably accounted for by a thinner population across this partly upland area. A similar distribution of group 2 centres can be seen across the chalk of Salisbury plain in region 8, probably resulting from a similar topography and base geology. The reason why more centres exist in region 8 than in region 2 is probably a result of the slightly denser clustering of towns on the southern fringe of region 8, in the wider, more fertile valleys between Wilton and Winchester. The distribution of towns in region 1 can be split into two. In Dorset a number of larger towns developed on the more open land, gaining increased status through a role as coastal ports. In the New Forest, however, a lack of agricultural land and a lack of the rights to carry out such practices, meant a smaller, and probably poorer, population. This consequently resulted in smaller, lower status, market centres. The exception was Lymington which gained increased activity through its role as a port. Southampton is also located in this area, although not particularly near the forest. It was, of course, particularly wealthy, a port of international standing, and well situated with access to the sea, rivers and roads, enabling the town to supply luxury commodities to other towns in the region and particularly to the City and Royal Palace at Winchester.

Medium-sized regions; 4 and 7

Both these regions exhibit a dense cluster of urban settlements, taking advantage of the better soils. In the Blackmore Vale the urban centres are mostly situated in the valley bottoms close to the heavier clay soils. Shaftesbury is an exception, its elevated situation being determined by defensive considerations in earlier centuries. The towns of the Central Somerset Plain are mostly situated on the low hills around the edges of the flat land. They tend to be small and are closely packed, following the best soils and dryer ground along the south east edge of the plain. The distribution of towns thins out near to the Somerset Levels in the centre of the plain, and also as soon as the surrounding chalk regions are reached.

Small regions; 3, 5 and 6

The density of sites in these three regions is roughly similar. Not a great deal can be said about general trends due to the small number of sites. Furthermore, only a small portion of region 6 is represented here, making generalisations pointless. The towns of region 5 are obviously situated in the fertile plains, as opposed to on the downs. The proximity of the coastline also contributes to town locations here offering scope for roles as ports, so long as supply routes through the higher ground inland are available. The siting of the two towns of region 6 probably echoes the factors dictating location in region 7.

2.5 Collections chosen for study

Urban contexts

From Tables 2.2 and 2.3 it is apparent that of all the 'natural regions' only 6, the Blackdown Hills, has experienced no excavation in urban contexts. This region is, however, only partly represented in the study area, the main body being further west in Devon. Regions 4 (the Blackmore Vale) and 5 (coastal vales and downs) have the next least urban excavation coverage, but the former still manages three out of seven urban sites with some form of excavation. The latter, however, is very poorly covered, the only excavation being one of little pottery and no features at the Glebe, Bridport (Bailey 1976). There is obviously scope for much more work in this town, as well as others nearby. Region 3 (Purbeck and Portland), although apparently having excavations at two of its three urban centres, is again not well studied. All the excavations in Corfe have been on the castle site itself and the work at Abbotsbury was on the abbey church and mill, and not actually in the town proper. This problem is not confined to this region only, Table 2.4 shows the rather poor coverage that many areas have if only excavations on the main body of the town, as opposed to those in castles and monasteries, are counted. Only regions 1 and 8 (both with excavations in five out of ten centres) manage fifty per cent coverage. In total, out of fifty one urban centres in the whole study area, only seventeen have experienced excavations of any form on the main economic body of the town.

Despite such a poor data set, some form of sampling of this sample was still necessary when considering which collections to study as part of this project. This was because if all the sites were studied, when all site types had been taken into account, the total would have been something like sixty-five sites to sample; an estimated six to seven years work. Thus it was decided that only material fom excavations in the following thirteenth century urban centres would be studied:

Region 1. Wareham, Wimborne, Poole, Christchurch, Southampton.
Region 4. Shaftesbury.
Region 5. Bridport.
Region 7. Ilchester.
Region 8. Old Sarum, Salisbury, Winchester.

The reasons why a degree of duplication of this site type occurred in region 1 are as follows. Firstly, it is a large region and it includes fifty per cent of the coastline with five of the nine ports in the study area. Christchurch, Poole and Wareham were included as much for their roles as differing status ports as for their being urban centres. Southampton was included as the premier port, but also because;

a). Laverstock ware is known from excavations at Southampton (Brown 1986).
b). It represents one of the very few centres within the study area that lie east of the Laverstock kilns, and may have been supplied by them. There is a need for some study in this area to compare and contrast with the distributions identified west of this kiln site.

For the same reason as b) above, Winchester has been included in the study. It is also included because of its importance as a royal centre, and because the royal household is known to have ordered ceramics from Laverstock, to be used at the palace at Winchester (Le Patourel, in Musty, Algar and Ewance 1969, 83).

Wimborne was included as a centre for study because it lies on the border between regions 1 and 2, and between, but slightly south of, the two kiln sites. As no material from normal urban contexts is available for study from region 2, it was thought that the Wimborne collection could be used partly to fill this gap.

To fill other geographical gaps in material from urban contexts, it was decided that material from monastic areas and castles that lay within towns would be studied as well. Thus the following sites were included in the study.

Region 2. Dorchester Prison (site of castle) and Milton Abbas Abbey.
Region 3. Corfe Castle.
Region 4. Sherborne Old Castle.

In this way coverage in urban centres can be extended across Dorset. It is appreciated that there are potential errors in comparing this material with material from 'true urban contexts', without regard for the possible different economic modes and networks by which ceramics were distributed to these sites. In the case of the three royal castles that were listed, we can identify these as an extra sub-group of sites, within all those from urban contexts, which may prove to possess some intra-group similarities concerning ceramic assemblage. Any such difference would be expected to be a result of the inherent royal connections of this group.

For the purposes of this study material from monastic centres will not be considered, except where no alternative collection is available in the immediate geographical area. Thus only material from Milton Abbey will be sampled. It is interesting to note (Table 2.5) that, within the region, only one excavation has been carried out on a monastic site in a rural context, and that does not seem to have been very extensive. Furthermore, no major excavation of a monastic complex has been carried out on any site that lies between Glastonbury, in the north west, and Romsey, in the south east.

Excavations on the site of castles in urban contexts have generally been much more frequent and extensive. No rural castle, however, has been excavated in the study region, except for Castle Neroche on the Blackdown Hills, which was abandoned by the early thirteenth century anyway (Davison 1972). Some work has been carried out at smaller late-medieval moated sites, e.g. Owermoigne and Lodge Farm, but these are really a completely different class of settlement to the large baronial strongholds of the twelfth and thirteenth centuries. Scope exists here for future research excavation policy, but the need is probably not as important as that for a good, extensive excavation of a monastic complex.

Excavations in rural contexts producing medieval pottery

Excavations producing medieval pottery from rural contexts in each natural region are as follows:

Region 1. Hamworthy, Foxcotte, Laverstock, Milton, Wickham Glebe.
Region 2. Daws' Mill, Fordington, Lodge Farm, Oakley Down, Owermoigne, Sydling St. Nicholas, West Stafford, Woolcombe Farm.
Region 3. Holworth, Portland St. Andrews, Radipole St. Ann, Radipole Village.
Region 4. Hermitage, Kington Magna.
Region 5. Seaton.
Region 6. Castle Neroche.
Region 7. Burrow Mump, Huish Episcopi, Stavordale, Stoke sub Hamdon.
Region 8. Clarendon Palace, Gomeldon.

There are obvious gaps in the geographical coverage of these collections, in fact, everywhere outside regions 2, 3 and 7 is poorly covered. This may be due to the data for some areas outside Dorset being incomplete. Even in Dorset however, regions 4 and 5 only possess one excavated rural site between them, this being at Kington Magna. There are many sites excavated on the central Dorset chalklands, a contrast to the picture for urban centres in this area. The exact opposite situation exists for east Dorset where the excellent urban collections are backed up by only two small rural excavations at Hamworthy and Milton. The heathlands of central and west Hampshire are almost totally devoid of excavated medieval pottery, a situation that exists for rural and urban sites alike. In the north of the study area rural sites are again thin on the ground, but the Kington Magna, Gomeldon and Oakley Down material still consitutes a useful, if somewhat minimal, data set when added to that from the urban sites.

To fill other gaps in the geographical coverage of rural sites, a study was made of additional collections of medieval pottery not derived from excavations. It was decided that, where no alternative excavated material exists, these groups of sherds derived from fieldwalking and chance finds could be utilised instead. It is appreciated by the author that such collections are very different in nature to well-stratified and well-recorded excavated groups. It was felt, however, that they still offered a useful source of data, so long as the collections were above fifty sherds in size and their total extent was kept for study. In this way some statistical validity could be placed upon the relative numbers of different fabric types identified, although it still would not necessarily mean that direct comparisons could be made between these numbers and those for excavated collections. This is because of fundamental differences between the nature of the total ploughzone assemblage, and assemblages from excavated features (Haselgrove 1985).

The total published groups plus those kept at the DIHE were listed in 2.3 and can be seen on Figure 2.4. Those selected for study are shown on Figure 2.7, along with the excavated material. Five collections from Region 2 are included. This is partly because some of this material (Whitcombe and Poxwell) was easily available for study, and partly because of the lack of excavated collections in the area north east of the Hermitage kiln. The complete set of collections from rural contexts chosen for study is listed below. The lack of material from regions 6 and 7 is regrettable, but necessary to keep the length of the project within the time allowed.

Collections of medieval pottery chosen for study; rural contexts:
Region 1. Alderholt, East Holme and Horton kilns, Hamworthy, Laverstock, Milton and West Grimstead.
Region 2. Compton Valence, Oakley Down, Quarleston, Whitcombe, Woolcombe Farm, Winterborne Houghton.
Region 3. Chickerell, Holworth, Portland St. Andrews, Portland Southwell, Poxwell.
Region 4. Hermitage, Kington Magna.
Region 5. Yondover.
Region 7. Donyatt.
Region 8. Clarendon Palace, Gomeldon.

2.6 The actual sherds studied and the assemblages they derive from

The main body of samples that were analysed derived from eighteen excavated and four surface collections, from locations as described below. These sites included two, Southampton and West Grimstead, from which wasters were also studied. These sherds are described in Chapter1 alongside the material from identified kiln sites. To differentiate non-waster material from these 22 collections from 'in situ' kiln products, these sites will be known as 'settlement' sites, as opposed to 'kiln sites'. The term 'settlement' is, perhaps, not universally applicable to all the sites these collections originate from, but a more fitting term does not seem to be available. Thus a 'settlement site' in this text is a site from which sherd samples have been analysed which is not identifiable as an actual kiln. The sherds that were analysed from the 22 settlement sites are described below. Included with this brief classification is any information available, either through study of the published reports, or through calculations made on the sherds themselves, regarding the make-up of the individual site assemblages.

The sherds from all of these sites have been classified into a series of broad ware types, as described in section1.7. The classes that were used are shown in Table 1.4. Some further ware types, or sub-types, were added to this list at a later date. These include the so-called scratch-marked wares (decorative variations of wares C1 and C2), Surrey-type white ware (A later variation on ware F4) and Poole red-painted and applied-strip wares (decorative variations of ware C1).

For all samples from all sites information was recorded concerning the form and fabric classifications that the sherd/vessel conformed with. The classification systems that were used were outlined in Chapter 1. Each sherd is identified by a case number, a site sample number and codes for ware type and form category. The list of these codings, which were devised for use with the multivariate statistical package **SPSSX**, can be found in the appendices, along with the measured concentrations of the four elements used in the main analytical study.

With each site, attempts have been made to place the wares identified into a numerical description of the medieval ceramic assemblage for that site. Such a task is made extremely difficult by the varied nature of the collections and the available pottery reports. The sites studied here include fieldwalking scatters, evaluation trenches, demolition clearance work and small and large scale excavations of both a rescue and research nature. The site pottery reports range from the non-existent to complete monographs. Attempts have been made to define an 'assemblage' for each site. This is simply a table giving percentage occurrences for the ware types, as defined in Table 1.2, calculated through sherd numbers.

There are great inconsistencies, between the contextual information available for material from many of the sites, and thus some assemblages, as defined here, are tighter, in terms of date-range and level of contextual contamination, than others. In many cases only selected contexts have been used to define the site assemblage. There are two reasons for this. Firstly, many collections were too large to consider properly in the time available. Secondly, many trenches, or contexts, were identified as being of limited use due to 'out of range' dates for much of the pottery, or high levels of contamination or confusion. An assemblage based on six uncontaminated thirteenth century contexts must undoubtedly be of more use than one based on a dozen contexts of mixed, or uncertain, date.

At worst some of the assemblages as defined in Tables 2.7 to 2.26 indicate one or two dominant medieval wares in a composite collection reflecting, maybe two and a half centuries of ceramic use. At best all the major, and most of the minor, wares used at a site in the periods 1150 to 1250, 1250 to 1350, and 1350 to 1500 can be identified, along with a quantification of each ware's presence in each period. For most of the sites discussed here the situation is not very like either of these extremes, with particular strengths and weaknesses in the available information concerning each collection. Exceptions to this include the fieldwalking collections, which are generally too small to provide meaningful statistics, and the Woolcombe collection, which is large, well-recorded and fully available for the author to work on at all times.

The method used to calculate the percentage occurrences of wares in assemblages is based purely on the number of sherds of each particular type. This was chosen as the method for calculation because it is the simplest and quickest method available. Some of the material studied was not removed from museum storage to the laboratory, usually because of restrictions on the movement of collections, and so calculations had to be made within limited time, and with limited facilities at the place of storage. Thus difficulties arose in weighing sherds and calculating minimum or maximum numbers of vessels from rim fragments. To do this accurately would have been incredibly time-consuming with the larger collections. Furthermore many collections were too small to provide meaningful, or statistically useful, results based on calculations of this type. Therefore, the simplest and quickest method was adopted, enabling similar types of data to be calculated for all sites and allowing the work to proceed at a reasonable pace. In many cases, especially with the larger collections, specific well-dated and secure contexts were chosen as the basis for these calculations, with other potentially contaminated contexts being ignored.

It is probable that, given the method of counting adopted and the problems of differing sample size and reliability, these calculations were not always very accurate. This was not perceived to be a problem, however, as all that was required were broad indications as to the common and uncommon wares present on each site at one or two notional temporal points. The data could therefore be of use, provided its poor quality was acknowledged.

Christchurch

A total of thirty sherds from excavations in Christchurch were chosen for analysis. They derived from three sites, W8, W9 and W10 (Davies 1983).

Site W8 was a trench of approximately 10m X 20m. The medieval features included 65 post-holes of probable 12th or 13th century date, four roughly contemporary gullies, which may have been property boundary markers, and two pit complexes. One of these latter, one (365 & 368) contained small amounts of 11th to 12th century pottery, the other (124, 246, 247, 248) was of a late 13th century to early 14th century date and contained larger amounts of pottery.

Site W9 was intended to identify the limits of a previously excavated 7th to 8th century pagan Saxon cemetery (Jarvis 1983). It was elongated in shape (3m X 20m), and was located outside the presumed line of the Saxon burh defences. A number of medieval ditches of 12th to 13th century date (89, 105, 135, 157) and of 13th to 14th century date (136) were found.

Site W10 was excavated in order to explore the possibility of defences on the east side of the burh. A long series of linear defensive structures were identified, the last episode of this sequence being 13th century activity.

All the 12th to 14th century pottery excavated from these sites can be seen in Table 2.7 (Davies unpub., with alterations). It is obvious that in this assemblage ware C1 (fabric 5) is the dominant type, with Poole-type decorated sherds (C1 and F4) and ware S4/C2 sherds also present. A few imported fine ware sherds were identified in the site report and, although these actual sherds were not specifically marked in the excavated collection, it is unlikely that any of these were sampled.

The sherds analysed were as follows:

CH1 to CH5	cooking pots of ware C1 with scratch-marked decoration.
CH6 to CH10	jugs or tripod pitchers of ware C1 with glaze.

CH11 to CH17	jugs of ware F1 with glaze.
CH18 to CH20	jugs of ware F4 with glaze.
CH21 to CH30	cooking pots of ware C1.

Compton Valence

Material collected as a field scatter after rotavation of part of a deserted medieval farmstead was described by Radley (1965). In publication two fabrics were described, a sandy ware and a flinty ware. The collection held at DCM fits this description, although the presence of an extra 44 sherds suggests that not all the material collected was described. The flinty ware (S4/C2) constitutes 204 sherds whilst the sandy ware (S1) constitutes 138 sherds. The former has been dated to the late 12th to late 13th century at Woolcombe (Spoerry unpub.), whilst the latter is of 13th or early 14th century date. Table 2.8 indicates the breakdown of the assemblage.

Twenty sandy ware (S1) sherds were sampled and analysed. their form groups were:

CV1 to CV16	cooking pots of ware S1.
CV17	bowl rim of ware S1.
CV18	jug handle of ware S1.
CV19	jug spout of ware S1.
CV20	cooking pot of ware S1.

Corfe Castle

Thirty sherds from recent National Trust excavations in the bailey of Corfe Castle were analysed. The pottery report for this material was compiled by Miss Nancy Grace (unpub.). In her report Grace identifies many fabric types, three of which have been sampled here. Most of the others are of post-medieval date. The medieval pottery is mostly unstratified, resulting from the civil war demolition of parts of the castle. Despite this it is a fairly simple task to separate the medieval sherds from the rest. The coarse wares are mostly of one fabric type that corresponds to ware C1, although many sherds are of a rather lighter colouration than is normal for this ware at, for example, Laverstock. The medieval fine wares are in two fabric types, CCFa and CCFb. These are both white fabrics and therefore correspond to ware F4. All this material is externally coated with an apple-green glaze and many sherds exhibit applied strips and pellets. This material can be dated to the late 13th or early 14th centuries.

The make-up of the assemblage, based on all the medieval sherds derived from the various disturbed contexts, can be seen in Table 2.9. It is apparent that the glazed and unglazed versions of ware C1 are dominant in the collection, with almost 84% of the assemblage being contributed by this ware type. The fact that half of this material is glazed may also be significant, illustrating a marked contrast with the portion of glazed material in assemblages from rural sites (e.g. Holworth and Woolcombe). It is also significant that ware F4 material is present as almost 5% of the collection, illustrating this type's dominance in the fine ware, although not the glazed ware, assemblage at the site. The indications are that, despite the readily available glazed ware C1 material, there was still a market for finer pottery in similar jug and pitcher forms at Corfe Castle.

The sherds that were analysed were as follows:

CC1 to CC15	white-bodied jugs of ware F4.
CC16 to CC22	cooking pots of ware C1.
CC23	jug of ware C1.
CC24 to CC30	coking pot of ware C1.

It is possible that not all this material is of one small date-range, bearing in mind the disturbed contexts it derives from. Despite this the coarse ware sherds, although possibly deriving from the 12th century, could also all date to the late 13th century. This would make these sherds potentially contemporary with the fine ware and would thus provide a tightly dated group after all. This is unprovable though, and so these data must be used with caution until better dating evidence becomes available.

Dorchester Prison

Thirty sherds were analysed from excavations in 1975 at Dorchester Prison, the site of the medieval castle (Draper and Chaplin 1982).

Twenty sherds of sandy ware (S1) were analysed. These derived from both cooking pots and jugs and included hard-fired and soft-fired material. The former is possibly later in date than the latter, although this suggestion is only based on the forms of a few sherds. This ware represents Draper's fabric 'group a' (Draper and Chaplin *op. cit.*, 85).

The quartz-gritted coarse ware pottery was all deemed to be of ware C1. One of the sherds was, however, of a lighter hue, reminiscent of material from Corfe Castle and Poole.

The material used here derived from contexts in Ditch 1 and Ditch 2 of Trenches 10 and 11. Draper states that there is no 'fabric a' in Ditch 2, it being replaced by a slightly finer, lighter-coloured quartz-gritted fabric. I am inclined to disagree here as, using my own identification, the range of quartz-gritted sherds seems to be similar for both ditches. Therefore in Table 2.10, in defining the assemblage from this site, the material from both trenches has been placed within one set of ware classes. This table perhaps indicates the dominance of the sandy ware, but also shows how the non-fineware assemblage on this site is not a simple case of one local product.

The sherds chosen for analysis were as follows:

DP1	cooking pot in ware S1.
DP2	jug in ware S1.
DP2 & DP3	glazed jugs in ware S1.
DP5 to DP8	cooking pots in ware S1.
DP9	jar in ware S1.
DP10 & DP11	cooking pots in ware S1.
DP12 & DP13	glazed jugs in ware S1.

DP14 to DP19	cooking pots in ware S1.
DP20	glazed jug in ware S1.
DP21 to DP25	glazed jugs in ware C1.
DP26	cooking pot in ware C1.
DP27	glazed jug in ware C1.
DP28	jug in ware C1.
DP29 & DP30	cooking pots in ware C1.

Holworth

Excavations were carried out on the deserted medieval settlement of Holworth in 1958 (Rahtz 1959).

The settlement remains identified by Rahtz included a tripartite long-house and associated toft earthwork of gradual accumulation. The site's occupation was dated to the 12th to 15th centuries by the pottery. This dating sequence was rather crude and the indications are that it would be much revised if the work was carried out today. Rahtz provided a table listing the number of sherds found of each broad ware type. This is reproduced here with additions as Table 2.11.

Of the 14,112 sherds that were excavated, approximately 13,500 were discarded on site. The remaining collection of several hundred diagnostic sherds was kept at DCM. Statistical counts of material from selected contexts, namely those that related directly to Buildings A and B, yielded the data in the last column of Table 2.11. These data illustrate well how the use of only diagnostic sherds in calculations unfairly favours the finer wares. It also identifies Rahtz's fine, unglazed 14th to 15th century sherds as type S1 and S2 medieval sandy wares. Rahtz's progression of increasingly finer temper with time, that can be seen in the dates he assigned to the groups in the central columns, is unfortunately an over-simplification of the development of medieval pottery in this region. These sandy wares (here called fine unglazed) have been identified in a number of early 13th century contexts elsewhere in Dorset, since the publication of this report. These wares do indeed continue into the 15th century, but there is little evidence to suggest that the examples found here are of that date. The only easily datable sherds are, either the Siegburg jug found in the topsoil, or the white painted sherd found in a drainage context that probably post-dates the buildings. The presence of some of the probable sandy ware sherds in contexts with identifiably medieval material,e.g. one sherd of Poole red-painted ware, or sherds of glazed, decorated fine ware and scratch-marked ware perhaps indicates that many of the sandy ware sherds are more likely to be of 13th or early 14th century date, rather than later. Some later examples of the ware do, perhaps, exist on the site, but there is no obvious reason for dating most of this material, or the associated structures to a period 200 years later.

The sherds from Holworth that were examined were as follows:

HW1 & HW2	cooking pots in ware S1
HW3	jug in ware S1.
HW4	cooking pot in ware S1.
HW5	jug in ware S1.
HW6	cooking pot in ware S1.
HW7 to HW15	jugs in ware S1.
HW16	bowl in ware S1.
HW17	cooking pot in ware S1.
HW18	jar in ware S1.
HW19	jug in ware S1.
HW20	cooking pot in wareS1.
HW21 to HW25	Scratch-marked cooking pots in ware C1.
HW26 to HW28	cooking pots in ware C1.
HW29	bowl in ware C1.
HW30	cooking pot in ware C1.
HW31 &HW32	glazed jug in ware F4.
HW33	glazed jug in ware F1.
HW34 & HW35	glazed jugs in ware F4.
HW36 & HW37	glazed jug in ware F1
HW38 & HW39	glazed jugs in ware F4.
HW40 & HW41	glazed jugs in ware C1.
HW42	red-painted jug in ware C1.

Kington Magna

Thirty sherds from Kington Magna were analysed from a total of 2010 excavated sherds. The site pottery classification (Harrison, in Ross 1985) was carried out using the Sherborne Old Castle pottery classes that were identified through petrology (Harrison and Williams 1979). Five Sherborne types were identified at Kington, but these fabrics were so similar that the excavators could not divide the material into these groups by visual means. To gain an insight into the make-up of the assemblage without having to study all 2010 sherds, one representative context was chosen for study, this being KM80 3 2 ca. Only two ware types were represented in this collection, as can be seen from Table 2.12, the quartz and flint-gritted sandy ware being dominant at 77.72% and the quartz-gritted coarse wares representing the other 22.28%. A large number of sherds of the latter ware, and some of the former ware, were scratch-marked, but a calculation of the number of sherds exhibiting this 'decoration' was not made. Harrison states that 14% of the total pottery from the site was scratch-marked. If this was so for this context, then upwards of 120 sherds would have been counted. Although no figures are available, it is fairly certain that many fewer sherds than this, from this context, had scratch-marking, perhaps indicating that the assemblage from this context is not representative of the excavation as a whole. No white fine ware (F4) or sandy ware (S1) sherds were identified, although Harrison again indicated the presence of a few sherds of both these types were found in the total collection.

The dominant ware (S4) has been identified at Sherborne Old Castle as an Ilchester ware, deriving from a Yeo Valley industry (Pearson 1982).
The sherds analysed from Kington Magna were as follows:

KM1	glazed bowl in ware C1.
KM2	glazed tripod pitcher in ware C1.
KM3 to KM10	glazed jugs in ware C1.
KM11 to KM30	cooking pots in ware S4/C2.

Lodge Farm

Excavations by the National Trust in 1987 revealed indications of medieval occupation at the site of Lodge Farm, a late medieval hunting lodge on the Kingston Lacey Estate. The excavations were only very limited, being in advance of renovations to the building itself. Despite this over 400 medieval sherds were found. These were categorised as in Table 2.13. This classification posed difficulties as a virtual continuum of size and quantity of quartz temper, from very fine to coarse in size, and from sparse to abundant in quantity, was identified in the site assemblage. These wares were eventually separated into ware groups, but it must be stressed that a number of differing classifications could easily be made for this material. Its date was possibly somewhat later than the sandy wares studied on many other sites, considering the probable date of some of the associated fine ware sherds, but as so few pottery collections from the chalk to the east of Lodge Farm are known, the sequence for this part of the county is rather vague. It is probable that the hard sandy ware, represented here by ware S2, first appears in the 14th century, and continues into the late 15th or early 16th century. The soft sandy wares, like material in the west of the county, are probably slightly earlier.

The sherds analysed from Lodge Farm were as follows:

LF1 & LF2	cooking pots in ware S2.
LF3	glazed cooking pot in ware S2.
LF4 & LF5	cooking pots in ware S2.
LF6	glazed jug in ware S2.
LF7	cooking pot in ware S2.
LF8	glazed cooking pot in ware S2.
LF9 & LF10	jugs in ware S2.

Milton Abbas Abbey

Twenty sherds from the 1972 excavations were analysed. The collection itself was studied at DCM where all the medieval sherds were classified into the ware groups shown on Table 2.14.

The dating of this assemblage is not very tight, with individual sherds of ware C1 indicating an early 13th century date, and individual sherds of ware S2 and possibly ware F4 indicating a late 14th or 15th century date. The sherds that were sampled were all in the hard sandy ware fabric S2. Sherds MA4, MA5, MA9, MA10, MA12, MA19 and MA20 were probably jugs. All of the other thirteen sherds studied were cooking pots.

It is possible that an assemblage from a monastic/ecclesiastical site, such as Milton Abbey church, may be not a good comparison with assemblages from sites with 'lay' origins. This is because monastic orders may not have procured ceramics in the same way, and from the same sources, as the general populace. Despite this, the Milton Abbey collection was used because of a complete lack of alternative collections from urban centres on the chalk of central Dorset. The collection did show some similarities with other central and west Dorset assemblages, but there are indications of differences as well. The most striking of these is the absence of ware S1, the soft sandy ware, with possibly the harder ware S2 in its place. This could, perhaps, be seen as resulting from the monastery procuring ceramics from a different source to other communities. Other possibilities, however, include that the assemblage is slightly later than many others studied (like Lodge Farm?), or that the lack of collections from the immediate region has resulted in other examples of ware S2 in 13th or 14th century contexts being missed. The true date-range, source and distribution of this ware will probably not become apparent until many more medieval sites on the chalkland have been excavated.

The sherds analysed from Milton Abbas Abbey were as follows:

MA1 to MA3	cooking pots in ware S2.
MA4 & MA5	jugs in ware S2.
MA6 to MA8	cooking pots in ware S2.
MA9 & MA10	jugs in ware S2.
MA11	cooking pot in ware S2.
MA12	jug in ware S2.
MA13 to MA18	cooking pots in ware S2.
MA19 & MA20	jugs in ware S2.

Poole

Thirty-five sherds from an excavation in the medieval town of Poole (PM3/75) were analysed. The unpublished pottery report (Jarvis, with Barton, Horsey and Thomson unpub.) was studied and a number of sealed medieval contexts, each containing upwards of twenty sherds, were chosen as the source for the pottery samples. The contexts were PM3/75 19, 27, 69, 81, 118, 123, 124, 125, 126 and 128.

These contexts were used as the basis for the data used in the calculations that appear as Table 2.15.

In this table, sherds of fabric C1 with two specific decorative motifs have been classified separately. These are the Poole (or Dorset) Red painted Ware and Poole (or Dorset) Applied Strip Ware (Jarvis 1983). This latter is known in ware F4 as well. These two types are specific to this part of Dorset, the former dating to the late 13th and early 14th centuries, the latter to the 14th century. The ceramics in ware C1 from Poole, Christchurch and a number of other sites in the immediate vicinity, exhibit fabric hues that are lighter than similar material from further inland. This perhaps suggests that more than one centre of production of this material exists. Ware C1 is manufactured at Laverstock, but virtually no sherds of C1 Red Painted Ware are known from the Salisbury area. The suggestion must therefore be that a second ware C1 manufacturing site exists, which produces these more eleborate decorated types as well as the common cooking pots, but both in somewhat lighter-coloured clays. This site is probably located on the shores of Poole Harbour, perhaps utilising the local white pipe-clays or pale Reading Beds material.

In this collection from Poole, decorated or glazed wares account for 37.64% of the assemblage. This is a very large proportion in comparison to rural sites in the region (less than 6% at Holworth, for example). It is therefore possible that this assemblage is atypical of the ceramics generally available in Poole in the late 13th or early 14th centuries, representing, perhaps, features associated with the rich merchant class. This is, of course, the explanation for elaborate ceramic

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assemblages from at least one other medieval south coast port (Platt and Coleman-Smith 1975), but, unlike Poole, in this example from Southampton most of the glazed material is of foreign origin.

The sherds analysed from Poole were as follows:

PL1 & PL2	applied-strip decorated jugs in ware C1.
PL3 & PL4	applied-strip decorated jugs in ware F4.
PL5	applied-strip decorated jugs in ware F1.
PL6 to PL10	applied-strip decorated jugs in ware C1.
PL11 to PL15	red-painted jugs in ware C1.
PL16 to PL20	glazed jugs in ware C1.
PL21	glazed jug in ware F3.
PL22	glazed jug in ware F4.
PL23	glazed jug in ware F3.
PL24 to PL27	glazed jugs in ware F1.
PL28	glazed jug in ware F3.
PL29	glazed jug in ware F4.
PL30 to PL32	glazed jugs in ware F3.
PL33 to PL35	glazed jugs in ware F4.

St. Andrews Old Church, Portland

Seventeen sherds from Dorset Institute excavations at Portland, St. Andrews were analysed. The reservations concerning comparing ceramic material from an ecclesiastical site with 'lay' settlement assemblages, which were indicated when considering the Milton Abbas collection, can equally be applied here. Despite this, the collection from Portland, St. Andrews does seem to contain wares that are present at settlement sites nearby, notably Holworth and Poxwell, which perhaps allays some of the fears concerning the comparison of this collection with others. The excavator published an interim site report (Hunt1983) and the pottery report was compiled by Miss J. Burrows, as a student dissertation at the Dorset Institute. 368 medieval sherds were identified in the collection, deriving from 45 contexts. Most of these contexts were post-medieval, with the medieval sherds present as contamination. There were 14 contexts that could be identified as probably uncontaminated medieval layers, five of which were pre 1150, by stratigraphical relationships. The other nine contexts contained 123 sherds of medieval pottery. This material was used as the basis for calculations of the assemblage. Some of these ceramics may have been of late 12th century date (e.g. the shelly fabric). Most, however, were of probable late 13th century date. The make-up of the assemblage is visible on Table 2.16. It is apparent that, as with most medieval assemblages from west Dorset, the sandy wares are the most abundant types. There are also many sherds of ware C1, which perhaps indicates the presence of material from south-east Dorset as well. This mix is evident in other collections from central southern Dorset, e.g. at Holworth and Poxwell.

The sherds that were analysed from the Portland, St. Andrews collection were as follows:

PS1 to PS3	jugs in ware S1.
PS4 to PS8	cooking pots in ware S1.
PS9 & PS10	jugs in ware S1.
PS11 to PS17	cooking pots in ware C1.

Poxwell

A small collection of medieval pottery from Poxwell deserted medieval village was field-collected by students of the Dorset Institute. Ten sherds of ware S1 and five sherds of ware C1 were sampled for analysis.

The breakdown of the field-collected assemblage can be seen in table 2.17. Obviously, with such a small collection which is derived from surface collection, any indications of the make-up of the assemblage can only be very vague, allowing for limited comparison with excavated material. Despite this, the indications are that the assemblage from this site is not unlike those derived for excavations in the same part of Dorset (e.g. at Holworth and Portland). The dominance of the sandy ware S1 is self-evident, but there are also significant numbers of wares C1 and S4/C2. It is probable that in this assemblage the former type is representative of producers in the Poole Harbour area, whilst the latter type is abundant to the north west, at Compton Valence and Woolcombe.

The sherds analysed from Poxwell were as follows:

PX1	glazed cooking pot in ware S1.
PX2	glazed jug in ware S1.
PX3 to PX9	cooking pots in ware S1.
PX10	glazed cooking pot in ware S1.
PX11 to PX15	cooking pots in ware C1.

Salisbury

Twenty five sherds from a site at Brown Street in Salisbury were analysed. These were all from glazed jugs, in three fabric types (Underwood unpub.).

Fabric S3 can be classified as ware F1.
Fabric S6 can be classified as ware F1.
Fabric S5 (and 5/2) is a Surrey-type white ware, classified as F4.

No coarse ware sherds were analysed as, by this stage, it was apparent that sherds of ware C1 from sites inland could not easily be chemically separated from Laverstock coarse wares in fabric C1, using the data generated in this project. It was thus felt that, as most coarse wares from Salisbury would possibly be made at Laverstock anyway, and if they were not, it would probably be impossible to tell that, then there was no point in expending time on this problem late in the project. Sherds of probable Surrey white ware were also analysed. This was because it was of interest to find out whether supposed Surrey white wares could be chemically differentiated from white wares found in Dorset. Although the latter are not stylistically like the former, this was of interest in gauging further the value of the chemical data.

Underwood's report considers ceramics from four sites in Salisbury, with Brown Street and Gigant Street representing the majority of the sherds in the collection. Unfortunately, the glazed, quartz-sand tempered pottery, represented here by fabrics S3 and S6, is grouped together in the report with three coarse ware fabrics. Together, these quartz-tempered wares make up almost 100% of the 13th or early 14th century pottery found on these four sites. These two glazed fabrics also constitute almost 100% of Underwood's glazed sherds on these sites. It is therefore apparent that the information from this pottery report is not of a format which allows an assemblage to be produced which is comparable to those from other sites that have been studied. As the actual excavated material is, at present, unavailable no alternative calculations can be made.

The sherds from Salisbury that were analysed were as follows:

SL1 to SL10	jugs in ware F1 (fabric S3).
SL11 to SL20	jugs in ware F4 (fabric S5 & 5/2 Surrey-type ware).
SL21 to SL25	jugs in ware F1 (fabric S6).

Shaftesbury

Thirty five sherds from three sites in Shaftesbury were analysed. The sites were all within the economic, rather than the monastic, quarter of the town. The sites were from no. 6 and no. 22 Bimport and also at Parkwalks. These excavations were all rather small and the amount of pottery found at them was not great. In all only 133 sherds of medieval date were available from these sites. Furthermore, the indications were that the smallest collection, that from 22 Bimport, was a mixture of 13th century coarse wares (5 sherds) and 14th or 15th century sandy wares (4 sherds). Despite this, attempts were made to quantify the importance in the assemblage of the different wares present. The nine sherds from 22 Bimport were left out of this calculation, but several of these sherds were used in the analytical work. The results of this quantification can be seen in Table 2.18.

This table can only provide indications of a very limited nature, owing to the poor quality of the data sets, in terms of contextual contamination and small size. The general indications are, however, that the dominant coarse ware is C1 and its variants. The presence of material that probably derives from the Poole and Ilchester areas as well as sandy wares of the broad Hermitage/north-west Dorset type, suggests a multiplicity of production sources for medieval ceramics from Shaftesbury. This is made more significant as most of this material is not very fine and is therefore of types that are not usually expected to be distributed great distances. This supports documentary evidence that identifies Shaftesbury as perhaps the most prosperous town in medieval Dorset, taking advantage of its position on major routes and as a market place where surpluses from the chalklands and claylands could be exchanged and sold, representing an example of a 'frontier market' (Bettey 1986).

The sherds that were analysed were as follows:

ST1	cistern in ware S1.
ST2 & ST3	jugs in ware S1.
ST4	cooking pot in ware S1.
ST5	cistern in ware S1.

ST6 & ST7	ridge tiles in ware S1.
ST8	jar in ware S1.
ST9 & ST10	ridge tiles in ware S1.
ST11 to ST20	glazed jugs in ware C1.
ST21 to ST25	glazed tripod pitchers in ware C1.
ST26 to ST30	glazed jugs in ware F1.
ST31 to ST35	cooking pots in ware S4.

Sherborne Old Castle

More sherds were analysed from Sherborne Old Castle than from any other site. There are a number of reasons for this, the most obvious being that the collection that was studied is very large (40+ boxes of pottery). This material derives from excavations carred out by the DoE in the 1970s. Another reason for the large number of samples was that this excavated material includes large numbers of fine ware sherds (wares F1, F3 & F4) of a variety of decorative types, and even larger numbers of sandy ware sherds (S1 & S2), many of which are identical to Hermitage products. The assemblage also includes vast numbers of flint and quartz-gritted sandy ware sherds (S4), that, according to his note accompanying the collection, Terry Pearson has identified as identical to the so-called 'Yeo Valley' products found in abundance at Ilchester (Pearson 1982).

A report on the pottery fabrics from the DoE excavations at Sherborne has been published (Harrison and Williams 1979) in which, through hand-specimen and petrological identification, a number of fabrics were identified. These classes have been, where possible, matched to the ware types used in this project. The results of this can be seen in Table 2.19.

From this table a succession of dominant wares is apparent. First of all, in the 13th century, the Ilchester-type fabrics (ware S4) are most abundant. In the late 13th/early 14th centuries, the importance of this type in the assemblage declines (as do the economic fortunes of the town of Ilchester), to be partially replaced by material of ware C1 (Poole Harbour or S. Wilts quartz-gritted wares). Also present by this stage is the Hermitage-type sandy ware S1, and comparatively large numbers of fine ware sherds (F1, F3 & F4). The scanty evidence from the 14th century garderobe can only be a very vague indication of the assemblage on the site at that date. Despite this it is evident that, in this part of the castle at least, Hermitage-type (S1) or hard-fired (S2) sandy wares constituted most of the assemblage by this stage.

Study of the almost 2,500 sherds borrowed from the Sherborne Old Castle collection indicated that sandy wares S1 and S2 constitute most of the sherds that can be dated to the later 14th, and 15th centuries. This part of the collection cannot be used to make any more detailed statistical judgements, however, as no information concerning the type and date of the contexts represented has been provided. Thus, this part of the collection can be viewed as nothing more than a large number of sherds from one site, dating to the 12th to 15th centuries.

The 100 sherds studied from the Sherborne Old Castle collection were as follows:

SC 1, 4, 6, 17, 30
Quartz-gritted coarse ware C1 glazed jugs. SC1 has an applied strip, SC6 & SC17 have red paint.

SC 2, 3, 5, 7, 11, 14, 15, 16, 19, 20, 26, 32, 39, 40
Fine ware F1 glazed jugs.

SC21
Ware F1 glazed jug. Possibly a waster.

SC13, 23, 28, 31
Red fine ware F3 glazed jugs.

SC8, 9, 10, 12, 18, 22, 24, 25, 27, 29, 33, 34, 35, 36, 37, 38
White fine ware F4 glazed jugs.

SC41, 42, 44, 46, 52, 56, 70, 71, 72, 73, 74, 79, 80
Sandy ware S1

SC43, 45, 47, 48, 49, 50, 51, 53, 54, 55, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 75, 76, 77, 78
Hard sandy ware S2

SC81-100
S4 sandy ware with flint and coarse quartz.

Southampton

Seventy two sherds were analysed from sites within the medieval borough of Southampton. These sherds included wasters, in both fine and sandy wares, plus fine ware and coarse ware sherds. The sherds were supplied by Duncan Brown of Southampton City Museums Archaeology Unit. Data regarding assemblages that have been found on late 13th century and early 14th century sites in Southampton were also supplied by Mr. Brown. This information is summarised in Table 2.20.

The sherds provided were originally classified into twenty-one Southampton Museums fabric types, which had also been grouped into broad wares as well. These ware groups mostly matched those used in this project and so it was not difficult to compare data from site assemblages with the studied material.

The assemblage that has been derived for the Southampton material (Table 2.20) is a composite calculation of all the material excavated from contexts of the period 1250 to 1350 (ceramic phase 2) from six sites in the city. The information that the calculations were based on was provided by Mr D. Brown and it allows the accurate identification of fine ware types, but does not unfortunately separate wares C1 and S4/C2. These calculations are based on the 'number of sherds', to allow comparison with the assemblages from other sites. The total number of sherds in this collection is 10,171. It is apparent from Table 2.20 that wares C1 and S4/C2 are the dominant unglazed wares, with ware S1 also present. The fine ware types and English and foreign imports are almost all glazed and these types account for more than 35% of the assemblage altogether. This high total for glazed material is due to the high social status, and wide ranging economic contacts, of some of the thirteenth and fourteenth century owners of properties studied. This is in keeping with other assemblages from merchants quarters within the town (Platt and Coleman-Smith 1975).

The sherds that were analysed were as follows:

SO1 to SO20	glazed jugs of ware F3.
SO21 to SO25	cooking pots of ware S1.
SO26 to SO30	glazed jugs of ware F1.
SO31 to SO35	cooking pot wasters of ware S3.
SO36 to SO39	glazed jug wasters of ware F1.
SO40 & SO41	glazed jugs of ware F1.
SO42 to SO44	glazed jug wasters of ware F1.
SO45 & SO46	glazed jugs of ware F1.
SO47 to SO51	glazed jug wasters of ware F1.
SO52 to SO57	cooking pot sherds of ware S4/C2.
SO58 to SO62	cooking pot sherds of ware C1.
SO63 & SO64	cooking pot sherds of ware S4/C2.
SO65 & SO66	cooking pot sherds of ware C1.
SO67 to SO72	cooking pot sherds of ware S4/C2.

Wareham, St. Martins House

Forty sherds from excavations at St. Martins House in the medieval town of Wareham were analysed. The sherds all came from one context in Trench II, that being the fill of pit 26. This feature is apparently the latest on the site (Hinton & Hodges 1977, 51), but unfortunately the pottery assemblage is possibly a mixture of late 12th century and late 13th/early 14th century sherds. The are no more large groups from 13th century features in the town, and so this potentially flawed collection had to be used for calculations of the site assemblage at the later period.

In the site report (Hinton and Hodges *op. cit.*), the pottery is studied by conventional hand specimen/typological means as well as through heavy mineral analysis. The results of the latter supported suggestions derived from the former techniques, concerning the number of identifiable fabric types. One particularly interesting suggestion from the heavy mineral analysis was, however, that the coarse quartz-gritted (C1) scratch marked pottery derived from a different source to the other coarse quartz-gritted (C1) sherds. Also, the fine ware sherd (Fabric D) was mineralogically very different to all other sherds studied.

The fabrics identified in the site report can be matched to the general ware categories as follows:

Fabric A	Ware S4/C2
Fabric B	Ware S4/C2
Fabric C	Ware C1
Fabric D	Ware F1
Fabric E	Ware C1

As has already been stated, the 'assemblage' that can be derived from the fill of pit 26 is probably a late 13th/early 14th century group contaminated with some earlier material. It is difficult to identify all the contaminating sherds because the coarser wares were probably present in both the late 12th, and late 13th, centuries. The evidence for late 12th century contamination is, however, only derived from the presence of two imported French sherds. It is therefore possible that little other material actually dates to the earlier period, but even so the make-up of the 'assemblage' derived from this group is still of rather dubious value. Despite this, the calculations of percentage occurrence for all wares present have been made. The results can be seen in Table 2.21.

It is apparent, even if there is contamination, that the dominant ware on this site is C1. This ware includes both glazed and unglazed sherds (the former much less common), and sherds with scratch-marking. Ware C2 is much less common and ware S1 is barely present.

The sherds analysed from Wareham were as follows:

WH1 to WH10	cooking pots of ware C1.
WH11 to WH20	glazed jugs or tripod pitchers of ware C1.
WH21 to WH30	scratch-marked cooking pots of ware C1.
WH31 to WH40	glazed jugs of ware F4.

West Grimstead

178 sherds of pottery, including a number of glazed fine ware pieces, were found in a sand pit at the village of West Grimstead in south Wiltshire.
Most of the sherds were of a fabric similar to that common in Salisbury and found at Laverstock, but the decoration indicated a possible date slightly later than that ascribed to the latter industry. Furthermore, at least three of the fine ware sherds recovered were wasters, or possibly seconds, perhaps indicating the presence of a previously unknown production site. The alternative suggestion is, of course, that these were seconds, dumped from the Laverstock kilns, which were located only a few miles distant. Fifteen sherds from the collection were analysed, including the three possible wasters.

The breakdown of the 'assemblage' from the sand pit is given in Table 2.22. This assemblage is certainly rather perculiar, not least because of the presence of at least three wasters in ware F1, but also because at least 60 of the sherds in ware C1 derive from one large cooking pot. The breakdown of the assemblage would obviously alter radically if this was taken into account when calculating the likely number of vessels represented in the assemblage. The end result would be a significant increase in the portion of the assemblage represented by the fine ware. Considering that this material derives from a small village, it would be difficult to explain the presence of small portions of as many as fifty very fine vessels in one place, without considering the presence of a production site. The presence of the three wasters adds weight to such a suggestion, but does not by any means prove the existence of a kiln here.

The sherds from West Grimstead that were analysed were as follows:

WG1 to WG7	glazed jugs in ware F1.
WG8	glazed jug in ware F4.
WG9 & WG10	glazed jugs in ware F1.
WG11 & WG12	glazed jug wasters in ware F1.
WG13	glazed jug in ware F1.
WG14	glazed jug in ware F4.
WG15	glazed jug waster in ware F1.

Whitcombe deserted medieval village

Fieldwalking on the DMV of Whitcombe by students of the Dorset Institute yielded a collection of 154 sherds, 61 of which were of 13th or 14th century date. Fifteen of these sherds were analysed.

The breakdown of the assemblage can be seen in Table 2.23. There are obviously too few sherds to provide meaningful statistics but despite this some indications as to the dominant medieval wares, at least in the upper layers of the site, can be made. It is obvious from Table 2.23 that the sandy wares comprise most of the assemblage. This is in line with other rural sites in the immediate area (Holworth, Poxwell), as is the presence of some sherds of ware C1 and S4/C2 as well.

The sherds that were analysed were as follows:

WT1 to WT5	cooking pots in ware S1.
WT6 to WT10	cooking pots in ware S3.
WT1 to WT15	cooking pots in ware C1.

Wimborne, The Leaze

Forty sherds of pottery were analysed from the collection excavated at The Leaze in the 1960's (Field 1972). The site was a deserted quarter (suburb?) of the medieval town, in which the remains of a succession of buildings were found. For this study, the whole of the excavated collection was first viewed, and then one part of the site, building 1, was chosen as the basis for calculations of the make-up of the assemblage. The sherds that were analysed were also taken from this material. The excavator dated this particular structure to circa 1300. On analysis, the pottery collection from this building and associated contexts does reflect a date between 1250 and 1350. Table 2.24 illustrates the make-up of this assemblage.

In the site report, Field states that 9% of the sherds found were glazed. In Table 2.24, glazed sherds in ware C1 have not been identified separately and so a comparison between the overall figure and the amount of glazed pottery in building 1 is not possible. Despite this, it can be stated that, when the collection was studied, the greater part of the glazed assemblage was identified as being in ware C1, thus supporting Field's statement. The dominance of this ware in the assemblage is indeed apparent from the table. This is comparable to other east Dorset collections that have been studied, e.g. Christchurch and Wareham, but is, perhaps, more pronounced here as the site lies directly between the two probable production centres of this ware, at Laverstock and around Poole Harbour.

The sherds that were chosen for analysis were as follows:

WB1 &WB2	glazed jugs in ware F4.
WB3	glazed jug in ware F1.
WB4 to WB6	glazed jugs in ware F4.
WB7	glazed jug in ware F1.
WB8 to WB10	glazed jugs in ware F4.
WB11 to WB20	glazed jugs and tripod pitchers in ware C1.
WB21 to WB40	cooking pots in ware C1.

Winterborne Houghton

A collection of sherds from fieldwalking, from a DMV at Winterborne Houghton in Dorset, was studied at DCM. This material was collected during the compiling of the RCHM volumes for Dorset. The collection totals only 155 sherds, but was chosen for analytical study due to the great paucity of collections from rural sites on the chalklands. Originally a number of collections of medieval ceramics had been identified as existing from this area (nos 4,14 & 22 on Figure 2.4), but it soon became apparent that most of these collections were, either too small (e.g. Darknoll Farm, Quarleston and Higher Loop Farm), or the finds themselves were not located (Oakley Down). Thus the Winterborne Houghton collection was used instead.

The assemblage is obviously not an excavated one and thus not directly comparable to most other sites studied, as discussed by Haselgrove (1985). Despite this, the information it provides (Table 2.25) does perhaps indicate the most abundant types of ware present in the upper levels of the site. Here, in contrast to similar rural settlement sites further west, the most abundant wares are C1 and S4/C2, with only small numbers of ware S1 sherds being present. This could result, in part, from temporal factors. Wares C1 and S4/C2 are both present in late 12th century contexts elsewhere, whereas ware S1 seems to appear in the 13th century and continue much later. Thus a collection such as this one could possibly be placed in the early/mid 13th century, whilst a more sandy ware-dominated assemblage, such as that at Poxwell, could perhaps be dated fifty years later. Statements of this nature are, perhaps, reading too much into what are small data sets. Despite this, temporal issues cannot be dodged, and may well account for other seemingly spatial trends.

The sherds that were analysed were as follows:

WN1 to WN10	cooking pots in ware S1.
WN11 & WN12	cooking pots in ware C1.
WN13	jug in ware C1.
WN14 to WN19	cooking pots in ware C1.
WN20	jug in ware C1.

Woolcombe

Excavations have been carried out on the site of a shrunken settlement at Woolcombe in west Dorset in both the 1960s and the 1980s. The earlier excavations were directed by Mr. G. Rybot, with the pottery report being published in 1983 (Poulsen). This report was based on only that material which Rybot had kept. As his pottery sampling was not quantifiable, this assemblage is of little statistical use. In the 1980's excavations have been carried out by the Dorset Institute, directed by Mr. A. Hunt. The pottery report is being compiled by the author.

A large number of separate trenches have been excavated at a wide variety of points within the 'site' and its immediate hinterland. The largest pottery group uncontaminated by previous excavations is from Trench 1. This is an excavation of a curvilinear platform within the settlement, bounded on the west side by the main hollow-way or street. This platform was not used for habitation, but seems to have at various times been a refuse disposal area, a yard with possible manure heap, a market garden and a post-medieval orchard. The pottery from this site has therefore been subjected to much post-depositional agricultural disturbance. This does not seem to have obliterated all stratigraphy, however, as there are marked differences between the assemblage in the topsoil, the sub-topsoil layer 42, and an organically-rich layer 45/46. Beneath this latter a number of rubbish pits were found, cut into the subsoil. The contents of these seems to have been disturbed, and this material probably forms much of the assemblage for layer 45/46. This latter assemblage is of late12th/early 13th century date and contrasts sharply with the late 13th/early 14th century material identifiable in layer 42. This is apparent from Table 2.26, where the data from one season's excavation on this trench have been used to estimate assemblages for the late 12th/early 13th centuries and the late 13th/early 14th centuries. Here the dominance of the coarse flinty ware S4/C2 in the earlier period contrasts sharply with the dominance of the sandy ware by the late 13th century.

The sherds that were analysed from Woolcombe included sandy ware S1 and a flint and quartz-gritted ware that has here been identified as ware S4/C2. At other sites further north (e.g. Kington Magna and Sherborne Old Castle), ware S4/C2 sherds are generally reduced, but here they are more commonly oxidised with fabric hues very similar to those of the ware S1 material from the site. It will therefore be interesting to see whether the sherds analysed here, that have been attributed to ware S4/C2, are chemically more like the Hermitage S1 sherds or the Laverstock C2 material.

The sherds that were analysed from Woolcombe were as follows:

WF1 to WF5	cooking pots in ware S1.
WF6 & WF7	bowls in ware S1.
WF8	cooking pot in ware S1.
WF9	jug in ware S1.
WF10	bowl in ware S1.
WF11 to WF15	cooking pots in ware S1.
WF16	bowl in ware S1.
WF17 to WF25	cooking pots in ware S1.
WF26 to WF28	bowls in ware S1.
WF29 & WF30	jugs in ware S1.
WF31 & WF32	cooking pots in ware S1.
WF33	jar in ware S1.
WF34 & WF35	bowls in ware S1.
WF36 & WF37	cooking pots in ware S1.
WF38	cistern in ware S1.
WF39	bowl in ware S1.
WF40	jug in ware S1.
WF41 to WF80	cooking pots in ware S4/C2.

Yondover

A builder's trench at a farm at Yondover in Loders parish revealed medieval pits and buildings in 1956.

The material found is kept at DCM. The assemblage is composed entirely of sandy wares, mostly corresponding to ware S1, but with some sherds with a slightly coarser temper as well. There are over 100 medieval sherds, all in sandy ware fabrics.

The sherds chosen for analysis were:

YO1	cooking pot in ware S1.
YO2	bowl in ware S1.
YO3 to YO8	cooking pots in ware S1.
YO9 to YO16	glazed cooking pots in ware S1.
YO17 to YO20	cooking pot in ware S1.

Chapter 3 Sample preparation and analytical technique

3.1 The Samples

Powdered samples were obtained from the sherds selected for study using large diamond-embedded dentists' burrs. The surface of the sherd was removed first and this material was discarded. It was assumed that this method would ensure that any glaze or heavily leached material did not enter the sample. The samples were taken, where possible, from parts of the sherds which had no decoration or other features, each sample being derived from one region of the sherd only. An average sample contained 300 to 500 milligrammes of powdered ceramic of which only 100mg was actually used in the dissolution stage.

Half the sherds initially studied formed part of an additional piece of work concerning sources of error. To this end three samples were taken from each of forty sherds, twenty from Hermitage and twenty from Laverstock. Each of the three samples derived from a different region of the sherd and care was taken to avoid contamination between samples from the same sherd, as with samples from different sherds. In this way intra-sherd variability could be studied and quantified.

For all other sites studied the standard 'one sample per sherd' system was adopted. This did not proceed until study of the multi-sampled sherds data had revealed that no significant within-sherds elemental concentration variations were evident for the Hermitage and Laverstock material. It was then assumed that a similar situation existed in ceramics from all the other sites and thus no other multi-sampling of sherds was carried out.

Such a 'leap of faith' was not made without first evaluating the situation carefully. There is no reason why groups of sherds from other sites, in other fabrics, should be as homogeneous as the studied kiln groups. If identifiable groups of material from other sites did originate from these kilns, then a similar spread of concentration measurements would be expected. If such material was made at other unidentified production centres, then no obvious method of quantifying the intra-sherd variability of this material is available, other than through experimentation on all separate site groups. Such a process would be very time-consuming and the results, if similar to those already gained for the Hermitage and Laverstock collections, would indicate again that the further work may not be necessary, but could never state this categorically. The assumption was therefore made that most contemporary ceramics were as homogeneous as the Hermitage and Laverstock material, thus preventing inordinate amounts of time being wasted on an insoluble problem.

Other factors that might also affect the variation of elemental concentrations within a given body of ceramics include a variety of depositional and leaching processes that occur when the ceramics are buried. These are not fully understood, but a variety of reported cases are discussed in 3.4.

3.2 Dissolution procedure

One of the drawbacks of AAS, in comparison to NAA and XRF, is that the samples used for analysis must be in liquid form. For ceramics this requirement has in the past been met by two general methods. The first is through fusion with, for example lithium metaborate, in a furnace, followed by dissolution in a weak acid. The second is through open digestion by a complex mixture of concentrated mineral acids. The decision concerning which sample preparation method to adopt was not difficult to make, however, it being based on the necessity to utilise materials and expertise already available and the potential cost of carrying out each method. The fusion method, although potentially quicker, is undoubtedly more expensive through the necessity of fusing the ceramic and lithium metaborate in platinum or platinum-gold alloy crucibles. These are very expensive and many thousands of pounds would be required to purchase enough to allow sample preparation to proceed at an unrestricting pace. The acid digestion methods available, although individually slow and complex in comparison to fusion, do allow simultaneous processing of many samples, thus making the process a viable proposition. These methods require competence in wet chemistry as well as appropriate facilities for acid digestion. As both of these were available, the latter technique was chosen as the most efficient sample preparation method.

The samples were accurately weighed into PTFE beakers and the ceramic was dissolved, using an open acid dissolution method where the silicate component is lost through evaporation. Initially attempts were made to devise a method where the dissolution was carried out using only hydrofluoric acid (HF). However, in using this technique not all the temper component of the coarser, quartz-gritted pottery was dissolved, and the method was soon abandoned in favour of a stronger 'cocktail' of acids. The method finally adopted was a variation of one commonly used with geological samples (Cantle 1982, Hatcher *et al* 1980). Here HF is used in combination with perchloric and nitric acids.

A stepwise description of the method used for dissolution of ceramic samples:-

i) Samples accurately weighed into PTFE beakers.

ii) 1.5ml of nitric acid (70%) added to each sample.

iii) 1.0ml of perchloric acid (60%) added to each sample

iv) 5.0ml of hydrofluoric acid (40%) added to each sample.

v) Samples placed on hotplate and heated to 100 degrees centigrade for approximately 30 minutes.

vi) Heat increased to between 200 and 220 degrees until liquid completely evaporated. This usually takes about an hour.

vii) When no more white fumes, or drops of liquid, are evident the samples are cooled and approximately 5ml of 5M hydrochloric acid added to each.

viii) Samples slightly warmed to aid dissolution in HCl.

ix) If any residue is present the sample must again be evaporated and steps ii) to viii) repeated (not usually needed with this material).

x) When cool samples are accurately made up with distilled water to known volumes (usually 50ml or 100ml). If necessary an ionisation buffer (0.2% KCL) is added at this stage.

xi) Samples are stored in polythene bottles.

n.b. Analytical grade acids and chemicals are used throughout.

3.3 Analysis

For the initial analysis it was decided that eleven elements in total would be studied, these being; Mg, Ca, Fe, Ti, Al, Ni, Co, Cu, Cr, Mn and K. The first ten listed here were analysed for using the AAS. A flame photometer was used to study K. These particular elements were studied for several reasons. Firstly the 'suite' above includes all the major, and most of the minor, oxides that are generally found in clay sediments. This, of course, does not include silicon, which was deliberately lost in the dissolution process. Secondl,y this suite contains some trace elements such as Mn, Cu, Cr etc. which are also of interest. The time spent analysing large numbers of trace elements would have been prohibitive, however, unless difficulties in discriminating between groups using all the more abundant elements had arisen. In such a situation study of all the majors and minors could have been abandoned in favour of trace elements. AAS is not, however, the best technique in such a situation as it not as sensitive as, for example, NAA and becomes very time consuming once many elements are analysed. Another reason for analysing the specified elements was that most other studies of archaeological ceramics had concentrated on a similar suite (e.g. Hatcher *et al* 1980). Thus without any reason to concentrate initially on any other particular elements it was felt that, for the time being, 'following suit' would be perfectly acceptable. Furthermore the economic constraints at the time dictated that hollow cathode lamps for no more than about a dozen elements could be purchased.

The analyses were performed using a Pye Unicam SP190 Atomic Absorption Spectrophotometer and the appropriate hollow cathode lamps. The potassium measurements were carried out on an EEL Flame Photometer. The AAS was usually set up as recommended for maximum absorption for each separate element. For most elements measurements were taken at maximum precision which gives the best repeatability of measurements. With some of the trace elements, however, especially Cr and Ni, readings were taken at maximum sensitivity, due to the concentrations of these elements being at very low levels. In fact it was found very early on that Cobalt was present in such small quantities as to be not detectable with any degree of accuracy. Thus measurements for this element were abandoned, as to make up separate sample solutions of a higher concentration would have been too time consuming, considering the potentially small amount of useful information likely to be gained.

Before proceeding further with a discussion of the analyses it is perhaps sensible that a short explanation of the fundamentals of AAS be made. Only through a clear understanding of the processes occurring during the analytical process can all errors, whatever the cause, be minimised. It is not the purpose of this thesis to describe in detail the complexities of AAS. A brief summary of the main theoretical and practical points, however, will be included to illustrate the necessary understanding required to carry out a large-scale analytical programme effectively.

Atomic theory and Atomic Absorption Spectrophotometry
(after Beaty 1978, Cantle 1982)

There are three techniques of atomic spectrophotometry (spectroscopy); these are atomic emission, atomic absorption and atomic fluorescence. Only the second of these will be considered here.

All atoms consist of a nucleus surrounded by a specific number and arrangement of orbiting electrons. The lowest energy state (ground state) of an atom is the normal orbital configuration. If energy of the right magnitude is applied to the atom, the energy will be absorbed by the atom and the outer electron will be promoted to a less stable configuration or 'excited state'. As this state is unstable the atom will immediately return to its ground state and radiant energy, equivalent to the amount of energy initially absorbed in excitation, will be emitted (Fig. 3.1). The wavelength of the emitted radiant energy is directly related to the electronic transition which has occurred. Since every element has a unique electronic structure, the wavelength of light emitted is a unique property of each individual element. As the electron configuration of a large atom is complex, there are many electronic transitions which can occur, each transition producing a characteristic wavelength of light.

If light of the right wavelength is made available to a ground state atom it may absorb the light in a transition to the excited state. This process is known as atomic absorption (Beaty 1978, 5).

The quantity of interest in atomic absorption measurements is the amount of light at the 'resonant wavelength' which is absorbed as the light passes through a cloud of atoms. As the number of atoms in the light path increases, so absorption increases in a predictable way. By measuring this amount of light absorbed, a quantitative determination of the amount of 'analyte element' present can be made. By the use of specific light sources and careful wavelength selection, the amount of 'analyte element' can be determined in the presence of other elements.

The cloud of atomic particles needed for measurement is produced by supplying enough thermal energy to the sample to dissociate the chemical compounds into free atoms. Aspirating a sample solution into a flame aligned in the light beam produces such a situation. Despite the supply of thermal energy, under correct conditions most of the atoms will remain in the ground state until light energy is made available at the correct wavelength.

Quantitative analysis by atomic absorption

The process of atomic absorption is shown diagramatically in Fig. 3.2. Light of the resonant wavelength with initial intensity I_0 is focussed on the flame containing ground state atoms. The initial light intensity is decreased by an amount determined by the atomic concentration in the flame. The light then passes onto a detector where the reduced intensity I is measured. The amount of light absorbed is found through comparison of I and I_0.

Terminology for the absorption process include the following (Beaty 1978, 6).

'Transmittance' is the ratio of final intensity to initial intensity, $T = I/I_0$. This indicates the fraction of original light which reaches the detector.

'Percent transmission' is the transmittance expressed in percentage terms. $\%T = 100 \times I/I_0$.

'Percent absorption' is the complement of percent transmission $\%A = 100 - \%T$.

'Absorbance' is a mathematical quantity $A = \log(I_0/I)$. Absorbance is the normal term used to identify high absorption in AAS. Absorbance is linearly related to the concentration of the absorbing species for a given set of instrumental conditions. Therefore, when the absorbances of standard solutions containing known concentrations of analyte are measured and the absorbance data are plotted against concentration, a straight line graph should result. As absorbance and concentration increase, however, non-idealities in the absorption process cause a deviation from this straight line (Fig. 3.3). Despite this, calibrations can still be established, and the absorbance of solutions of unknown concentrations may be measured and their concentrations determined from the calibration curve. With modern instrumentation, accurate calibration and direct concentration readouts can be provided even in the non-linear part of the curve.

Sensitivity and detection limits

'Sensitivity' and 'detection limit' are terms used to describe characteristics of instrument performance in AAS.

Sensitivity can be defined as the slope of the absorbance versus concentration calibration for each element. It is expressed in µg/ml (ppm) required to produce 1% absorption; or in terms of absorption units. The sensitivity is the microgrammes of element per millilitre which will give an absorbance of 0.0044. In the linear part of the concentration curve the sensitivity of an element can be determined by reading the absorbance produced by a known concentration of the element and then solving the following equation:

$$\frac{\text{Concentration of Standard}}{\text{Measured Absorption}} = \frac{\text{sensitivity}}{0.0044} \quad \text{and}$$

$$\text{Sensitivity} = \frac{\text{Conc. of Standard X } 0.0044}{\text{Measured Absorption}}$$

The sensitivity values for a standard set of instrumental conditions are normally given for an instrument. Knowing the expected sensitivity enables the operator to determine whether the instrumental conditions are optimised, by measuring the absorbance of a known concentration and comparing the results to the expected value. Furthermore, a known sensitivity value enables a prediction to be made of the absorbance range which will be observed from samples with a known range of concentrations, or it can be used to determine the concentration range which would produce optimum absorbance levels.

The detection limit for an element is the lowest concentration at which it can be measured. It is defined as the concentration which will give a signal-to-noise ratio of two, i.e. the lowest concentration which can be differentiated from zero.

The concepts of sensitivity and detection limit have important distinctions and must not be confused. Sensitivity defines only the size of the absorption signal, serving as a reference for instrument set-up. Knowing the sensitivity also makes it possible to determine optimum sample concentrations for analysis. The detection limit describes the signal-to-noise ratio characteristics for the instrument. It therefore defines the analytical capacity of the instrument and provides an estimate of the lower limit of concentration detection.

A number of effects contribute to uncertainties in the final signal displayed on the readout system of any A A spectrophotometer. These sources of error are:
a) fluctuations in the hollow cathode lamp emission signal
b) photomultiplier 'shot' noise
c) electronic (Johnson) 'noise'
d) flame fluctuations
e) nebulisation and atomisation noise
f) inaccuracies in the readout system
g) systematic and random errors incurred in sample preparation
h) inter-element interferences

Most of these factors are taken into account in the design of the instrumentation and are thus not valid topics for discussion here. The last two factors, however, are both under the control of the operator, and therefore have to be considered. They are discussed next in section 3.4.

3.4 Sources of error

Potential sources of error in analytical provenance study are many and varied. A variety of factors relating to instrumentation error were listed in 3.3. It is not necessary to discuss these here as they can usually be accounted for by sympathetic adjustments to, and careful use of, any spectrophotometer. More important sources of error do also occur, particularly relating to how representative are the samples chosen, of the whole statistical population they derive from. Such error can be caused by bias in selection of sherds to be studied, or by the sample of sherds available for analysis being chemically altered in some way. Further error can derive from sample preparation and from irregularities in the standards used for calibration.

How representative is the material from the kiln site?

Most of the ceramics excavated at a kiln site are liable to be wasters, that is, failed products. The reasons why a pot fails in firing are many, but generally the problem is either that the kiln conditions were wrong, or that the fabric of the pot was 'wrong'. By identifying a fabric as 'wrong' the implication is that the raw materials, or the mix of raw materials, used to make the vessel was not intentional or typical, and that the fabric may be unrepresentative of the great body of vessels that did not fail and were subsequently marketed. This therefore suggests that a chemical comparison of wasters and marketed products from the same kiln site might wrongly identify the products as not deriving from that site, because the comparison is between two different types of material; successful products and failed products.

Wasters at kiln sites, except where stratified long-term dumps or mounds are found, are more likely to derive from the later or last firings of the kiln, or from the first firings of a subsequent kiln, than the whole period of production. This is because older material left on a site tends to be subjected to tertiary deposition, carted off for use as hard-core etc. Thus the sample of sherds from a kiln site represents only a discrete segment of the population of all vessels produced there. This would not matter if there was no variation whatsoever in the raw materials used at the site. The mix of materials, however, is quite likely to have altered with time, either through deliberate innovation, deliberate or forced use of new clay deposits, or through unidentifiable inhomogeneities in the deposits used. This latter would probably have been an unwitting alteration as no medieval potter could chemically analyse his clay. Conscious selection of clays exhibiting particular physical characteristics could conceivably enable a potter to discriminate against some chemical variation, but changes in many elemental concentrations would not be physically manifested. Thus over a period of many years chemical variation in the products of one site may steadily increase. Analysis of material from only one part of the production sequence might therefore conceivably result in confusion because of errors of this kind.

It is apparent that comparisons between groups of material from kiln sites and 'market-place' sites have to be used with some caution. The whole concept of ceramic provenance study, however, is based on the premise that, despite the problems outlined above, wasters and distributed products can be chemically matched. Providing that awareness of the potential problems is retained, quantifiable probabilities of similarity can be gained through a variety of statistical techniques.

Post-depositional changes in ceramic fabrics

During the burial of pottery the concentrations of certain elements may change as a result of, for example, chemical interaction with ground water. Little work has been carried out which attempts to understand the processess involved. Freath (1967) found calcium leaching from pottery and iron and manganese being deposited on sherds. Hedges and McLellan (1976), in a paper which studied the cation exchange capacity of fired clays and archaeological ceramics, identified that, with solutions in contact with sherds, cations could be exchanged. Prag *et al* (1974) refer to calcium carbonate deposition on buried pottery and this is supported by many published examples of large calcium concentration variations within groups of otherwise similar sherds. Freestone, Meek and Middleton (1985) identified the deposition of phosphate on ceramics and Freath (1967) carried out a study which suggested manganese deposition was occurring. Sayre *et al* (1971) stated that alkali metal concentrations in sherds are affected by leaching, although this was not quantified with experimental data. Furthermore Bieber *et al* (1976) suggest that sodium, calcium and barium in pottery can be subject to leaching and deposition effects and, although they do not specifically prove this, awareness of such possible changes is indicated as being of prime importance when considering elemental data from archaeological ceramics.

Tubb Parker and Nickless (1980), when considering processes of the kind outlined above, state that with low-fired or under-fired sherds, most of the effects will be more serious. This is because, when not vitrified, the ceramic fabric has an open structure with a larger surface area and reactive phases (Freestone *et al* op. cit.).

The possibility of post-depositional effects has therefore to be considered when carrying out a provenance study across many excavated collections. Material from settlement sites may be perceived as chemically different to a kiln group, purely as a result of the effects of leaching and deposition of a number of the elements used in the analysis. Characterisation of kiln groups may also become biased or difficult if leaching effects upon the buried wasters have created an abnormal set of elemental concentrations. In this study the initial analyses suggested that the concentration values for calcium, at both of the kiln sites initially studied, may have been suspect. Neither group of concentrations was well-clustered or normally distributed, with a number of individual sherds having extremely high calcium concentrations. Thus, when the decision was made to exclude some elements from further analyses, calcium was a prime candidate even before considerations of discriminating power had been taken into account.

As with the problem of chemical differences between wasters and 'normal products' the suggestion is that caution must be exercised, rather than the work not carried out at all. If elements that are known to be mobile in soils (e.g. Ca, Na, K, Ba, P and perhaps Fe and Mg) are analysed in ceramic provenance study, the results must be scrutinised, with widely varying or peculiarly distributed elements being excluded from the statistical analyses. Also, if a site is known to have had, or is liable to possess, extremes of soil pH, then again care should be exercised when attempting to match ceramic elemental concentrations from this site with others. Elements with widely varying concentration data sets could then be identified by studying the raw data and perhaps calculating the standard deviation and kurtosis (peakedness) factors for the distribution. The latter statisitic is discussed in Chapter 4. A large standard deviation or very platykurtic distribution would indicate an ill-clustered data set. Reasons for this could include that, either the group of sherds includes material of more than one provenance -each type with a different concentration range for that element, or that the concentrations of that element have varied during burial.

It is certain that post-depositional elemental concentration changes do occur in ceramics. The factors governing these changes are not well-understood, however, and the likelihood of specific alterations occurring under given conditions is not at present known. Thus there is no simple way that these problems can be quantified and eliminated. Until further work is carried out in this area the best methods of avoiding biases resulting from post-depositional alterations must be of the 'rule of thumb' type as described above. Furthermore, problems of this type can usually be avoided in the first instance by removing the potentially leached surfaces of all sherds used.

Sources of error in sample preparation

Sample preparation errors can obviously be minimised with careful procedure. Provided all equipment, balances etc. are in full working order the most common source of error at this stage is through human failings. This tends to be random, as opposed to systematic, and is often easy to identify at a later stage allowing correct action to be taken. This usually entails discarding the affected sample(s) and replacing them if the sample batch is quite small. If only one or two of many samples of a type are affected in this way, the samples at fault can be discarded, or the results ignored without affecting the validity of the whole analysis.

Systematic errors that occur at the sample preparation stage are usually more difficult to cope with. The complexity of the dissolution stage in the analyses described here results in a variety of possible causes for any suspected systematic preparation error. When such a problem occurs it is usually most sensible to discard the whole batch of samples and initiate the preparation stage again. In some cases easily quantified systematic errors can be accounted for through re-calculation of the concentration values. This is not, however, advisable where the real source of error is not specifically known, the normal state of affairs where sample preparation errors are concerned.

One area of sample preparation where systematic errors often occur is through faulty standard preparation. Such errors should be easily identified if proper inter-batch calibration checks are carried out. The causes of such error are usually minor variations in the amount of commercial standard solution taken for dilution into the set of working standards. Through such calibrations to slightly erroneous known concentrations, long-term analysis programmes can slowly accumulate errors over a period of time. Often it is not practicable to produce all the necessary dilute standards prior to initiating a long-term research programme, as dilute standards of many elements alter concentration with time, even when stored in supposedly inert plastics. Therefore new standards are required at regular intervals in a long -term programme, necessitating some other form of calibration check to be used. Many laboratories utilise homogenised standards which are newly dissolved and added to each batch of samples; e.g. the Oxford Research Laboratory's homogenised Knossian sherd (Hatcher *et al* 1980), or the internal British Museum Research Laboratory's pottery standard BMSP (Hughes pers. comm.).

In this research project no such 'inexhaustible' stock standard was used. Instead, after initial work had been calibrated via comparison with a small NAA study of some Hermitage and Laverstock sherds (Appendix 2) and analysis of the British Museum standard BMSP and the University of Bradford stock ceramic standard NPS1, periodical re-checking was carried out using either solutions derived from NPS1 or 'representative' sherds from the Hermitage and Laverstock collections. Differences did occur between the 'given' concentrations in these external standards, and the values gained through these analyses. Such inter-laboratory variations are, however, only significant when directly comparing results and, provided they are of an acceptable level, can be ignored once quantified. Elemental concentrations for these sherds had been repeatedly accurately determined at an early stage using BMSP, NPS1 and some standard sherd material provided by the Research Laboratory at Oxford. By using one of these three possible checks, no one of the standards was exhausted before the end of the analysis programme. It must be stressed that this procedure for checking accuracy was only adopted for the four elements used in analyses subesquent to the pilot study (Chapter 4). For the initial work, involving the suite of eleven elements, no inter-lab comparisons are possible for the data from the extra seven elements.

Some indications as to the inter-laboratory variation of elemental concentrations were gained through a study of measurements made on the Bradford, British Museum and Oxford standards by a number of laboratories including the Dorset Institute Archaeology Unit. The results of this comparison are displayed in tables 3.2 and 3.3. Although incomplete in places they do indicate the variations in concentration measurements that can occur between a number of institutions.

Matrix interferences

Matrix interferences can occur in the first stage (nebulisation) of the flame process. A common matrix effect results from differing samples and standards possessing different surface tensions and/or viscosities. This can cause the rate of uptake of these different solutions into the nebuliser to vary and this will result in different numbers of atoms being present in the light beam for the different solutions; consequently differing absorbances will result (Beaty 1978, 26).

The possible causes of these variable solution viscosities are numerous. The presence of large amounts of mineral acid in a solution will impede sample uptake and therefore decrease absorbance, conversely organic solvents can enhance absorbance. The only way to counteract such problems is to ensure that both samples and standards contain similar matrices. If acids are present in samples as a by-product of dissolution procedure then similar amounts of acid should be added to all standards. This was necessary in this study where 2ml of 5M HCl was added to every 100mls of standard to provide a matrix that was comparable with the samples, the latter being taken up in HCl after evaporation of the HF, HNO_3, H_3PO_4 'cocktail'.

Other matrix interferences can result from the presence in the sample solution of one or more elements greatly in excess over the analyte element. Furthermore, the mere presence of some elements in sample solutions can slightly suppress the absorption of others. Such cases include the depression of chromium and molybdenum by iron, and the depression of calcium by aluminium. The easiest way of overcoming such problems is to add to the standards the same amount of interferent as is present, on average, in the sample solutions.

With this particular project the ranges of concentrations of elements measured in the sherds from the kiln sites at Hermitage and Laverstock were used as guideline concentrations for adding elements to the standards to 'matrix-match' them. The actual elements added and their concentrations can be found in section 3.5.

Chemical interferences

Chemical interferences occur at the fifth stage of the flame process, atomisation. At this stage, sufficient energy must be provided to dissociate the molecular form of the analyte to create free atoms. If the sample contains a thermally stable component, which includes atoms of the analyte, then the latter will not be completely dissociated in the flame and a chemical interference will exist. Examples of chemical interferences include the effect of phosphates, sulphates, aluminates and other oxygenated ions on the alkaline earth metals (e.g. Ca and Mg). There are two generally accepted ways of countering chemical interferences of this nature. Firstly, another element can be added in excess which more readily forms a stable compound with the interferent. This method is simple but it has the effect of reducing analytical sensitivity as well. The alternative method for removing chemical interferences is through the use of a much hotter flame, for example that provided by nitrous oxide and acetylene. Using such a flame, with a special burner head, the temperature is sufficiently high to dissociate all necessary compounds and therefore overcome chemical interferences. Under such extreme temperatures, however, the problem of ionisation interference is created.

Ionisation interference

Figure 3.1 illustrates only part of the possible dissociation process. If energy is applied, the ground state atom can be thermally raised to the excited state. Then, with the provision of further heat energy, outer electrons may be removed from excited atoms to create ions. As this depletes the number of ground state atoms available for light absorption, atomic absorption is reduced and an ionisation interference occurs.

Ionisation interference can be eliminated by adding an excess of an element which is also very easily ionised, creating a large number of free electrons in the flame and suppressing ionisation of the analyte. The ionisation suppressant normally used is sodium or potassium.

In this research project chemical interferences on calcium and magnesium measurements were avoided by the use of a hot nitrous oxide-acetylene flame. The subsequent ionisation interferences were suppressed through the addition of an excess of potassium ions (5ml of 4% KCl added to every 50ml of solution). This obviously prohibited the use of potassium as an analyte element. Potassium was used as a flame photometry analyte in the pilot study on Hermitage and Laverstock sherds. Although it proved a good discriminator, it was found to be correlated with Iron and therefore was dropped from subsequent analyses, without the loss of much discriminating power. 5ml of 4% KCl was added to every 50ml sample used thereafter.

3.5 Standards and Calibration

The instrument was calibrated using standard solutions made up from BDH "Spectrosol" concentrated standards. Initially separate standards were made for each element under study. These contained, in addition to that element, only distilled water and an ionisation buffer if needed. As the work progressed some other elemental concentrations, matched to those found in the samples, were added where relevant interference effects were known from the literature. However, it became apparent that some matrix effects, of inter-element and other nature, may still have been causing undetected errors. Effects of this type are explained in detail in the preceeding section.

To account for inter-element interferences, once the approximate elemental concentrations for each of the two kiln groups had been identified, formulae for complex multi-element standards were created. These were then made up and used where appropriate. The elemental break-down of these complex standards can be seen in Table 3.1.

The concentrations visible in Standard A represent roughly the maximum amounts of those particular elements measured in samples derived from the Laverstock kilns. The same can be said for Standard B when applied to the data from Hermitage.

When studying a particular element X using these standards, a complex mixture needs to be available without the presence of X. This is so that a variety of different solutions with differing concentrations of that element, but with the same complex standard 'background', can be made up. To this end the complex standard was made up many different times, each time without the presence of one particular element and always in concentrations ten times those needed. Thus when the standards with differing concentrations of X were made up, the complex standard was added as one tenth of the final volume.

One problem with the above method was that vast amounts of time were needed to make up twenty different complex standards; two sets of ten, each one lacking in one element. To cut down the time it was eventually decided that it was possible to work with only one set of ten standards, representing the maximum elemental concentrations likely to be found in any of the pottery. It was hoped that this would suffice by always providing the maximum interferences that were likely to be encountered in the samples, in all the standards.

Some of the elemental interferences, and also some other interferences due to the presence of mineral acids etc, could be avoided by using the hotter nitrous oxide/acetylene flame instead of the cooler air/acetylene one. At these higher temperatures, however, many elements ionise thus causing a change in measured response. This can be avoided by the addition of an ionisation buffer to both samples and standards. To account for this, potassium chloride was added to all solutions after the initial study. The concentration used was 0.2% K for all solutions. This obviously meant that potassium content could no longer be measured in the samples and thus the usefulness of potassium as a discriminator had to be studied first. It was found that although potassium did not contribute greatly to discrimination between the two sites, it was useful in separating sherds of Laverstock coarseware and fineware. Other elements, however, when used together were almost as good as potassium in providing this same discrimination. It was therefore felt that the loss of the potassium data could be accepted, as it included little unduplicated variation. Furthermore, potassium was measured by flame photometry thus providing less accurate data than for most other elements, and also as it is known to be very mobile under certain soil conditions, the data for this element were perhaps the least valuable.

Inter-laboratory comparisons of pottery standards

Internal regulation of between-batch variations in analytical precision was, as described above, effected through the use of standard ceramic materials. To this end the concentrations of five elements in two samples, 167 and 005, derived from one Hermitage and one Laverstock sherd, were precisely determined. This involved repeated measurements on three different days. These then acted as internal ceramic standards that could be used to check the accuracy of new dilutions of the stock standards. These particular sherds were chosen purely because they were broadly representative, in terms of the elemental concentrations measured, of the general body of material from each site.

Intra-laboratory regulation of measurements was thus carried out through frequent re-checking of samples for which elemental concentrations were accurately known. The problem of inter-laboratory comparisons was not so pressing as all the AAS described here was undertaken in the same laboratory. Despite this, the importance of indicating how accurate the measurements were, in comparison to other laboratories, was realised. It has recently been suggested that it is necessary for all laboratories to achieve analytical results as close to absolute as possible (Hughes pers. comm). In the past this has not been 'the norm', but recent meetings between workers in the field of analytical provenance study of ceramics have seen moves towards such aims. Therefore to give indications as to the degree of absolute accuracy that the internal determinations provided, and also to reassure that the bias involved was not significantly greater than elsewhere, some comparative tests were carried out. The material studied was three stock ceramic standards from other laboratories. These were NPS1 from the University of Bradford Schools of Archaeological Sciences laboratories, BMSP from the British Museum Research Laboratory and the Lefkandi Brick Standard (LBS) originally from the Fitch Laboratory at the British School in Athens, but supplied here by the University of Oxford Laboratory for Archaeology and the History of Art, with measurements by the British Ceramic Research Association. The comparative results can be seen in Table 3.2 and Table 3.3.

Table 3.2 is a comparison of iron concentrations as measured by Bradford, the British Museum and the Dorset Institute on two standards, NPS1 and BMSP. Although measurements for other elements were made, the only data from all three sources was for iron. It is evident that the Dorset Institute data is the lowest of the three. The difference, however, is in both cases no more than the difference between results from the other two laboratories. The indications are, therefore, that the degree of absolute accuracy of the Dorset Institute data is probably as good as it is for either of the other two sets.

Table 3.3 is a comparison of the BCRA and Dorset Institute data for five elements on the standard LBS. The BCRA data can be taken as 'as near to absolute as is possible', thus making the comparison particularly important. For three elements, Mg, Mn and Ni, the Dorset Institute data are within the margin of error that the BCRA determinations inherently carry. This is most reassuring, suggesting that the Dorset data are very good. For the nickel measurements, however, the margin of error is ± 100%, due to the difficulties encoutered in measuring such minute quantities. The other two Dorset Institute determinations are 89.5% of the BCRA , for aluminium, and 94.9% of the BCRA data for iron. These are both close enough to be acceptable, although further tests on many samples and elements would still be required if a real index of variation is needed. The general indications are therefore that the data used in this project are not perfectly matched with absolute values, but that they are within the degree of variation expected at any laboratory at present.

Chapter 4

The Pilot Study

4.1 Study of Univariate Concentrations Data

The kiln sites and the excavated material derived from them have already been described in Chapter 1. Initially twenty sherds were selected for study from each site. This was subsequently increased to forty from each site. Half this material was also subjected to multi-sampling, three different samples being taken from twenty sherds from Hermitage and the twenty sherds from Kiln 6 at Laverstock. Material from this particular kiln was selected because, being the only kiln to produce a partial load *'in situ'*, it was probably the most cohesive body of ceramics, all of a similar age, available. The vessel forms these sherds derived from are outlined in table 1b. The fabrics were as follows:-

Hermitage	40 sherds of sandy ware (Fabric 1).
Laverstock cooking pots	10 sherds of coarse quartz-gritted ware (Fabric 3).
	1 sherd of flint and quartz-gritted ware (Fabric 4).
Laverstock jugs etc	29 sherds of fine ware (Fabric 2).

The initial calculations of the pilot study were based on a smaller data set of only twenty sherds from Laverstock and twenty sherds (sixty samples) from Hermitage. This smaller body of information was soon, however, deemed to be not of sufficient size to be properly representative of the larger statistical 'population' of material from the kiln sites. A statistical population can be defined as "a well-defined set (either finite or infinite) of elements" (Davis 1986, 28). In this case the 'elements' are sherds and the population is a finite one, being all the sherds of vessels made at the Hermitage kiln in existence at a particular time. Provided that it includes enough 'elements', a sample of a population is representative of the total variation inherent in the population. Therefore the 1,000 plus sherds found at Hermitage ought to be representative of the larger number of vessels actually made at the kiln (provided no change in raw material usage occurred), and the number of sherds actually sampled would in turn need to be large enough to be representative of the total excavated collection. To be sure that this was the case the total number of samples was increased to 160, representing forty sherds from each site. This larger data set was then used for all subsequent statistical analyses.

As has already been explained in Chapter 1, a total of eleven elements were chosen for inclusion in the pilot study in its first phase. These were: Al, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Ni and Ti. Of these eleven one element, Co, was found to be present in concentrations that were too low to be accurately measurable. Thus a final suite of ten elements produced the data used for the first phase of statistical analyses. The actual concentrations of these elements in all the samples can be found in the appendices. These 'raw' figures were used to produce an extensive amount of univariate information as well as being converted into new multivariate functions and factors through the use of computer packages.

Examples of the effectiveness of some of these single element concentrations in discriminating between material from the different kiln sites can be seen in Figures 4.1 to 4.4. Figure 4.1 shows how iron and manganese divide the kiln groups. Both these elements separate the material from the two sites admirably. Iron is, however, the more powerful discriminator with 100 percent success between kiln sites and also a generally more compact range of values for the Hermitage material. The manganese concentrations only give about eighty per cent success in 'between sites' discrimination and have a range of values for the Hermitage sherds of between about 0.005% and 0.08% Mn, which cannot be described as compact. Figure 4.2 shows the separation achieved when magnesium concentration is plotted against nickel concentration. It is evident from this graph that magnesium is a good discriminator between the kiln sites and also between the two different wares that were studied from the Laverstock collection. The magnesium data are not enough on their own to discriminate totally between the two sites, however, and thus this information must be plotted with another set of concentrations to achieve total separation. It is evident from both fig 3.2 and 3.3 that the use of the magnesium data plus concentrations from either nickel or aluminium is not sufficient to achieve 100 per cent separation of the previously defined kiln groups. This can only be achieved when the magnesium and iron data are combined as in Figure 4.4.

The ability to separate the kiln groups using only bivariate data is a rare occurrence in this type of study and where it occurs the suggestion could be made that only the concentrations of these two elements, Mg and Fe need be measured on the subsequent unprovenanced material. It was felt, however, that such a decision would be ill-advised, despite its obvious savings in time and effort. This was because the actual provenancing problem being tackled was perceived to be a much larger and more complex situation than one where all the material being studied derived from one or other of the studied kiln sites. Accepting the fact that only a small portion of the locally produced wares were made at either of the two excavated kiln sites might indicate the need to attempt to isolate at least vague 'production zones' for unprovenanced types, if any sense was to be made of the economic interactions between the various thirteenth-century ceramic producers in the region. Thus a data set would be needed that, not only discriminated between the known kiln groups, but also separated out various groups of unknowns. Therefore as the elements that would do this were at this stage as 'unknown' as the provenances of the groups themselves, a complete abandonment of all measurements except those for Fe and Mg would be most dangerous. The author still felt the need to cut the number of elements being studied from the initial set of ten down to a smaller, more quickly processed, set of between four and six elements. Thus great savings in time and labour could still be made without sacrificing the usefulness of the study. The need for a shorter analysis stage was deemed necessary due to the massive data set, in terms of excavated medieval ceramic collections, available from the study region. It was felt that an intensive study, using the concentrations of many elements on collections from a small number of sites, would ultimately not be as useful as a study of many more sites utilising concentration data from fewer actual elements.

The study of bivariate concentration plots had identified two elements necessary for inclusion in the final 'suite' chosen for study, these being Fe and Mg, but some method of quantifying the usefulness of the other eight elements studied was necessary, before the best two or three of these could be identified also. To solve this problem a programme of multivariate statistical analyses was carried out on the data from the kiln sites. The major forms of test used were discriminant analysis and principal components analysis along with multivariate analysis of variance (**MANOVA**). Through use of these powerful statistical tests, not only could the raw elemental concentrations which discriminated between the kiln groups be identified, but also the elemental concentrations that were useful discriminators when combined with the data from other elements could be indicated.

Simplified explanations of the methods by which both discriminant analysis and principal components analysis work are included next, followed by a discussion of the results of these tests when applied to the kiln sites data.

4.2 Normality of elemental data

"The distribution of elements in archaeological ceramics from a single clay source is not, in general, known" (Pollard 1982). Early work studying rocks suggested that all elements are lognormally distributed in geological materials (Ahrens 1954), but not all subsequent authors have agreed that this holds true for groups of archaeological ceramics. Picon et al (1975) stated that "among all the workshops studied we have never found any distribution which could have induced us to use a logarithmic pattern rather than a linear one". Furthermore Catling *et al* (1963) produced results showing the normal distribution to be a reasonable match for those distributions produced using Ca and Mg measurements on Mycenean pottery, a statement that remains valid, despite the subsequent revision of some of this work. Sayre, however, states in a number of papers that experience suggests many elements to be lognormally distributed in groups of archaeological material (Abascal-M et al 1974). Furthermore, Pollard (1982) states that the Brookhaven Laboratory "routinely log-transform all their NAA data before clustering".

This confusing array of contradictory statements was tackled by Pollard in his 1982 paper. After detailed study of the statements and, where possible, the data, he came to the conclusion that some of the elemental distributions described as normal could in fact also be almost lognormal in cases where the concentration mean was high and the standard deviation relatively small. He suggested that this indicates that some of the contradictory statements can be reconciled if the nature of the particular elements being studied is considered alongside the group values for the mean and standard deviation. Pollard claimed no actual answer to the problem of the shape of the frequency distribution of elemental concentrations in groups of similarly produced pottery. Instead he decided to compromise, only suggesting that data for elements such as Cr, Mn and Ni should be lognormally transformed, and data for all other elements studied should be left in the raw state.

Because of the importance of elemental concentration data normality in terms of its effect on the 'success' of many multivariate statistical tests, the normality of the frequency distributions of concentrations for the three kiln-group fabrics were studied. Thus the Hermitage sherds, the Laverstock fine-wares and the Laverstock coarse wares were all treated as discrete groups liable to exhibit different concentration curves. It must be stressed that no lengthy consideration of the possible effects of the raw materials being 'mixtures' was made at this stage, although it is to be expected that clays derived from single geological deposits would be likely to exhibit more regular elemental concentration curves than those resulting from blends of clays and tempers. A comparison was, however, made between the distributions derived from the differently-tempered Laverstock fine wares and coarse wares, and the distribution produced when all the products from the site were treated as one.

Study of univariate normality

Using a **MANOVA** program from the **SPSSX** package (SPSS inc. 1986) a variety of simple statistics that indicate the degree of 'normality of distribution' of variables can be computed. These tests include a number of simple visual plots that are useful for giving quick indications as to the relative normality of distributions of values. These do not, however, provide quantifiable values with which to compare or rank such distributions, in terms of their normality.

The visual indicators of normality available when using **SPSSX** include stem-leaf plots, normal probability plots, and detrended normal probability plots. The first of these three types of display produces a vertical histogram of the data, which is divided into intervals. The degree of normality of these plots can be gauged by eye against 'expected' normal distributions which are represented as a dotted line. 'Normal probability plots' rank the observed values of a variable from the smallest to largest and these are then paired with expected normal values derived from a standard normal distribution, for a sample of identical size. A straight line graph indicates normality. Deviations from this line indicate degrees of non-normality. To further assess the linearity of the normal probability plot, the difference between the observed and expected plots can be calculated, and the resultant difference is then plotted against the original values. If the observed sample is from a normal distribution, these differences should be fairly close to zero, and be randomly distributed above and below this point.

All three types of display were used on recognisable sub-units in the total data set. These sub-units were the concentrations data for all elements analysed, for each of the three ware types identified in the Hermitage and Laverstock assemblages. Thus, with ten elements being studied in each ware group, there were ten times three displays of each test being produced. The result of this was ninety different displays in total, each of which provided a visual indication of the 'normality of the distribution of values for a particular element, in a particular type of kiln product. It was not felt necessary that such a vast array information, that could only be subjectively interpreted, should be reproduced here. Thus, one example of each type of display has been included in the appendices, and a brief observation made that the elements identified as having the least normal distributions from these tests were fundamentally the same set of elements that can be shown to have the least normal distributions through the use of tests of skewness and kurtosis in the next section. The advantage of these latter tests over the former group is primarily that, with the latter, an actual value can be attached to suggestions of 'normality of distribution' that remain very vague and subjective otherwise.

Skewness and kurtosis

Standard deviation and other measures of dispersion are concerned with the spread of values in a frequency distribution. In a sense they measure the 'width' of the distribution. Such measures of do not, however, provide information about other characteristics of the shape of a distribution. Other measures such as mean, median and mode only identify single specific points within a distribution.

Two measures that have been specifically designed to quantify aspects of the shapes of frequency distributions are skewness and kurtosis. Skewness is a measure of the assymmetry of a distribution, whereas kurtosis quantifies 'the peakedness' of a distribution.

Skewness

Skewness measures the extent to which the bulk of the values in a distribution are concentrated to one side or the other of the mean. If the majority of values are below the mean, the distribution is positively skewed; if there are more values greater than the mean, the distribution is negatively skewed. A perfectly symmetrical distribution, such as the normal or lognormal distribution, has no skewness.

The most commonly used measure of skewness, and the one that is used later is calculated thus:

$$\text{Skewness} = \frac{\sum (X-X)^3}{no^3} \qquad \text{(Davis 1986)}$$

Where $(X-X)^3$ is the cube of the deviations of the values from their mean, o is the standard deviation and n is the number of values. A symmetrical distribution has a values of 0.0. Therefore both normal and lognormal distributions have a skewness value of 0.0.

Kurtosis

Kurtosis measures the extent to which values are concentrated in one part of a frequency distribution. If one class, or group of adjacent classes, in a distribution contains a large proportion of all the values, then the distribution has a high degree of kurtosis. It is therefore very 'peaky' or leptokurtic. In a distribution with a low degree of kurtosis (platykurtic), each class contains a similar proportion of the values.

The measure of kurtosis used subsequently is as follows:

$$\text{Kurtosis} = \frac{\Sigma(X\_X)^4}{no^4} \qquad \text{(Davis 1986)}$$

Where $(X\text{-}X)^4$ denotes the fourth power of the deviations of the values from their mean. o is the standard deviation and n is the number of values. A leptokurtic distribution has a kurtosis value of greater than 3.0. A platykurtic distribution has a kurtosis value of less than 3.0. Normal distributions have kurtosis values of 3.0.

Results of the study of frequency distributions of elemental concentrations

To study the shape of the elemental concentration distributions for the three different kiln-group fabric types, and quantify this is some way as a comparison with normal distributions, values of skewness and kurtosis were calculated. This was carried out using a **frequencies** program from the **SPSSX** package, run on the Dorset Institute mainframe computer. The printout was in the form of printed values as well as histograms overlaid with example-normal curves. One histogram was constructed for the data from each element from the following groups:

i) The Hermitage samples.
ii) The Laverstock samples.
iii) The Laverstock fine wares.
iv) The Laverstock coarse wares.

Histograms were also created for these same groups with log-transformed data. This resulted in a total of eighty histograms, a large enough volume of information to necessitate some form of summarisation. Thus the skewness and kurtosis values for all of the histograms were tabulated, the tables relating to the four categories described, and their log-transformed counterparts. The skewness and kurtosis values for all these distributions of concentrations were in each case compared with the expected values for a normal distribution with identical mean. In this way some indication of which elemental distributions were closest to normal, and which were least normal, could be gained. These summary tables are listed as Tables 4.1 to 4.4, for the untransformed data, and Tables 4.5 to 4.8 for the log-tansformed data.

Histogram summary table 4.1

Normality of the frequency distributions in data derived from the Hermitage sherds.

Data from 78 samples were used in these tests. The skewness factors ranged from -0.935 (Mg) to 5.619 (Mn). The least skewed, and therefore potentially most normal distributions were those for Al, Cr, Ni and Ti. The kurtosis factors ranged from 0.081 (Mg) to 39.863 (Mn). Normal distributions exhibit kurtosis factors of 3.0. Few elements showed distributions close to this, the only close value being for Fe (3.929) with Ni at 1.595 and K at 1.170. The only element thus showing normal characteristics for both skewness and kurtosis was Ni, with Cr and Fe as other distributions with some normal characteristics. The Ca and Mn distributions were the most non-normal of the whole suite of elements.

Histogram summary table 4.2

Normality of the frequency distributions in data derived from the Laverstock sherds.

Data from 78 samples were again used. The skewness factors ranged from -0.574 for Mg to 4.505 for Cu. The least skewed, and therefore potentially most normal distribution, was that for Fe, with a skewness value of -0.013. Other slightly skewed elements were Al and Cr, followed by Mg and Ti. The kurtosis factors ranged from -0.894 for Fe to 24.174 for Cu. The potentially most normal distributions were Ca at 3.697 and Ti at 1.685. Most other distributions were significantly platykurtic, with only Cu and Mn being significantly peaked. Using this particular data set no frequency distributions are therefore very normal, the closest being Ti with perhaps Cr a poor second. This lack of normality in the distributions for the Laverstock material is probably due to the presence of two fabric types within this group. These finewares and coarsewares have already proved to be separable using some bivariate plots of concentrations (Figs 4.1 to 4.4), and the elements most useful in such separations, Mg and K, do exhibit very non-normal frequency distributions here. This must surely result from their distributions being partially two-peaked, something that is visible in the actual histograms themselves. A more valuable approach to the elemental frequency distributions of the Laverstock data must therefore be one which studies them seperately.

Histogram summary table 4.3

Normality of the frequency distributions in data derived from the Laverstock fineware sherds.

The skewness factors ranged from -.0285 (Fe) to 5.252 for Cu. This is in fact quite a narrow distribution with six of the ten elements producing distributions in the -0.3 to +0.3 range. The least skewed and therefore potentially most normal distribution was that for Cr at 0.035, followed by Al, Ti, Ni, K and Fe. The only elements to show very skewed distributions were Ca and Cu. The kurtosis factors showed more variety with one extremely leptokurtic distribution for Cu (34.268) and a number of significantly platykurtic distributions (Fe, Ni, and Ti). Two elements had kurtosis values approaching that for normal, these being Ca (3.556) and K (2.263). Two other distributions were quite close to this value, these being Mn and Mg. The overall best match for a normal distribution was K, with only Al and Mg also showing affinity to normal.

Histogram summary table 4.4

Normality of the frequency distributions in data derived from the Laverstock. coarseware sherds.

The skewness factors ranged from -0.503 to 3.638. the most skewed elemental distributions being Cu (3.638) and Ca (3.077), with Mn and K not far behind. Two elements were only very slightly skewed, these being Ni (0.012) and Cr (0.087). Other factors close to zero included Al (0.486) and Ti (-0.503). The kurtosis factors were however predominantly large, with five elements giving factors above 6.3 and a further four elements having minus factors. These distinctly non-normal curves are probably a result of the data set being too small to produce proper curves. Only twenty-one samples were used in this distribution which is obviously too few to provide really meaningful results. When selecting those elements with the most normal distributions over both factors, difficulties arise in finding any candidates whatsoever.

Because a number of authors have suggested in the past that many elements produce lognormal frequency distributions in data from geochemical deposits (Pollard 1982), the tests as illustrated in tables 4.1 to 4.4 were carried out a second time, but this time the elemental concentrations were converted to their natural logarithms. It was hoped that some of the elements which had produced non-normal distributions when particular groups of samples were studied, would produce more normal curves when the logarithms of the concentration values were plotted.

Histogram summary table 4.5

Distributions of log-transformed data for Hermitage samples.

The most normally distributed element in this group before log-transformation was Ni. After transformation this element did not show a significantly less normal curve, with a skewness of -0.681 and kurtosis of 1.839. The least normal elements before transformation were Ca and Mn. These were certainly much closer to normal, in both skewness and kurtosis, after transformation, but with skewness factors of 0.996 and 1.296 respectively, they could not be matched very closely to a normal distribution.

In summary it would seem that the log-transformed data for the Hermitage samples is not significantly more normal than the untransformed data. It is probably not worthwhile adopting log- transforms for any of the elements here.

Histogram summary table 4.6

Distributions of log-transformed data for Laverstock samples.

In the untransformed state only the Ti data proved anything like normal with this group of sherds. With the log-transformed values shown in table 4.6 there is, not surprisingly, very little improvement. As stated previously the divided nature of the data, deriving from two identifiable types of ceramic, must be the cause of this great lack of normality in both the transformed and the untransformed frequency distributions.

Histogram summary table 4.7

Distributions of log-transformed data for Laverstock fineware samples.

With the untransformed data the most normal distribution was that for K, followed by, albeit not very closely, Al and Mg. After log-transformation the Mg data is greatly improved with a skewness of -0.271 and kurtosis of 2.636. The Al frequency distribution, however, is no nearer to normal and neither are most of the other elements. The exeption is K which was originally quite normally distibuted. The log-tansformed frequency distribution is a poorer match for normal, but it is still good in comparison to most of the other elements.

Histogram summary table 4.8

Distributions of log-tansformed data for Laverstock coarseware samples.

Before log-transformation most of these elements showed non-normal distributions and it was suggested that this is a result of the data set being too small for adequate histograms to be constructed. This is probably backed up by the log-transformed data where, although individual element scores for skewness and kurtosis have mostly improved, none of the combined values suggest a normal curve.

In summary the skewness and kurtosis calculations do not provide much evidence to support the use of log-transformed data for multivariate statistical tests. It must be stated that, in many cases, the data sets do not seem to be very normal or log-normal. Some elements are better than others, however, and they will serve well to indicate at least those which are most non-normal, and therefore most worthwhile avoiding inclusion in further work involving multivariate statistics.

The elements with the least normal distributions across most or all the kiln and fabric groups in the untransformed data are Cu, Mn and perhaps Ca. After transformation there are no significant improvements for any of these elements, suggesting that they do not possess lognormal distributions either.

4.3. F-tests and t-tests on the pilot study data

F-tests and t-tests were carried out on the pilot study data to establish whether the distributions of elemental concentrations, for identifiable groups of material, were the same; i.e. whether these samples derived from different populations.

The groups of samples used were as follows:
(i) Hermitage material and Laverstock material.
(ii) Laverstock finewares and Laverstock coarsewares.

The F-test

Tests to determine equality of variance for groups of samples are based on the F-distribution. This is a theoretical distribution of values that would be expected by randomly sampling from a normal population and calculating, for all possible pairs of variances, the ratio;

$$F = \frac{S_1}{S_2}$$

where S^2 = the variance of a group of samples.

This distribution cannot be negative as it is the ratio of two positive numbers. Furthermore the sample variances will range more from trial to trial if the number of observations used in their calculation is small. Thus the shape of the F-distribution changes with sample size and the concept of 'degrees of freedom' must be used to account for this. The F-distribution is in fact dependent upon two values of V (degrees of freedom), one associated with each variance in the ratio. Furthermore, because the ratio of variance is always made positive, only one-tailed tests are needed.

Each test has two possible outcomes. The null hypothesis (H_0) is where the variances of the two parent populations are the same, the alternative hypothesis (H_1) states that they are different. Thus the test hypothesis is:

$$H_0 : 0_1 = 0_2$$

against $$H_1 : 0_1 \neq 0_2$$

The degrees of freedom used for such a test would be $(n_1 - l)$ for V_1, and (n_2-1) for V_2.

It is normal to carry out an f-test prior to a t-test when no knowledge of the population parameters is available. If no significant difference is detected between the sample variances, it is then generally 'safe' to continue with a comparison of the means.

In the tests of the data from the pilot study, the population parameters are obviously not known, the population being elemental concentration measurements from all sherds of a particular type from all vessels produced at a particular site. It is obviously impossible to tell what these distributions actually look like, but certain assumptions must be made concerning their normality for the successful execution of any statistical tests on samples derived from these populations. These assumptions were discussed in section 4.2.

The T-test

The t-distribution is another distribution that varies with sample size. It is generally similar to the normal distribution which it approaches in shape with increasing sample size. The t-test can be used to test the equivalency of population means and thus to determine whether groups of samples derive from different parent populations.

The t-statistic may be computed by:

$$t = \frac{X_1 - X_2}{S_e}$$

where;

X_1 = mean of sample 1

X_2 = mean of sample 2

S_e = standard error

But S_e must be based on both samples and therefore is generalised as;

$$S_e = S_p \frac{1}{n_2} + \frac{1}{n_2}$$

Here S_p is the pooled estimate of the standard deviation found by combining the sample variance of the two data sets;

$$S_p^2 = \frac{(n_1-1)\,S_1 + (n_2-1)\,S_2}{n_1 + n_2 - 2}$$

The null hypothesis is therefore $H_0 : \mu_1 = \mu_2$

against the alternative $H_1 : \mu_1 \neq \mu_2$

To obtain the initial value of t from the table, two items must be specified. These are the desired level of significance (chosen) and the degrees of freedom, which are (n_1+n_2-2), as two parameters are estimated.

Results of f-tests and t-tests on the pilot study data

F-tests and t-tests to compare the groups of samples from the two kiln sites; Table 4.9

One f-test was carried out on data for each of the ten elements studied. The null hypothesis (H_0) can be stated as:

The parent populations of the two groups of samples have equal variances;

$$H_0 : 0_1 = 0_2$$

The alternative hypothesis states that they do not;

$$H_1 : 0_1 \neq 0_2$$

The two groups of samples are those from Hermitage (group 1) and those from Laverstock (group 2). The parent populations are all sherds from all vessels produced at each kiln-site; that is, the total possible variation in sherds derived from each site. Group 1 comprises 79 samples, group 2, 78 samples. Although in total 80 samples from each site were actually measured, the data from three samples were omitted from the calculations. This was because the concentrations received for these samples were so very different from all others that it was assumed that they must be the result of errors. These errors could have derived from sample preparation, measurement, or be a result of the sherds being 'rogues', produced at different kiln-sites altogether. The inclusion of such widely differing sets of concentrations in most statistical tests impairs the precision of analysis of the general body of data. These extreme values often have extreme effects on the functions that are derived, which by far outweigh the significance of such single sherds. It is therefore usually sensible to omit such 'rogues' from all calculations, an acceptable procedure in a complex multi-step analytical programme where random errors can be introduced in many different ways.

The degrees of freedom associated with the tests are:

$(n_1$-1) for V_1
and $(n_2$-1) for V_2
=> (79-1) + (78-1)
=> 155 degrees of freedom

The level of significance chosen for these tests is, as ever, a fairly arbitrary number. For the purpose of this work a 5% level has been set for all tests. Using these criteria a critical value of F was found from the tables (Neave 1978) to be 1.32. Therefore if the F-values for any element exceeded 1.32, the null hypothesis would be rejected and the suggestion could be made that the samples derived from separate parent populations. This was the case for seven out of the ten elements studied (see Table 4.11, summary of simple statistical tests). The three elements for which the null hypothesis stood were Ni, Ti and Cr.

The null hypothesis for the t-test on the two kiln site groups was that the population means of the two samples were the same, the alternative being that they were not the same. With 155 degrees of freedom (d.f.) at the 5% level of significance, the t-value above which the null hypothesis would not stand was 1.96. Only three elements did not produce critical t-values of this size; they were Ca, Al and Cr.

F-tests and t-tests to compare the coarsewares and finewares from Laverstock; Table 4.10

Of the 78 Laverstock sherds whose elemental concentrations were deemed useful, 21 were classified as fabric 3 (coarse quartz-gritted) and 57 as fabric 2 (fine ware). It was felt to be important that this visually identifiable difference could be chemically and statistically confirmed. Therefore f-tests and t-tests were carried out on the data from these two groups of samples. The results can be seen in Table 4.10, summarised in Table 4.11.

Using the f-test to study equality of sample variances it was found that the critical value of f was 1.81, with 76 degrees of freedom at the 5% level of significance. The f-scores for four elements were over this value, these being Ca, Ni, Mn and Cr. Thus H_0 was rejected for these four elements.

The t-test null hypothesis was that the sample means of the two groups were the same. This would be rejected if the critical value of t exceeded 1.98, with 76 d.f. at the 5% level of significance. The values for four elements were above this level, these being Mg, Ni, Ti and K.

Conclusions from the results of f-tests and t-tests

By studying the relative values of f and t for each element and each inter-group comparison, a form of ranking could be achieved indicating which elements would be of most use in separating particular groups of samples.

When attempting to separate material from the two kiln-sites, little faith could be placed in data for those elements where the null hypothesis for f in the first test was not rejected. Such elements would prove even less useful if the comparison of sample means resulted in this null hypothesis standing as well. Only one element, Ti, fell into this last category, with Ca, Ni, Al and Cr all showing equality of group variances or means. Those elements liable to prove of most use in separating the kiln-groups can be, in part, indicated by studying the other f and t scores. This information suggests that Fe, Mg, Cr and Mn may well prove of use in this capacity.

For the comparison of the Laverstock wares, fewer elements were to prove useful separators of the two groups of samples. This time only one element provided enough difference in sample means and variances to reject both null hypotheses, that being Ni. The other elements where sample variances proved significantly different were Ca, Cr and Mn. The t-test null hypothesis was rejected for K, Mg and Ti, besides Ni. Any further statistical analyses using this data would therefore have to include the information concerning Ni concentrations at least, if the separation of the Laverstock coarsewares and finewares was to be retained. The best separators of sample means and variances were Mg and Mn respectively.

These statistical tests therefore suggested that most of the elements were useful for separating at least two of the groups studied through a comparison of sample variances or means. Some elements, however, were definitely much better than average, specifically Fe, Mg and Ni.

4.4 Inter-element correlations

One of the most important criteria for the selection of elements to be used in future studies must be the degree of inter kiln-group separation achieved using the single elemental concentrations data. The possibility that the same separation is also being achieved through the use of other elemental measurements must also be taken into account. Where such a situation exists the elements are said to be 'highly correlated'. This linkage between the variation of two or more elements is quite common in geologically derived materials and where it exists it is sensible to cease the analyses for one of each pair of highly correlated elements, thus saving much time and effort for a negligible drop in analytical achievement.

It is generally accepted by authors in the field of provenance study that data from highly correlated elements are not used (Perlman and Asaro 1969, Wilson 1978). The reasons for this are not, however, just the pragmatics of time and money. There is a real danger that the complex multivariate statistical tests used when dealing with such data can become biased through elemental correlations. This is because many tests, except those based on Mahalonobis distance calculations (e.g. some cluster analyses) are calculated assuming negligible correlation. If correlations do actually exist in such situations, then the inter-group separating power of the functions can be severely reduced. An example of this can be seen in Figures 4.5 and 4.6, which are taken from a paper by Vince Robinson (unpublished). Here, because the cluster analysis treats variables as independent it "overestimates the volume of (hyper)space occupied by each group in terms of individual standard deviations" (Robinson unpub.). Wilson suggests that all correlations with a coefficient of over 0.5 should be deemed of dubious value. This corresponds approximately with the 0.05 level of significance (Wilson 1978). This has been used as the basis for suggestions based on the three correlation matrices identified as Tables 4.12, 4.13 and 4.14.

The Correlation Coefficient

Visual indications of positive and negative correlations can be gained if the raw concentrations for two elements are plotted against each other. Positive correlations appear as diagonal straight lines sloping up towards the right-hand side of the plot (away from the y-axis); negative correlations appear as straight lines sloping down away from the y-axis. To quantify these correlations, however, an actual value is needed. This is known as the correlation coefficient.

Before correlation coefficients can be computed, the variance-covariance matrix for all elements involved must be calculated. This is a matrix with rows and columns representing all the elements (variables), the cells being filled by the sums of squares or sums of products of each pair of variables. Once this matrix has been created a correlation coefficient (r) can be calculated for each cell in the matrix. This is defined as "the ratio of the covariance of the (two) variables to the product of their standard deviations" (Davis 1986).

$$r_{jk} = \frac{cov_{jk}}{S_j \, S_k}$$

For example, with a data set comprising just the Hermitage sherds, r for EL1 and EL2 can be calculated as follows.

From the variance-covariance matrix the value of covariance between EL1 and EL2 with this data is 0.04329. The standard deviations of the two sets of elemental measurements on these samples are

EL1 (Magnesium)	s.d. = 0.14135
EL2 (Calcium)	s.d. = 0.75213

$$r_{Mg/Ca} = \frac{0.04329}{0.14135 \times 0.75213}$$

$$r_{Mg/Ca} = 0.40721$$

Using the **SPSSX** package a **MANOVA** (multivariate analysis of variance) program can be constructed that provides the correlation coefficients required. These are displayed in matrix form as with the variances and covariances.

Tables 4.12, 4.13 and 4.14 are correlation coefficient matrices of data from all the ten elements, each matrix showing the coefficients derived from separate subsets of the total data. These three subsets are the data for the Hermitage sherds, the Laverstock fine wares and the Laverstock coarse wares respectively.

Discussion of Tables 4.12, 4.13 and 4.14

Overall indications of the most correlated elements, as seen in these tables, has been summarised as Table 4.15. Here all correlations of over 0.5 have been listed for each of the three groups of samples.

Number of Significant Correlations (From Table 4.15)

The elements exhibiting most significant correlations with others are magnesium, aluminium and potassium. Calcium, copper and manganese do not show any significant correlations with any other elements.

The presence of significant inter-element correlations was not ranked as the most important criterion during selection of those elements to use in subsequent analyses. Of the four elements eventually chosen as the basis for further work, two, magnesium and aluminium, were shown to have significant correlations, as seen in Table 4.15. There was also some significance in the Fe-Ni correlation for the Laverstock fine wares. Despite this, these four elements remained the selected group. The process by which these choices were made can be found later in this chapter. These particular selections were mainly based on the separating power of the elements when various multivariate statistical tests were applied to the three kiln fabric groups. The alternative elements available were, on the whole, either of little use in these tests, or difficult to measure accurately. Potassium proved to be a useful discriminator, but was very heavily correlated with most of the chosen elements. Its elimination was, however, also a result of chemical considerations (see section 4.6).

4.5 Multivariate Statistical Analyses.

With all the statistical tests described so far in this chapter one problem arises, that of interpreting the behaviour of more than one or two variables at any one time. Statistical techniques that consider more than two variables come under the general heading of 'multivariate techniques'. Despite being sometimes different to, and usually more complex than, the types of tests discussed so far, multivariate techniques are still reliant on a number of basic assumptions concerning the data. The most important of these, as has already been stated, is the necessity for the data sets used to be normal, or near-normal, in their shape of distribution. Unfortunately, it is very difficult to measure the joint normality of the variation in more than one variable considered together. Despite this it can be stated that, for a set of variables to have a multivariate normal distribution, each one taken individually must first be normally distributed. It does not, however, follow that a group of normally distributed variables automatically possess a normally distributed multivariate distribution. By studying the degree of normality of the individual variables, however, any indications of large degrees of non-normality will suggest that the assumption of multivariate normality is likely to be violated. Sections 4.2 and 4.2 gave some indications as to the degree of univariate normality of the analytical data for each of the three wares studied from the Hermitage and Laverstock assemblages.

As has been discussed in section 4.4 another basic assumption concerning the variables that are used in multivariate statistical tests is that there is little correlation between individual variables. A test is available using a **MANOVA** program with the **SPSSX** package that identifies if correlations are in fact present in the multivariate data sets. This is Bartlett's Test of Sphericity (Norusis1985). This tests the hypothesis that the population correlation matrix is an identity matrix, that is, all diagonal terms are equal to 1 and all off-diagonal terms are equal to 0. If the variables are independent, the observed correlation matrix is expected to appear similar to the identity matrix, with small off-diagonal elements. The test is based on the determinant of the within-cells correlation matrix. A determinant that is close in value to 0 indicates that one or more of the variables can almost be expressed as a linear function of the other dependent variables. Therefore in such a case the hypothesis that the variables are independent would be rejected.

A Bartlett's Test of Sphericity was carried out on the kiln sites data. The resultant statistics were:

Determinant = 0.13329
Bartletts Test of Spher. = 2.99.93398, with 45 d.f.
Significance = 0.0000

As the significance level here is less than 0.0005 (in fact 0.0000), the hypothesis that the correlation matrix is an identity matrix is rejected. Thus there are significant correlations between elements in the data set.

To identify where these correlations actually occurred variance-covariance matrices were derived, using a **MANOVA** program, for each of the three ware groups and for each pair of elements. These matrices were then combined to form a pooled matrix.

The homogeneity of these matrices was then studied through the calculation of Box's M test. This is based on the determinants of the variance-covariance matrices in each cell, as well as of the pooled matrix. The significance level for this test can be based on either an F or Chi-squared statistic and both approximations are provided in the **MANOVA** program output.

The values for the Box's M test on the three wares from the kiln sites were:

Box's M =	668.12542
F with (110,11330) d.f. =	5.23190, p = 0.000 (approx.)
Chi-Squared with 110 d.f. =	581.99505, p = 0.000 (approx.)

As the significance levels are both very low (i.e. 0.000), it can be concluded that the variance-covariance matrices for the three groups are not homogeneous. Thus the indications are that the inter-element correlations that do exist in the data are strongly ware, or site, specific and are thus likely to derive from 'real' geological factors, rather than measurement or sampling processes.

Multivariate statistical tests used

Most multivariate statistical tests that are applied to archaeo-geochemical data are of a classification type. This means that they attempt to create maximum separation between the samples in the data set on the basis of the measured variables, and then group this data into groups, or clusters, that are relatively homogeneous and distinct from all other groups. Cluster analysis is the obvious example of this type of test, with principal components analysis (PCA) representing a variation that includes only the 'separation' stage of the above description. Both these tests are, however, internally based, that is, they do not depend on *a priori* knowledge about relationships between samples to formulate the new factor scores. In discriminant analysis, however, the number and members of the groups to be identified are set prior to analysis, the discriminant functions being derived to produce these particular divisions in the sample set. Thus discriminant analysis is not a classification method, the 'classification' not being a product, but a producer, of the derived functions. Hence discriminant analysis is more likely to produce the required results, as the 'desired outcome' is dictated, in contrast to the situation where the outcome is unknown in advance.

Such benefits also have their shortcomings as bias is introduced through this dictatorial approach to analysis.

When a discriminant function is created the original set of measurements for each sample (elemental concentrations for each sherd) are transformed into a single discriminant score. That score, or transformed variable, represents the sample's position along a line defined by the discriminant function. The discriminant function itself is created to separate pre-determined groups of samples. In a case where two groups are being separated, the discriminant function is created by the identification of a transform which gives; "the minimum ratio of the difference between the pair of group multivariate means to the multivariate variance within the two groups" (Davis, 1986, 479). If the two groups are represented as two clusters of points in multivariate space, then what is being sought is the orientation along which the two clusters have the greatest separation while simultaneously each cluster has the least inflation.

For a discriminant analysis to be of any use the actual data set must satisfy certain conditions. A particularly important criterion is the 'normality' of the data. Sets of concentrations derived from geochemical data ideally give normal distributions when the data are plotted by simple graphical methods. A normal distribution is symmetrical and thus the mean of the distribution is also the median point. As the calculation of a discriminant function is based around the separation of the means of the groups being discriminated between, if the means of the groups are very different to the medians of the distributions, then the success of the function will be impaired. If the data being used derive from many variables, and the distribution for each variable varies greatly from 'normal', then the difficulties are compounded still further and the derived function becomes worthless. Therefore before the results of a discriminant analysis are accepted unconditionally, the 'normality' of the data being used must be studied. Thus a further set of statistical analyses were carried out to study, amongst other factors, the normality of the data being used. These analyses were described in section 4.2.

The actual type of discriminant analysis used in this chapter is a 'stepwise discriminant analysis'. Stepwise methods enter and remove variables one at a time, selecting them on the basis of specific criteria. Different criteria are used for different stepwise methods. The method that was used in this case was 'Wilks method' which enters the variable that minimizes the overall Wilks' lambda coefficient.

In contrast to discriminant analysis, the success of a principal components analysis (PCA) does not rest on the normality of the data. PCA is a form of factor analysis. All techniques of this nature attempt to reveal a simple underlying structure that is presumed to exist within a set of multivariate observations. Such structure is expressed in the pattern of variances and covariances between variables, and the similarities between observations. PCA operates by extracting the eigenvalues and eigenvectors from a variance-covariance or correlation matrix. If m variables are measured on the samples, an m X m matrix can be computed and m eigenvalues and m eigenvectors can be extracted. Because a variance-covariance matrix is symmetrical, the m eigenvectors will be orthoganal. Therefore where the original data set is bivariate, two eigenvectors and two eigenvalues can be calculated. The eigenvectors are then used to orientate the principal axes of an ellipsoid described around the eigenvectors themselves and the 'origin' in two-dimensional space (Figure 4.7). The eigenvalues then represent the lengths of the two principal semiaxes of the ellipse, and the two principal components that it is possible to derive in this two-dimensional example are represented by the principal axes of this same ellipse. What has in actual fact happened is that new axes have been created along which the data scores can be replotted. The first of these new axes contains more variance than was present in any one of the original variables and in a case where more than two variables were originally used, the same would be true of further axes. The data have been converted from their original form into principal component scores by projection onto the new axes. Thus through the use of principal components analysis most of the variance inherent in a data set with m variables can be transferred into a new form represented by, for example, two variables.

In the case being studied here, the work on the material from the Hermitage and Laverstock kilns, the PCA results were only marginally less successful than the discriminant analysis results. That two fundamentally different techniques produce results of such similar quality and character is reassuring. This suggests that the groupings of samples that were produced are 'real' and are not merely a product of the data manipulation.

Graphical representations of both a discriminant analysis and a principal components analysis on all the kiln site material, using ten elemental concentration variables, are shown in Figures 4.10 and 4.9. In the former, the discriminant test, the two kiln groups were initially defined and one function was derived to separate them. The complete success of this is visually obvious from the histogram plot, although it can also be identified as 100% correct classification on Table 4.17 as well.

This 'success' or correct classification in discriminant analysis can be explained as follows. Once the pre-determined groups of samples have been discriminated between (the analysis phase), the results are used to classify all the samples into the groups they are most likely to belong to. The classification data are tabulated as shown in Table 4.16. The 'case' or sample is first identified, and then the group it actually belongs to is stated. This is followed by the identification of the group it is statistically most likely to be a member of and this is in turn succeeded by the probability of a case in this group being this actual distance from the centroid (P(D/G)). The probability of the case being a member of this group is located in the next column (P(G/D)). In an analysis where two possible groups are identified, the probability of any sample being in one group prior to analysis is 0.5. The after analysis probabilities for all the cases in Table 4.16 are all 1.0000 for the highest group, which indicates that these samples are definitely in the stated group when compared against the second highest group. The second to last column confirms this by identifying their probability of being members of the second group as .0000. The success of this part of the program is collated in a classification results table, e.g. Table 4.18. This identifies the percentage of each group of samples that have been correctly and incorrectly classified using the techniques explained above.

In Figure 4.8 two principal components of the data have been plotted against each other. It is apparent that the separation is over 90% using only the first principal component, and complete when this is plotted versus the third principal component. A degree of separation between coarse and fine ware material from Laverstock is also evident on this plot. This intra-kiln site division can be amplified if the discriminant analysis part of the package is used, with the factors being derived to separate the Hermitage sandy ware and the Laverstock coarse and fine wares. Figure 4.9 shows these two sets of discriminant scores plotted versus each other, with the classification success table appearing as Table 4.18. Again the inter-kiln site discrimination is most distinct and the variation between the two Laverstock wares is also shown to be fairly pronounced, only three sherds out of 78 being wrongly classified here.

Another division within the data that can be looked at is the possibility of differences between the material from the two different kilns from Laverstock that were sampled. These two kilns represent roughly the start and finish of the approximately fifty-year lifespan of the industry, and a shift in raw material extraction or usage might be expected over this time period, producing different group 'fingerprints' for the material from the two kilns. The scatterplot of discriminant scores for this analysis is seen in Figure 4.10, with the classification success table appearing as Table 4.19. The success of separation is very good here, being about 80% between the two groups of Laverstock samples. Thusit is apparent that there was definitely some difference in analysed chemical content of samples from the two Laverstock kilns, indicating that the geochemistry of the raw materials used for making ceramics fired in the two kilns was slightly different. These differences are minimal when compared to the inter-site variation with the Hermitage samples. Thus, despite this 80% success in separating Laverstock Kiln 1 and Laverstock Kiln 6 material, there is still no danger of confusing such samples with any derived from Hermitage, and hopefully elsewhere as well.

Another possible source of variation in the data from each kiln site is based on the form of vessel that the sherds derive from. In the case of the Laverstock industry, the two most heavily represented form categories (as classified in chapter 1), are cooking pots and glazed jugs. As the former was only produced in its own exclusive fabric (with some internal variation), these factors have already been studied through the above investigation of differences between Laverstock coarse ware and fine ware sherds. As only three sherds of Laverstock products in the other two form categories were studied, intra-kiln site variation derived from these factors could not be accurately determined. It must be said that no visual differences could be discerned between the fabrics of Laverstock jug sherds and the pieces of bowls and roof furniture. Similarly with the material from Hermitage, few visual differences were apparent in the fabric of the sherds that could be related to the type of vessel the pieces derived from. The exception to this was with the ridge tiles, which tended to br more reduced than the vessels. The possible reasons for this have already been discussed in Chapter 1, where it was also noted that this material may actually be slightly later in date than the vessels.

4.6. Selection of elements to be included in further analyses.

As has already been explained, it was decided that some of the elements initially studied would have to be left out of future work, so as to save on the time spent actually carrying out the analyses. In this way time would be made available for the study of material from many more sites, thus creating a more complete data set which would be more suited to answering questions concerning the micro-economics of medieval ceramic production.

The relative usefulness of the ten elements used to create the first data set could be quantified in a number of ways:

1. By comparison of the effectiveness of the raw concentration data in splitting up the kiln material, when plotted bivariately.

2. By identification of those elements that have normal distributions of concentrations for groups of samples from particular provenances.

3. By identification of those elements that show large 'between groups' variation, when t-tests and f-tests are carried out on the raw concentrations.

4. By identification of those elements that contributed most to the derivation of useful multivariate functions.

Some results of 1. have already been shown (Figures 4.1 to 4.4), the elements used for these plots being those that proved most useful out of the ten studied. These were Fe, Mg, Ni, Al and Mn. The simple statistical tests in sections 4.2 and 4.3 identified the elements that were most useful in the multivariate analyses; this did vary, however, depending on the actual type of test being carried out.

With a stepwise discriminant analysis the best elements can be identified as those that are:

a) Entered first into the stepwise equation that derives the functions.
b) Those that have the largest discriminant function coefficients for each particular discriminant function.
c)Those that have normal distributions of concentrations for particular site and ware groups.

Most of this information can be made available when the particular analysis is run on the computer as it accompanies the printout of results. The exception is the data for category c), which can be found through the use of multivariate analysis of variance programs.

Below is a list of the five elements most useful in a discriminant analysis designed to separate the two site groups.

Element entered at step 1. Fe
2. Mg
3. Ti
4. Al
5. Ni

The best five standardized canonical discriminant function coefficients:

Fe	1.02673
Mg	0.78148
Al	0.42558
Ti	0.29653
Ni	0.26260

This information can be compared with similar tables derived from the analysis designed to derive two discriminant functions that separate the three wares found on the kiln sites, these being Hermitage sandy ware, and Laverstock coarse ware and fine ware. The tables for this analysis are shown below (best 5 elements only).

Element entered at step
1. Fe
2. K
3. Al
4. Mg
5. Ni

The best five standardized canonical discriminant function coefficients for both functions:

Function 1. Sandy ware vs. coarse ware and fine ware.

Fe	1.02473
Mg	0.71695
Al	-0.55592
Ti	-0.18044
K	0.11932

Function 2. Coarse ware vs. fine ware.

K -1.05587
Al 0.62049
Ni 0.46086
Ti-0.40350
Fe-0.24847

This information firstly shows quite dramatically the use of different elements to derive two differing functions. Function 1 has major contributions from Fe, Mg and Al, whilst Function 2 derives mostly from the K. Al, Ni and Ti data. Using this information alongside that derived from the earlier discriminant analysis, a 'best elements' list for the discriminant analyses can be drawn up. Such a list can be seen below.

Best elements for discriminant analysis in descending order of usefulness.

1. Fe
2. Al
3. Mg
4. K
5. Ti
6. Ni

If the principal components analysis is considered next, again the program printouts have to be scrutinised to find information concerning the relative usefulness of the various elements that were studied. As has already been explained, with principal components analysis (PCA) the derived factors represent variation across the whole data set as opposed to variation between previously determined groups of samples. Thus information that will prove useful here will be derived from one program which creates principal components representing variation between all the 160 kiln-site samples. A so-called 'scree plot', a graphical representation of the size of the eigenvalues calculated on this total data set, can be seen in Figure 4.12. Here the ten elements used are listed on the x-axis in the order that they were included in the analysis, selection here being based on the amount of additional variation provided by the data for that element. The y-axis indicates the percentage of the total variance of the data set provided by the eigenvalue for each element. The usefulness of this type of plot is that it gives an indication of the maximum number of factors that it is worth including in the analysis. This number is usually found by the identification of a 'shoulder' in the scree plot where the increase in percentage of variance gained levels out. In this case a shoulder can be seen after the fifth eigenvalue indicating that the use of the first five factors includes 82.5% of the total variance, with only an extra 5.4% being added through inclusion of the sixth factor. In actuality only the first four factors were used for the PCA carried out here utilising, in total, 75.5% of the variance.

Once these factors had been created, the actual factor scores for each case, or sample, had to be computed. These values were then displayed as bivariate scatterplots, with each of the four factors plotted against all others on separate graphs. Of these factors, or 'principal components', Factor 1 separated the material from the two sites with almost 100 per cent success. No factor separated the two Laverstock wares with such a a good degree of success, but Factor 2 gave a reasonable separation of these two types, as can be seen from Figure 4.9. Such a situation, where the first two principal components separate out three known groups, is an ideal case. This is because the first two components include the largest amount of variance found in any two factors, 54.6 % in this case. If principal components 3 and 4 were the most useful for the separation of these groups, the total variation included would only be 20.9%. Therefore no matter how successful this operation was, its statistical validity would be in serious doubt, due to these principal components representing only minor variations in the total data set. Thankfully such a situation does not exist here.

This study of the most useful factors leads directly to the identification of those elements that may prove most useful in future analyses using PCA. Each principal component is derived through the varying contributions of the ten variable elements. Therefore it is a simple process to study these contributions, or factor score coefficients, to identify which elements are most useful in the production of the discriminating factors. In this case they are principal components 1 and 2 in Table 4.20, which gave the scatterplot Figure 4.9. From Table 4.20 it is evident that the most useful elements in the derivation of Factor 1 were, in descending order:

Fe 0.27805
Cr 0.26066
Ni 0.24584
Mg 0.22520
Mn 0.19507

The elements contributing most to the variation within Factor 2 were:

Ti 0.48124
Al 0.42269
K 0.23993
Ca 0.14799
Ni-0.13980

From these figures a list of the five most useful elements was compiled. These were:

1. Fe
2. Cr
3. Ti
4. Al
5. Ni

If this list is compared with the six elements chosen from the results of the discriminant analyses, we find that the following elements appear on both lists:

Fe
Al
Ti
Ni

The decision could therefore be made that these four elements would be used in all future analyses on similar ceramics. But if this suite was used, in reality a quite poor separation of the two types of Laverstock material was achieved. This was because the Ti-derived variability of scores from Factor 2 in Table 4.20 did not separate the two groups, but rather accentuated the spread of values at the tails of the distribution. It was found that K or Mg had to be included in the factor calculations before a good separation of the two types of Laverstock pottery was achieved. Thus a decision was made to 'drop' Ti measurements in favour of Mg, which had shown good separation of these two wares in the original bivariate elemental concentration plots (Figure 4.2). Despite its great usefulness in separating the two Laverstock wares, K was not chosen for inclusion in future analyses. This was because it had been found that the addition of Potassium Chloride to all sample and standard solutions was necessary to inhibit flame ionisation error effects. Measurements of elemental Potassium would be impossible with this omnipresent background of approximately 2,000ppm K.

The final suite of elements chosen for analysis of all future non kiln-site material was therefore as follows:

Fe
Mg
Ni
Al

It was appreciated, however, that the addition of one or two other elements was still possible at a later date if the above suite did not provide powerful enough discriminating factors. The most useful of the statistical analyses were then carried out again but this time only four or five of the elements were used to derive the functions. Five element suites including the four chosen elements plus Mn, Cr and Ti were used to produce discriminant functions, as were four element suites including only two or three of the chosen elements. The success of all of these tests was then compared to that achieved when a discriminant analysis was carried out using only the four chosen elements. It was found that no other combination of four elements produced as good results as these. Furthermore none of the five element suites, these being the chosen four plus either Mn, Cr or Ti, produced results that were significantly better than those achieved with Fe, Mg, Ni and Al. This therefore confirmed that the chosen suite was the optimum, as had been previously suggested.

The four-element discriminant analysis that was used in these comparisons is shown graphically in Figure 4.13. The100% 'between sites' discrimination of the ten element example has been preserved, however, the separation of the two Laverstock wares is not quite as good, being only about 90%. This is due to the unavoidable loss of the potassium data, the only element that was dropped for reasons other than its degree of usefulness. Despite this the discrimination achieved without the help of K is still very good indeed. Figure 4.14 shows the success of a principal components analysis, using only the four element data. Again the separation of the Laverstock fine ware and coarse ware has been reduced, whilst the inter-kiln discrimination remains basically unchanged. This is obviously not a great loss as the actual ware of any potential Laverstock sherd is known prior to analysis anyway. One oddity about this plot is that the third principal component is used for the y-axis, rather than the second. The reason why the second component does not produce as good 'between wares' separation is not known. However, there is little cause for concern here as the total variation in the data accounted for by these two components is 68.6%, an acceptable proportion under most circumstances.

Chapter 5
Results of Analyses

5.1 Introduction to the methods used

The main body of this chapter is provided by descriptions of scatterplots of sherds from particular sites, produced through the use of two multivariate statistical techniques. These statistical methods, discriminant analysis and principal components analysis, were discussed in Chapter 4, and further consideration of how the functions and factors are derived will not appear here.

Concentrations data for the elements Al, Fe, Mg and Ni was produced for all the sherds defined in Chapter 2. The total number of samples analysed was 946. These derived from only 866 sherds as some multi-sampling was carried out on material from Hermitage and Laverstock (see Chapter 1).

When all the raw measurements had been converted to concentrations, the whole of the latter information was typed into files on a mini computer at the Dorset Institute, thus enabling statistical analyses using the available packages to be carried out. The package used for this work was **SPSSX** (SPSS inc. 1986). This is a multi-procedure package which enables a variety of multivariate techniques to be applied to very large data sets. Initially, as described in Chapter 4, three methods of multivariate analysis were applied to the total data set these being, cluster analysis, discriminant analysis and principal components analysis. With all three of these techniques a number of choices concerning the actual methods and measures utilised, and/or the statistical outputs produced, can be made.

With cluster analysis, once the data set has been defined, in terms of the number of cases to be studied and the number of variables to be used, rescaling of the data has to first be considered. When variables have different scales or widely differing magnitudes on the same scale, and they are not standardized, any distance measure will reflect primarily the variable measured in the largest number of units. This can be overcome by conversion of the data to the standard normal form, where all variables possess a mean a 0 and a standard deviation of 1. The altered variables exhibiting this form are generally known as Z-scores. Other standardization methods are also available but the standard normal form is the most commonly used and was the one adopted here. Using this data set. a matrix of similarities, or distances, between cases is computed. A variety of similarity or distance measures are available when using the SPSSX package but not all are applicable to pure numerical data of the forms used here. The most commonly used distance measure, and the one adopted here, is the squared euclidean distance. This is the sum of the squared differences over all the variables, and is calculated for all pairs of cases.

Once the distance measurements have been made, clustering can be carried out. There are again a number of different clustering methods available with the **SPSSX** package. Of the seven possible techniques, two were not used because of their simplicity , and two others because of undesirable properties affecting the data produced. The first of these, the 'Manhattan' or 'City Block' measure is based on absolute differences between pairs of samples. Since the distances are not squared, large differences are not weighted as heavily as with the 'squared euclidean distance' measure. Thus pairs of samples that are quite similar and very dissimilar are clustered at closer levels than with measures based on squared distances. The second of these, the 'Chebychev' distance measure, defines the distance between pairs of samples as the maximum absolute difference in value over all variables, thus ignoring much of the data. Of the three techniques identified as potentially useful two were used here, these being the 'average linkage between groups' (Baverage) method and 'Ward's' method. The arbitrary choice of method is perhaps rather peculiar, but there are no definitive guidelines concerning the use, or relative value of, any of these clustering methods.

Using the squared euclidean distance measure and the 'Baverage' and 'Wards' methods, cluster analyses were carried out on the total 946 case data set. The results of these analyses can be seen in Figures 5.1 and 5.2. Figure 5.1, the Baverage method, has been truncated at the two clusters level. The cluster membership of the former is very asymmetrical, there being a total of only five cases in groups 3, 4 and 5, with 941 cases in groups 1 and 2. The cases, or sherds, represented in groups 3 to 5 are easily dismissed as 'outliers'; that is, sherds that are not representative of the groups they derive from. The causes of these distinct differences are unknown, but they may well be derived from the dissolution and measurement procedures. The removal of the groups containing these outliers results in a situation very similar to that seen in Figure 5.2, with Ward's clustering method. The basic indications from these two analyses are therefore that there is a dichotomy in the data, with the two sides of this rift being represented by the sandy wares and ware C2 on one hand, and the fine wares and coarse wares excluding ware C2 on the other. Ware F3 is about evenly split between the two groups.

If Figures 5.3 and 5.4 are now considered, this dichotomy can be seen as being repeated whatever statistical method is used. In Figure 5.3 a principal components analysis has been carried out on the total data set and Components 1 and 3 plotted against each other. In this particular example the omission of Principle Component 2 (PC2) is not a case for concern as it contributes only slightly more variance than Principal Component 3 (24.8% compared with 19%) in the total data set. The reasons why the second principal component does not illustrate this particular split in the data are not immediately obvious. It is probably because this factor is loaded very heavily with Ni and very lightly with all three other elements, which is almost an inverse of the situation with PC1 where Fe and Mg are heavily loaded, with Al at a moderate level. Thus, the second component has merely used that data not utilised by the first, which in this case means information from an element that does not separate the data set into the two expected groups. PC3 is heavily loaded with Al and also has contributions from Fe and Mg, with almost no variation provided by Ni. Here the dichotomy is again found when utilising the rest of the data set. When the PC3 variance is added to the variance provided by PC1 (48.4%), the total variance being used is perfectly acceptable at 67.4%. Using these two factors, the same dichotomy that was identified in the cluster analyses is produced, with the sandy wares being generally separate to the coarse and fine wares. This plot is actually only derived from material from five sites. This is because any more additions to the figure would have rendered it uninterpretable. In this form the separate symbols can still usually be discerned, and the similarity between the Laverstock and Hermitage products and visually similar marketed wares is well illustrated.

In Figure 5.4 the two discriminant functions have been derived to separate the Laverstock and Hermitage products, with the material from the five sites as used on Figure 5.3 all added as 'unknowns'. This means that the factors have not been derived to separate these latter groups, but their discriminant scores and subsequent positions have still been calculated. The dichotomy as seen in Figures 5.1 to 5.3 is again illustrated, with the sandy wares being grouped on the right with the Hermitage sandy ware products, and the coarse and fine wares being more loosely grouped to the left with the Laverstock products. Further structure and separation is evident within the data on this figure but this will not be discussed at this stage.

The illustration of this dichotomy by three separate statistical techniques confirms the validity of the initial observation on Figure 5.1. This division occurs between those groups that may have been expected to be different on the basis of the pilot study. From this situation a decision was made to split the analytical interpretation into two areas, echoing the already apparent natural form of the data. Further principal components and discriminant analyses were therefore carried out, but this time separate tests were made on, broadly, the sandy wares and the coarse and fine wares. Sherds of wares C2 and F3 were included in both analyses, as these represented those groups that perhaps did not conform to the simple classifications that had been illustrated by tests on the whole data set. In this way further structure in the data could be examined, without the magnitude of such differences being overshadowed by more obvious variations already identified. The results of these analyses on both data sets have been displayed on a site-specific basis, using the Cricket Graph program on an Apple Macintosh microcomputer. The following section of this chapter describes and discusses these plots site by site in an alphabetical fashion. Alongside this site-specific approach, in 5.3 medieval and post-medieval wasters are discussed as separate problems, and then in 5.4 cross-site correlations are analysed.

For each site or group, scatterplots have been constructed illustrating the location of the ware types from that site in relation to material of known provenance. The data sets used to define the principal components are identified (either coarse and fine wares or sandy wares), as are the groups of provenanced sherds between which the discriminant functions are separating. All the discriminant analyses are carried out using three groups and two discriminating functions. These are always plotted with Discriminant Function 1 (DF1) on the x-axis and DF2 on the y-axis. With the principal components analyses there are scatterplots of PC1 vs. PC2 and PC1 vs. PC3 for all sites. The percentage of the variance accounted for by these factors in both the coarse and fine ware and sandy ware analyses is shown on Tables 5.1 and 5.2 respectively. In both cases the variance inherent in the second and third principal components is of a similar order. Therefore any of the scatterplots that derive their data from the first and third principal components include an acceptable level of at least 60% of the total variance inherent within the data sets. If any of these factors represented only less than 10% of the variance, the validity of any assumptions made from such data would be put in doubt. This is because variation that on an overall scale was quite small could in fact be being used to make much broader statements than its real importance warranted. This must always be guarded against when using principal components analysis as an interpretative tool.

Each principal component can be plotted as a linear function that has been derived from these data to include more variation than is present within the data set for any one original variable. Each of these functions is weighted to a greater or lesser degree with variation derived from the original variables. This weighting is determined from the magnitude of coefficients used in the linear functions corresponding to the component in question. This 'factor loading' is quantified in a 'factor matrix' which gives the values of the coefficients for each variable used in the calculation of each function. The factor matrix for the principal components analysis using the coarse and fine wares data is shown as Table 5.3. It is apparent here that Factor 1 is closely related to the Fe and Mg data, whilst Factor 2 is closely related to the Ni data and Factor 3 to the Al data.

Table 5.4 shows the factor matrix for the sandy wares data. In this case Factor 1 has virtually equally heavy loadings for Al, Fe and Mg, with Factor 2 being related to the Ni data. Factor 3 is quite heavily loaded with the Mg data, with the negative sign indicating that high Mg concentrations will give low values of Factor 3.

Similarly, the relative importance of the variables in producing variation within each discriminant function can be studied. This must only be carried out through the study of standardized canonical discriminant function coefficients, as opposed to unstandardized coefficients. The former are based on data in the standard normal form and thus great magnitude in some original measurement does not cause undesirable bias between variables. Coefficients with negative signs indicate that high values of that variable will produce low values in the discriminant function. Coefficients with positive signs have the opposite effect, as would be expected. The values of the coefficients are in no way absolute, and can therefore only be understood in comparison with the coefficients for all other variables. Tables 5.5 and 5.6 illustrate the standardized canonical discriminant function coefficients for the two discriminant analyses represented in the majority of relevant scatterplots relating to this chapter. It is apparent from these tables that with the coarse and fine wares data set, when separating the Laverstock wares and the Southampton ware F1 wasters, the three groups are only fully separated through the use of both discriminant functions. The first function relies heavily on the Mg data, whilst the second is mostly derived from the Fe and Ni data. With the sandy wares, when separating Hermitage products from the Sherborne Old Castle ware S4, and Laverstock coarse ware sherds the latter group is separated by DF1, which relies heavily on the Fe and Mg data, whilst the ware S4 sherds are separated from the other groups through the use of DF2, which has major contributions from Al and Ni.

5.2 Results of discriminant analyses and principal components analyses on the concentrations data from sherds derived from the settlement sites

This section is structured on a site-by-site basis, with the information used being derived from the discriminant and principal components analyses, as described earlier. The discriminant analyses membership table which is referred to in most of the discussions of sandy ware sherds is a table provided as part of the normal statistical output of the 'discriminant' program using **SPSSX**. The format of these tables was discussed in Chapter 4. Briefly, the table lists the probability of each case (sherd sample) being a member of one of the groups of sherds of 'known' provenance that have been used to derive the discriminant functions for that particular analysis. This probability derives from the case's distance from each of the group centroids, with regard to the discriminant functions. The membership table for the discriminant analysis using the sandy wares data set can be found in the appendices as appendix 5. This lists the two highest probabilities of group membership for each case.

Christchurch

Figures 5.5 to 5.7

In Figure 5.5 the indications are that the fine ware sherds from Christchurch are on the whole not chemically very similar to the Laverstock material. This is supported by Figures 5.6 and 5.7. One sherd of ware F4 is located with the Laverstock ware F1 wasters, but the Christchurch ware F1 sherds show a variety of positions on all three plots, with no obvious clusters or groupings in other areas.

The coarse ware sherds show some affinity to the Laverstock ware C1 wasters, this being more noticeable with the unglazed sherds. The scratch-marked sherds in ware C1, however, show very varied scores on all three scatterplots and include some sherds with extremely high values, particularly in Principal Component 2 on Figure 5.5 and Discriminant Function 2 on Figure 5.7. The indications are that these sherds do not have a homogeneous group of concentrations.

On the whole, little obvious structure can be seen in the positions of sherds from Christchurch on these three scatterplots. They are all, however, unlike the Southampton wasters in Figure 5.7.

Compton Valence

Figures 5.8 to 5.10

Only sherds of ware S1 were analysed from Compton Valence. It is apparent from all three plots that there is great similarity between the Compton Valence sherds and the Hermitage products. Furthermore, the Compton Valence sherds are unlike the Laverstock and Sherborne Old Castle material, as shown in Figure 5.10. There is a suggestion in all three figures that the mean value on each axis for the Compton Valence sherds is identifiably less than the mean for the Hermitage products. The two distributions undoubtedly overlap, but there are detectable differences. This is borne out by the fact that, in the group membership table (appendix 5), only nine out of the twenty sherds are defined as 'most-like' the Hermitage waster group, the other eleven sherds being 'most-like' the ware S4 sherds from Sherborne Old Castle.

Corfe Castle

Figures 5.11 to 5.13

The coarse ware sherds from Corfe (ware C1) show quite distinct similarities with the coarse ware sherds from Laverstock. The match is by no means perfect, but the two distributions cover much common ground in all three plots. The fine ware sherds from Corfe are all white wares of ware F4. In Figure 5.11 there is some overlap with the Laverstock ware F1 sherds on both of the axes. This is absent when PC2 is replaced by PC3 (Figure 5.12), the latter factor being heavily loaded with the Al data, as opposed to PC2 which is largely related to the Ni concentrations. On Figure 5.13, the Corfe ware F4 sherds have been almost completely separated from all the other sherds plotted, and they form a discrete cluster which has low values on both axes. Discriminant Function 2 is heavily reliant on the Fe and Ni data and the low values on this axis represented by the ware F4 sherds is in keeping with their white, low-iron content fabric. One sherd of ware F4 does not appear in this group, being instead located with the Laverstock ware F1 sherds on the discriminant plot.

Dorchester Prison

Figures 5.14 to 5.19

The sherds of ware C1 from Dorchester Prison show a general chemical similarity with the ware C1 wasters from Laverstock, although the 'match' is by no means perfect. There is a suggestion that most of the sherds are similar, with exceptions in two or three outliers which exhibit higher values on virtually all the axes on Figures 5.14 to 5.16.

The sherds of ware S1 from Dorchester Prison are mostly quite tightly grouped, when the principal component scores are plotted on Figures 5.17 and 5.18. About 75% of the sherds exhibit 'fingerprints' that can be matched to part of the distribution derived from the Hermitage products. When the discriminant functions are plotted, however, the match is not very good with only about six out of twenty sherds visually conforming to the range of concentrations exhibited by the Hermitage products. Furthermore the group membership table places only eight sherds within the Hermitage distribution with eleven being classified as 'most -like' the Sherborne ware S4 group. The surprising linearity of these sherds, when plotted using the principal components visible in Figures 5.17 and 5.18 is discussed in the Winterborne Houghton section.

Holworth

Figures 5.20 to 5.25

Most of the sherds from Holworth in ware C1 show close chemical similarity with the Laverstock ware C1 sherds. This is apparent in both principal components and discriminant plots.

The picture is more confusing when the fine wares are considered. Using the first and second principal components, one of the two ware F1 sherds appears identical to Laverstock products. This is not, however, echoed when the third principal component is substituted for the second (Figure 5.21), or when the discriminant functions are plotted (Figure 5.22). With all three scatterplots, the ware F4 sherds are shown to be different from all the kiln products displayed and different to the ware C1 sherds from Holworth. The distribution of these sherds echoes that identified in ware F4 sherds from Corfe Castle (Figures 5.11 to 5.13).

The sherds of ware S1 from Holworth are displayed on Figures 5.23 to 5.25. Using principal components 1 and 3 these sherds can be matched to the Hermitage products. This does not hold true with PC2, however, which produces values for most of the Holworth ware S1 sherds slightly below those for the Hermitage products. On Figure 5.25 the majority of the Holworth sherds have discriminant scores that place the symbols midway between the Hermitage products and the ware S4 sherds from Sherborne, with much overlap with both of the separated groups. One sherd is, rather surprisingly, located with the ware C1 Laverstock products. In the group membership table only three of the sherds are classified with the Hermitage group, the rest being 'most-like' the ware S4 sherds from Sherborne.

Kington Magna

Figures 5.26 to 5.31

The sherds of ware C1 from Kington Magna seem to be chemically rather variable. The first two principal components do not reflect this (Figure 5.26), but the third principal component locates the ten sherds into three groups, five with the Laverstock ware C1 wasters, two with much higher PC1 and PC3 scores and three sherds also with high PC3 scores, but low PC1 values. The discriminant analysis perhaps reflects this with five sherds showing similar values to those for the Laverstock ware C1 wasters, two with higher Discriminant Function 2 scores, and three with high Function 1 scores as well.

The sherds of ware S4 are shown plotted alongside the other ware S4 groups that were analysed on Figures 5.29 to 5.31. The sherds of this ware show chemical similarity with Hermitage products using Principal Components 1 and 3, but some dissimilarity with Principal Component 2. In Figure 5.31, the discriminant functions have been derived to separate the Hermitage ware S1 products, Laverstock ware C1 products and the sherds of ware S4 from Sherborne. It is perhaps not surprising, and certainly reassuring; to see that, using these functions, most of the ware S4 sherds from Kington Magna can be identified as chemically similar to the Sherborne ware S4 sherds. The evidence from the group membership table confirms this where 19 out of 20 of these sherds are grouped with the ware S4 sherds from Sherborne.

Lodge Farm

Figures 5.32 to 5.34

Ten sherds of ware S2 were analysed from Lodge Farm. The first principal component separates these sherds into two groups, of seven and three members, but this is not reaffirmed by the other factors and functions that were derived. On the whole these sherds seem to be similar to, but not the same as, the Hermitage products if the principal components are considered. With the discriminant analysis (Figure 5.34) these ten sherds show a very wide distribution, which overlaps partly with the Hermitage products, but also extends left along the x-axis (DF1) as far as the Laverstock coarse wares. The group membership table does, however, confirm the suggestion derived from the PC1 values, placing seven of the sherds into the Hermitage group and identifying the other three as being 'most-like' the Laverstock coarse ware products.

Milton Abbas Abbey

Figures 5.32 to 5.34

The sherds of ware S2 from Milton Abbas are plotted on Figures 5.32 to 5.34 alongside the Lodge Farm sherds. The Milton Abbas sherds have a distribution that closely echoes that for the Hermitage products with Principal Components 1 and 3, but which is only partially comparable when using Principal Component 2. When the discriminant scores are plotted the sherds of ware S2 from Milton Abbas are mostly grouped in the area of the ware S4 sherds from Sherborne. There are, however, at least two sherds that are located within the Hermitage ware S1 zone. The sherds from Milton Abbas do not form a very compact grouping in any ofthe three scatterplots. The classification table identifies all but one of these sherds as being more like the ware S4 sherds than either of the kiln groups.

Poole

Figures 5.35 to 5.40

The glazed sherds of ware C1 from Poole are broadly similar to the ware C1 products from Laverstock, if plotted using the first two principal components (Figure 5.35). There is, however, a suggestion of difference if the first and third principal components are plotted (Figure 5.36). The discriminant functions surprisingly group the Poole sherds together with the Laverstock fine ware material, with only one sherd located outside the zone of occurrence of the latter. The five sherds of ware C1 from Poole which have red-painted decoration seem to split into two distinct types. The first group of three sherds is located alongside the other ware C1 sherds, as described above, in all three plots. The other two sherds are distinctly different, but similar to each other. They do, however, match the Laverstock ware C1 sherds on all three plots.

The fine wares are shown on Figures 5.38 to 5.40. There are examples of three fine ware types F1, F3 and F4. The five sherds of ware F1 are closely matched to the Laverstock ware F1 products in Figures 5.38 and 5.39, but the match is not quite so good when the same sherds are plotted using the discriminant functions (Figure 5.40). There is still a large degree of similarity with the Laverstock products, but there is also the suggestion that one or two sherds are chemically similar to the Southampton ware F1 wasters. The ware F3 sherds show a rather enigmatic set of distributions. In Figure 5.38 five of the six sherds of this ware are grouped with the Laverstock and Poole ware F1 sherds, whilst one of the ware F3 sherds has a much higher value on the y-axis (PC2). This solitary outlier is joined by another outlier when the third principal component is plotted (Figure 5.39), and a third appears when the discriminant scores are plottted (Figure 5.40). These outliers are not grouped together, nor do they match the Southampton ware F1 wasters in the discriminant analysis plot. The ware F4 sherds from Poole are divided into two groups. The smaller group of three sherds closely matches the Laverstock ware F1 products when the principal component scores are plotted, and loosely matches this same material using the discriminant scores. The larger group is very different to all other Poole sherds and seems to match the values of many ware F4 sherds found elsewhere (e.g. at Corfe Castle and Holworth).

Portland, St. Andrews Old Church

Figures 5.23 to 5.25 and 5.14 to 5.16

Ten sherds of ware S1 were analysed from Portland, St. Andrews. In none of the three scatterplots are these ten sherds very closely grouped, but in all three plots they show some affinity to the wasters from Hermitage. This match is weakest when the discriminant scores are plotted as in Figure 5.25. Here, the Portland ware S1 sherds are shown to be also comparable with ware S4 sherds from Sherborne. The group membership table goes some way to confirming this, placing six sherds with the ware S4 group and four with the Hermitage wasters.

The ware C1 sherds from Portland are shown on figures 5.14 to 5.16. In the first of these, the Portland sherds closely match the Laverstock ware C1 products. This is not wholly backed up by evidence from the PC1 vs. PC3 plot where three sherds are located outside the zone of occurrence of the Laverstock wasters. The discriminant analysis separates all seven sherds from the Laverstock coarse ware, albeit only just. The indications gained from a study of all three scatterplots are therefore rather confused and contradictory.

Poxwell

Figures 5.41 to 5.46

Four of the five sherds of ware C1 from Poxwell are located with the Laverstock ware C1 wasters, when the principal component scores are plotted as in Figures 5.41 and 5.42. This is not the case when these sherds are added as 'unknowns' into the discriminant analysis shown in Figure 5.43. Here those same four sherds are shown to be very different to all others plotted, including the Laverstock products, and the one sherd that was located elsewhere in the principal component plots is now directly matched with the Laverstock ware C1 sherds. There is little cohesion amongst this group of material in any of the three scatterplots.

In Figures 5.44 to 5.46, the ten ware S1 sherds from Poxwell are shown. Most of these sherds show similarity with Hermitage products in all three of these plots, but occasional outliers do occur, particularly in the discriminant analysis. The group membership table identifies seven of these ten sherds as being 'most-like' the Hermitage group, the other three sherds being matched with the ware S4 material.

Salisbury

Figures 5.47 to 5.49

Throughout all the three plots that illustrate the Salisbury sherds there is much similarity with the ware F1 wasters from Laverstock. The ten sherds of ware F1 (fabric S3) have very similar PC3 values to those for the Laverstock products. The PC1 and PC2 values of this material are, however, generally slightly lower than the values for the Laverstock fine ware wasters. Conversely, the discriminant scores of these sherds match the Laverstock F1 material very closely. The five sherds of ware F1 (fabric S6) are even more closely matched with the Laverstock ware F1 wasters and are distributed within the spread of the latter in all three scatterplots.

The ware F4 sherds (Surrey -type) are a less cohesive group. They show similarity with the Laverstock products in Figure 5.47, but a number of the sherds appear different in Figure 5.48, this being derived from the PC3 values. In Figure 5.49 there are six sherds that are grouped with the Laverstock wasters and the other sherds from Salisbury, whilst four further sherds are grouped elsewhere. This group has slightly higher scores for Discriminant Function 1, and lower scores for Discriminant Function 2. The resultant position of these sherds is alongside the Laverstock ware C1 wasters.

Shaftesbury

Figures 5.50 to 5.55

The sherds of coarse ware C1 from Shaftesbury show a confusing picture over the three scatterplots 5.50 to 5.52. In Figure 5.50 they show general similarity with the Laverstock ware C1 wasters, but this is not confirmed by the values for the third principal component , as seen in Figure 5.51. In this plot these sherds are most similar to Laverstock fine ware wasters, a situation that is repeated when the discriminant functions are plotted, as in Figure 5.52. Principal component 3 and Discriminant Function 1 do separate three sherds from the others, and these are in fact located with the Laverstock coarse wares in Figures 5.51 and 5.52. Both of these axes have some reliance on the Al data, a fact which possibly accounts for the similar divisions seen in these two scatterplots.

The five fine ware sherds (F1) from Shaftesbury are not tightly grouped along PC1, but are more closely tied together with PC2 and PC3. At least three of the sherds can be matched to the Laverstock fine ware wasters using the principal components analysis. In Figure 5.52 this is supported, where four ware F1 sherds are clearly located with the Laverstock fine ware, whilst one is different, perhaps in a position matching with that seen for the fine ware sherds from Corfe Castle.

The locations of the sandy ware sherds from Shaftesbury are shown in Figures 5.53 to 5.55. Figure 5.53 groups all these sherds with the Hermitage ware S1 wasters. This is not repeated to such an extent in the other two plots where five of the ware S4 sherds, and perhaps some ofthe ware S1 examples, are shown to be different to the Hermitage products. When the ware S4 sherds from Sherborne are included in the derivation of the discriminant functions, as in Figure 5.5, the Shaftesbury ware S4 sherds match closely with this group. In the group membership table for this analysis all five of the ware S4 sherds have highest probabilities of being members of the Sherborne ware S4 group. This is also the case for two of the ware S1 sherds.

Sherborne Old Castle

Figures 5.56 to 5.61

In Figure 5.56, PC2 provides a confusing separation of the fine ware sherds from Sherborne Old Castle. PC1 and PC3, however, (Figure 5.57) create groupings that are interpretable. Using the scores from these two factors the majority of the ware F1 sherds, and two of the ware F3 sherds are shown to be like the ware F1 wasters from Laverstock, whilst the ware F4 sherds are generally different. This is confirmed by the plot of discriminant scores (Figure 5.58). Here ten of the ware F1 sherds are matched closely with the Laverstock fine ware wasters, along with two of the ware F3 sherds and one ware F4 sherd. At least thirteen of the ware F4 sherds are very different, with low scores for both discriminant functions, and these are joined by one ware F1 and one ware F3 sherd. This group is similar to the ware F4 sherds from Corfe Castle and elsewhere as described in previous sections. A further group of three ware F1 sherds and one ware F3 sherd are different again, exhibiting high values in both discriminant functions.

Only five ware C1 sherds were analysed from Sherborne Old Castle, all of these being pieces of glazed jugs. Four of these show affinity with Laverstock products in the discriminant analysis, lying at the interface between the two groups of the latter. One of these sherds is rather different, with high scores on PC3 and both discriminant functions.

The sherds of ware S1 and ware S2 are shown on Figures 5.59 to 5.61. All three of these scatterplots suggest that there is little difference between these two groups. Virtually all forty of these sherds show similarity with the Hermitage wasters in the principal components analyses, but some differences are evident in the discriminant plot. Here, most of the Sherborne Old Castle sherds are located in the space between the Hermitage ware S1 wasters and the ware S4 sherds from Sherborne, overlapping more with the former. In the group membership table five of the thirteen ware S1 sherds are most probably members of the Sherborne ware S4 group, along with thirteen of the twenty seven ware S2 sherds.

The ware S4 sherds from Sherborne were used as one of the discriminating groups in the sandy wares discriminant analysis. This material can easily be separated from the Hermitage products using PC2 (Figure 5.29) or DF1 and DF2 (Figure 5.31). The relationship between this group and other ware S4 sherds is discussed in section 5.4.

Southampton

Figures 5.62 to 5.70

Figures 5.62 and 5.63 illustrate the location of coarse ware sherds from Southampton in relation to Laverstock ware C1 wasters when principal components of the fine and coarse ware data set are used. The indications from both of these plots, are that the Southampton material, although quite variable itself, is not comparable to the Laverstock products. This is true of most of the ware C1 sherds and all of the ware C2 sherds from Southampton. The discriminant analysis confirms these suggestions, but here there is no similarity whatsoever with any Laverstock product, but some similarity with fine ware wasters from Southampton.

Figures 5.65 to 5.67 show the fine ware sherds from Southampton and also the ware F1 wasters from the city. In the principal components analyses the picture is somewhat confused as the ware F3 sherds appear similar to the ware F1 wasters from Southampton with PC1 and PC3, but generally dissimilar with regards to PC2, which is heavily loaded with the Ni data. The ware F1 wasters from Southampton are confused with the Laverstock products with regards to PC1 and PC2, but are separated by PC3. The latter function is principally derived from the Al data. The ware F1 sherds from Southampton are, with one exception, different to the wasters from the city in both scatterplots. The suggestions made by the distributions of points in Figures 5.65 and 5.66 are clarified in Figure 5.67. In this scatterplot the discriminant functions have been derived to separate the Laverstock products and the Southampton ware F1 wasters, which is achieved perfectly. When the nine ware F1 sherds from Southampton are added as 'unknowns' only one is matched with the wasters from the city. Seven sherds are located with the Laverstock fine ware products, however, a suggestion that was only partially hinted at by the principal components scatterplots. The one other ware F1 sherd from Southampton is grouped away from the separated kiln products alongside most of the twenty sherds of ware F3. These form a loose group which is distinct from the ware F1 wasters from both sites, but which has some similarities with the ware C1 wasters. The ware F3 sherds seem to possess high Ni and Fe concentrations echoed by high values for Discriminant Function 2, Principal Component 2 and, perhaps, Principal Component 1.

The sandy ware sherds from Southampton are illustrated with the Hermitage wasters in Figures 5.68 to 5.70. The principal components scatterplots both show strong similarities with the Hermitage material, for both the Southampton ware S3 wasters and ware S1 sherds. This is not completely confirmed by the discriminant analysis where sherds of both types are located between the ware S1 wasters and the ware S4 sherds from Sherborne. In the group membership table, however, four out of five of each of the Southampton sandy ware types are most closely matched with the Hermitage products.

Wareham, St. Martin's House

Figures 5.71 to 5.73

Little sense can be made of the distributions shown in Figure 5.71 other than that two unglazed sherds of ware C1 from Wareham seem to possess very high values of PC2, in comparison to all the other material shown. It is also apparent, however, that the ware F4 sherds are not a good match for the ware F1 sherds from Laverstock using these functions.

The latter suggestion is supported by the evidence from Figure 5.72, but the former indication is not supported on PC3, which relocates the unglazed ware C1 sherds amongst most of the other samples. In both scatterplots discussed, the glazed sherds of ware C1 from Wareham exhibit a wide distribution, with only some of these sherds showing similarities with the Laverstock ware C1 wasters. Conversely, the ware C1 sherds with scratch-marked decoration form a very homogeneous group, which is closely matched to the Laverstock wasters.

Figure 5.73 supports most of the indications provided by the principal components plots. The scratch-marked sherds are again very homogeneous, and match the ware C1 Laverstock products. Some of the ware C1 unglazed sherds are also located here, and there are two outliers as before. The glazed ware C1 sherds are again very variable, with only two sherds truly matching the Laverstock products. The ware F4 sherds are located low on both axes, and at least seven of these sherds can be matched with the Corfe ware F4 group.

West Grimstead

Figures 5.74 to 5.76

Three wasters and twelve fine ware sherds were studied from West Grimstead. The ware F1 wasters are located with the Laverstock fine ware products on all three scatterplots, as are at least six non-waster sherds in this ware. The two ware F4 sherds are, however, different and can perhaps be matched to the ware F4 sherds from Corfe and elsewhere. It is possible that two ware F1 sherds are also part of this group, although this is not certain. One other ware F1 sherd is located with the Southampton ware F1 wasters in Figure 5.76.

Whitcombe

Figures 5.41 to 5.46

The five sherds of ware C1 from Whitcombe are located with the Laverstock ware C1 wasters on all the principal component axes. In Figure 5.43, the discriminant analysis, one sherd is located away from this group, but is still similar to the fine ware sherds from Laverstock.

The sandy ware sherds are similar to the Hermitage wasters in Figures 5.44 and 5.45, but four of the ten sherds have a higher probability of being members of the Sherborne Old Castle ware S4 group in the group membership table.

Wimborne, The Leaze

Figures 5.77 to 5.79

The unglazed sherds of ware C1 from Wimborne are mostly located in approximately the same region of Figure 5.77 as the ware C1 wasters from Laverstock. This is also true of the ten glazed sherds in ware C1, although the grouping of these sherds is not as tight when Figure 5.78 is considered. Here, the unglazed sherds also do not match the Laverstock material exactly, there being at least seven sherds with higher values for PC3. This is confirmed in Figure 5.79, where there is a tendency for both glazed and unglazed sherds to exhibit discriminant scores for Function 1 which are slightly in excess of those for the Laverstock coarse ware. The difference is not great, however, and the majority of both types are still comparable with the visually similar Laverstock products.

The two sherds of ware F1 are directly comparable to the ware F1 wasters from Laverstock in all three figures. The eight sherds of ware F4 seem to be composed of three groups. The first group, of three sherds, has values that place them alongside ware F4 sherds from Corfe Castle and a number of other sites in east Dorset. The second group, of four sherds, appears to be similar in some aspects to the first group, but is not directly comparable with these or any other fine wares. They do, however, possess chemical similarity with coarse ware sherds from both Wimborne and Laverstock, but only when the discriminant scores are plotted. There is also one outlier sherd which has high values on all axes except PC2.

Winterborne Houghton

Figures 5.17 to 5.19 and 5.26 to 5.28

The ten sherds of ware C1 from Winterborne Houghton are located on Figures 5.26 to 5.28. In all three of these scatterplots at least six of the sherds are located with the Laverstock ware C1 wasters. The combination of PC1 and PC3, however, results in four sherds being located away from the Laverstock products. When the discriminant scores are plotted, as in Figure 5.28, the same six sherds are again matched with the Laverstock coarse ware, whilst two of the outliers are matched with the Laverstock fine ware. The two remaining sherds are located in between the two Laverstock products, but are ultimately perhaps more closely related to the coarse ware.

The sandy ware sherds from Winterborne Houghton are located away from the main body of the Hermitage products, when the PC1 and PC2 scores are plotted, in contrast to, for example, the ware S1 sherds from Dorchester Prison which are shown on the same plots 5.17 to 5.19. An interesting feature of Figure 5.18 is the linear form of both the Winterborne sherds and to a lesser extent the Dorchester Prison sherds, when plotted using PC1 and PC3. The former have an almost constant value for PC3, at around 0, and a PC1 value of between -2 and +1. This is mainly indicative of similar Mg values, and differing Fe values for these sherds. By contrast, the DP sandy ware sherds exhibit roughly constant PC1 values of about +1 (with two outliers) and widely varying PC2 and PC3 values. This is perhaps indicative of relatively constant Fe and Al concentrations, against widely varying Ni concentrations.

"Linear relationships" are absent when the discriminant scores are plotted as in Figure 5.19. Here, the majority of the ware S1 sherds are located between the ware S4 sherds from Sherborne Old Castle and the Hermitage products. In the group membership table only four of these sherds are grouped with the Hermitage wasters, and four with the ware S4 sherds. Perhaps surprisingly, two sherds are grouped with the Laverstock ware C1 wasters, something that is also visually evident from Figure 5.19.

Woolcombe

Figures 5.80 to 5.82

The forty sherds of ware S1 and the forty of ware C2 that were studied from the Woolcombe collection have all been plotted on Figures 5.80 to 5.82. The ware S4/C2 sherds were identified as being chemically more like the Hermitage ware S1 kiln group than the Laverstock ware C1 wasters in section 5.1. This is borne out here where, in all three scatterplots, little significant difference is seen between the two groups from Woolcombe, both of them being similar to the Hermitage material. There is a tendency, however, for the Woolcombe material to exhibit slightly lower values for all three principal components and both discriminant functions, in comparison to the Hermitage products. In Figure 5.82 this results in many of these sherds being located in the zone between the Hermitage group and the ware S4 material from Sherborne Old Castle. The group membership table indicates that, of these sherds, twenty of the forty ware S1 sherds are 'most-like' the ware S4 group along with 28 of the ware C2 examples.

Yondover

Figures 5.8 to 5.10

Twenty sherds of ware S1 were analysed from Yondover. The principal component scores derived for these sherds are quite variable, but generally they result in positions that lie within the area encompassed by the Hermitage wasters. The exceptions to this are three or four sherds with higher PC3 scores, probably indicating low Mg values (for Mg is inversely correlated with this factor), and one or two sherds with low PC3 scores, suggesting the opposite.

The discriminant analysis seems to confirm the former suggestion as one group of four sherds is separated from the main body as a result of low DF1 scores. This function is loaded heavily with the Fe and Mg data, the latter being of particular interest here. On Figure 5.10 there is one other outlier which has a very low DF2 score and is located with the ware S4 sherds from Sherborne. The rest of the sherds from Yondover are closely matched to the Hermitage products, only three of these fifteen being identified as 'most-like' the ware S4 group in the group membership table.

5.3 Results of statistical analyses on the material from kiln sites

Alongside the many samples from 'settlement' sites and the original 160 samples from Hermitage and Laverstock, a number of wasters from known, or suspected, kiln sites were also analysed. These can be divided into two groups, medieval wasters, and post-medieval wasters. Examples of the former derive from two sites, the 'sand pit' at West Grimstead and The High Street in Southampton. Other non-waster material from both these localities has been discussed in the previous section and the results here must be viewed in comparison with the relevant scatterplots. Post-medieval material from Alderholt, East Holme and Horton was also studied.

The twelve Southampton fine ware wasters have already been used as a comparative group alongside the Laverstock material, in the discriminant analysis carried out on the coarse and fine wares data set (section 5.2). The sherds of ware F1 are well separated from the Laverstock material when the results of this analysis are plotted (Figure 5.85). This is achieved, particularly through the use of the Discriminant Function 1 (DF1) scores but also in part from DF2. The former scores are higher for the Southampton ware F1 sherds than they are for the Laverstock material and this function is heavily loaded with the Mg data (Table 5.5). The second function is mainly reliant on variation provided by Fe and Ni. In the principal components analysis (Figures 5.83 and 5.84), the situation is somewhat different. Here the Southampton ware F1 sherds overlay the Laverstock ware F1 material, if PC1 and PC2 are used. It is only PC3 which is loaded heavily with Al, which separates the groups. This is rather peculiar as in the discriminant analysis Al is only a moderately useful variable when the separating function DF1 is derived.

The five wasters of ware S3 from Southampton are shown on Figures 5.68 to 5.70, which are scatterplots derived from analyses on the sandy wares data set.

It is apparent from all these plots that the Southampton wasters are chemically quite similar to the Hermitage material. The only axis where some discrimination is achieved is that of Discriminant Function 2 in Figure 5.70. Here the Southampton wasters have lower values than those for the Hermitage products, but they are still quite close and not easily distinguished. A multivariate analysis of variance (MANOVA) program was used to study the extent of this difference. Some of the results of this can be seen in Tables 5.7 and 5.8. In the former a number of tests of the significance of the variation between the concentrations for the 80 Hermitage ware S1 samples and the five Southampton ware S3 samples have been calculated. All three of these tests give significance values of 0, which indicates that the hypothesis that 'the sums of squares and cross-products matrices for the two groups of samples are the same' is rejected. This indicates that the groups are highly significantly different.

The actual elements responsible for the differences between the two groups of samples can be derived from Table 5.8. Here it is apparent that Ni and Fe, and to a lesser extent Al, are responsible for the variation, as these possess significance levels that are near 0. This corroborates the evidence from Figure 5.70 as DF2, the separating variable, is heavily loaded with Ni and Al.

Despite this, the differences between these two groups are still not great, especially when visual displays are used as in Figures 5.68 to 5.70. Furthermore, the Southampton group only comprises five samples and may therefore not be truly representative of the broader 'population' of sherds of this type. Thus, for the moment, it is considered rather 'dangerous' to base any archaeological assumptions on this evidence. Statements can be made,. but they remain rather vague. Sandy wares from Dorset and Southampton seem to possess differences in their concentrations of the four elements Al, Fe, Mg and Ni, albeit minor ones. Samples of unknown origin could not, however, be safely identified as one or the other, as not enough wasters from Southampton have been studied to gauge the full extent of this distribution. The ware S1 sherds that were analysed from Southampton very closely match the ware S3 wasters. Although both overlap considerably with the Hermitage products in the principal components plots (Figures 5.68 and 5.69), they are, within themselves, more tightly matched. This is confirmed by the discriminant analysis scatterplot (Figure 5.70) which also illustrates the small degree of separation from the Hermitage kiln group. Thus it is most likely that all the sandy ware sherds from Southampton have a similar production source, which is probably local, and not related to the Dorset-derived Hermitage material.

The ware F1 wasters from West Grimstead will be considered next. There were only three of these in the collection that was analysed and they are plotted in relation to the Laverstock and Southampton wasters in Figures 5.83 to 5.85. In all three of these scatterplots these sherds show similarity to the Laverstock ware F1 products, and little similarity with the Southampton material. It is possible that these wasters do in fact derive from the kilns at Laverstock, with the sand pit being used as a convenient dump by the Laverstock potters. It is also possible that the chemical similarity between these sherds and the Laverstock products results from both groups deriving from a common macro-geological source. The clay used at Laverstock was probably from Reading Beds deposits at Cockey Down or Clarendon Ridge, or Reading Beds-derived clay or London Clay from Alderbury (Musty *et al* 1969, 85 and 91). The latter is only about two kilometres from West Grimstead, thus suggesting that a common origin for raw material for the Laverstock industry and any supposed kiln at West Grimstead is perfectly acceptable.

Figures 5.86 and 5.87 show the post-medieval wasters that were studied and the medieval wasters from Laverstock. These are joined by ware F1 wasters from Southampton on Figure 5.88. Wasters from these particular sites were analysed for a number of specific reasons which were outlined in Chapter 1. Briefly, the East Holme material was analysed because it represents the only ware F4 products known from the region in either the medieval or post-medieval periods. There are indications that many medieval sites in this same part of south-east Dorset have large numbers of ware F4 sherds, many more than comparable sites elsewhere in this period. The suggestion is therefore that a ware F4 production site was operating in this area in the period 1250 to 1350, some four hundred years before the known site at East Holme. It is possible that a common white clay source was utilised by both, and chemical similarity between the post-medieval wasters and medieval sherds might strengthen this argument.

It is perhaps unfortunate that in all three relevant scatterplots (Figures 5.86 to 5.88) the East Holme material does not appear as a discrete group. This is due to PC1 in the principal components scatterplots, and to DF2 in Figure 5.88. The former is heavily reliant on the Fe and Mg data and the latter also on Mg, with additional variation provided by Al and Fe. Thus it seems that the Mg concentrations are mainly responsible for the widely varying locations of these sherds in the scatterplots. Magnesium is known to be a quite mobile element in soils (see section 3.4) and so the wide variation in its concentrations within this group of wasters could be due to differential leaching onto sherds in different parts of the site. It could, of course, also result from changes in the raw materials used, or the mixture of clays adopted. The great range of this distribution results in half of the East Holme material becoming confused with the Laverstock coarse ware sherds in Figure 5.88. There is also some overlap between the East Holme material and wasters from Alderholt and Horton in Figures 5.86 and 5.87, deriving from principal components scores.

When compared with the medieval ware F4 sherds, the East Holme material provides a confusing picture. This is because of the group's disparate nature, resulting in a partial match with both ware F1 Laverstock products, and ware F4 sherds from a variety of sites. Thus no valuable conclusions can be gained from such a comparison, but the possibility of a common raw material source for medieval ware F4 sherds and the East Holme wasters does exist, with at least some of the latter being chemically matched with many of the former.

The Alderholt and Horton material was studied because examples of the 'Verwood and District' ceramic industry were not available from the medieval period, although it is known that kilns were active at Damerham in the late thirteenth century (Le Patourel 1969) and Alderholt in the early fourteenth century (Algar *et al* 1987). Thus, material of a later date was studied as 'dummy' medieval products, the sites chosen being from Alderholt, where earlier production is documented, and Horton, which was a significant medieval settlement and represents an approximate geographic extreme of the industry in comparison to Alderholt. In the principal components analyses, the Alderholt and Horton sherds are shown to be quite similar to, but distinct from, the Laverstock material when PC1 and PC3 are used (Figures 5.86 and 5.87). The situation is somewhat different when the discriminant scores are plotted (Figure 5.88). Here the Alderholt material is very closely matched to the Laverstock ware C1 sherds and the Horton wasters are undeniably distinct from all other groups plotted. It is therefore apparent that no one chemical definition of 'typical Verwood industry products' will suffice, although in comparison to material from further afield, there are in fact similarities between the Alderholt and Horton groups.

When compared to medieval fine ware sherds from settlement sites it is apparent that the Horton wasters are similar to the group of twenty ware F3 sherds from Southampton. This is evident by comparing Figures 5.86 to 5.88 with Figures 5.65 to 5.67. In all three pairs of scatterplots these two groups occupy similar areas, the match being particularly obvious with the discriminant analysis. There is also a suggestion that some sherds of ware F1 and F4 from Christchurch and ware F1 from Sherborne Old Castle also match the Horton group.

Although the Alderholt wasters closely match ware C1 products from Laverstock, this is not deemed to be significant as the material is visually very different. The similarity is thus purely coincidental. A few sherds of ware F4 from Wimborne do match the Alderholt products, as do occasional single sherds of ware F1 from Salisbury and Wareham. There is not, however, enough information to support suggestions of any actual link here as there are too few sherds involved.

5.4 Further study of inter-site and intra-site trends using multivariate statistical methods

When the data from discriminant analyses and principal components analyses are presented on a site-by-site basis, as in section 5.2, it is difficult to appreciate fully how comparative are the values for samples of the same ware type, which derive from different sites. It has already been made apparent that there are in fact differences between visually similar material from some sites, and this is expanded upon in this section. Furthermore, new statistical analyses on separate parts of the total data set have been formulated, which test suggestions concerning the grouping of samples, which were indicated from the analyses described in section 5.2.

In this section the three broad categories of fabric are discussed separately, starting with sandy wares, followed by coarse wares and fine wares. 'Cross-references' between these groups will of course be made, but this is only necessary in certain cases. It has already been proven that few discrimination difficulties are present between the sandy wares and the other two groups.

Sandy wares

(as defined in Chapter 1)

The major sandy ware kiln products that were studied were the 80 Hermitage samples. The relationship of these with the five ware S3 wasters from Southampton was discussed in section 5.3. The significance of their relationships is in the similarity of the two types. Although visually discernable as two variants of the broad sandy ware category, these two groups are difficult to separate using the scatterplots. Statistical differences do exist between the two groups (Tables 5.7 and 5.8) but they are not really great enough to be of use in a study of this nature. Thus it must be concluded that great difficulty would be found in any attempt to identify unprovenanced sandy ware sherds as being products of either Hermitage or Southampton kilns. The five sherds of sandy wares from Southampton may therefore be either locally produced or imported from Dorset, although from Figure 5.70, the close-knit nature of all the sandy ware sherds from Southampton and their location on the periphery of the Hermitage distribution, perhaps suggests the former alternative to be more likely.

Virtually the whole statistical interpretation of the plots of sandy wares is of a similar nature to the problem of the Southampton ware S3 wasters, in the sense that many sherds are located very close to the Hermitage group on the scatterplots discussed in section 5.2. This results in difficulty in producing estimates of numbers of sherds likely to be chemically the same as the Hermitage material, or any other sandy ware group.

Multivariate tests of significance were carried out, testing the variation between the elemental concentrations of the Hermitage sherds and all of the ware S2 sherds, all of the ware S4 sherds, and the ware S4/C2 sherds from Woolcombe. For all these groups of samples the significance levels of the Phillais', Hotelling's and Wilks' tests was zero. This indicates that the groups are statistically separable from the Hermitage samples, as their 'sums of squares and cross-products matrices' are different to that of the Hermitage group. This information is useful in confirming that these groups differ from the Hermitage products and allows further analyses to proceed on the basis of this knowledge.

Two cluster analyses were carried out on the sandy wares data set. These both utilised the squared euclidean distance 'measure', but had differing 'method' commands, these being 'Baverage' and 'Ward's'. The analyses were studied at a variety of cluster levels, but have only been described here at the eight groups level. The cluster level selected as significant is always a fairly arbitrary decision (Davis 1986, 513), and this case was no exception. It was felt that there was not liable to be more than about eight different sandy ware producers in the whole of the region studied, and therefore division into many more groups than this would have been unecessary. Also, with Ward's clustering method, the level of the eight group solution was quite well separated from the solutions with more groups on the distance axis of the dendrogram, and it was therefore deemed to be of some significance.

The group membership at this level can be seen for the Baverage method on Table 5.9, and for Wards method on Table 5.10. The former analysis was not very successful, with over 63% of all cases grouped into Cluster 3 and over 21% into Cluster 2. The reasons for this are not identifiable from the program output, but they undoubtely derive from idiosyncracies in the particular method used. This also reflects the fairly homogeneous nature of this data set by illustrating difficulty in dividing the cases up into meaningful groups. It is certainly apparent, however, that the material from a few sites is perhaps slightly different to the general body of sandy ware sherds studied. In particular, Lodge Farm and Yondover can be singled out as the groups which are most 'unlike' the main body of samples.

These results can be contrasted with those derived from the same data set, using the same 'distance' measure, but Ward's method of clustering, which can be seen in Table 5.10. Here a much more even spread of membership is evident across the eight groups, the largest being Cluster 4 with just over 30% of the cases, and another four clusters possessing over 13% of the cases each. As with the Baverage method, a large number of the sherds are grouped with some of the Hermitage products, but a lesser number are members of the groups possessing most Hermitage samples. This supports the evidence from the discriminant and principal components analyses, where many of the groups of samples from 'settlement' sites were located near to, or partially overlapping with, the Hermitage kiln products, but few were perfectly matched.

It is evident from Table 5.10 that Clusters 1 to 3 possess most of the Hermitage samples (60 out of 80, to be precise), with the eleven samples from Hermitage in Cluster 4 also being perhaps significant. Other sites which possess over 50% of their members in Clusters 1 to 3 include Compton Valence (ware S1), Yondover (ware S1) and Woolcombe (ware S4/C2), with perhaps Lodge Farm (ware S2) and Woolcombe (ware S1) as well.

The presence of numbers of the Lodge Farm ware S2, and Woolcombe ware S4/C2, sherds in these clusters is important as it immediately indicates that they cannot represent purely Hermitage products, as significant numbers of examples of other ware types are chemically similar enough to be included along with the visually comparable material. Despite this, the three sites with ware S1 sherds identified here are all from one part of West Dorset, and represent three of the five nearest sites to the Hermitage kiln, from which ceramics were studied. The result may therefore have archaeological significance in giving indications as to the area into which the Hermitage products were mostly distributed.

Cluster 4 contains the largest number of sherds from settlement sites, followed by Clusters 5 and 3. It is apparent from Table 5.10 that many site collections are well represented across the first two of these three clusters, but not in the third. These include Dorchester, Holworth, Portland St. Andrews, Poxwell, Shaftesbury, Woolcombe and Whitcombe ware S1 groups, and Sherborne ware S1 and S2 groups. All these groups have over 50% of their members classified into Clusters 4 and 5, but not all are directly comparable with each other.

Many still show affinities with the Hermitage material, e.g. the Woolcombe ware S1 sherds, of which fourteen out of forty are in Clusters 1 to 3, and 24 are in Clusters 4 and 5. The indications are still perhaps for a continuum of chemical fingerprints (as in the scatterplots described in section 5.2) for the material from these sites, one extreme of which can be described as 'like Hermitage ware S1' and the other 'like Sherborne ware S4'.

It is possible, however, to identify some groups as 'most-like' the ware S4 material from Sherborne. The latter is grouped almost exclusively in Clusters 4 and 8. A number of other site collections match this distribution, notably the ware S4 material from Kington Magna and Shaftesbury, and possibly ware S1 groups from Poxwell, Whitcombe and Yondover. The latter is perhaps a different case altogether. The twenty ware S1 sherds from Yondover are spread across seven of the eight clusters with no obvious particular group affinity, but partial comparability with both the Hermitage and Sherborne material for some of the sherds. The scatterplots of the Yondover material support these indications of greater 'within-groups' variation (Figures 5.8 to 5.10) and the resultant explanation must surely be that material from more than one production site is represented here.

Other sites for which a similar explanation can be used for both the results in Table 5.10 and on scatterplots of discriminant and principal components analyses, include Lodge Farm, Dorchester Prison and perhaps Milton Abbas. The inclusion of the ware S2 groups from Lodge Farm and Milton Abbas here is important, illustrating the variable chemical nature of this type. The reasons for this may perhaps include the existence of more than one production site, although further chemical data to support this is not yet forthcoming. The Dorchester ware S1 group was noted to be very variable in colour and hardness in Chapter 2 and also in the site report (Draper & Chaplin 1982). This may be the cause of the intra-group chemical variation identified in Table 5.10 and may result from the presence of material of more than one provenance.

Integration of the results of all the multivariate statistical analyses applied to the sandy wares data set

An attempt has been made to summarise the information provided in all of the multivariate statistical analyses applied to the sandy wares data set. This is in the form of two tables. The first of these quantifies the maximum number of sherds of each ware type from each site that can be matched to particular known groups, with further indications as to the membership of other groups of indeterminate provenance. These suggestions are presented as Table 5.11. It must be stressed that this table is a subjective assessment of the statistical results, and it must therefore serve as a broad indication , rather than a classification, of group membership.

Most of the site-specific trends visible in Table 5.11 have been discussed here, or in section 5.2. The groups of sherds in the 'other' categories are a wide variety of ware types from sites across the whole region studied. No significant correlations between location or ware type and these groups of sherds can be identified. The occasional sherds showing chemical similarity with the ware C1 material from Laverstock can usually be explained as unrepresentative 'rogue' sherds, but some were perhaps given the wrong ware classification in the first place. The majority of sherds are classified as 'like Hermitage ware S1' or 'like Sherborne ware S4'. This simple division has proved very difficult to dissect any further using the multivariate techniques discussed, the total data set proving to be a virtual continuum between the two identified types.

Some site groups have been shown to be more like one or the other of these two sandy ware types, particularly through the use of the cluster analysis data shown in Table 5.10, but for many other sites the samples are located as internally homogeneous groups, which overlap considerably with both the Hermitage and Sherborne distributions. In such cases this could perhaps be taken to indicate a separate fingerprint for the unprovenanced material, rather than it representing a combination of contributions from Hermitage and Sherborne (Yeo Valley-type) products. Sites for which separate groups may exist, well-clustered internally, but overlapping with the material of known provenance, include Compton Valence, Holworth, Milton Abbas, Portland St. Andrews, Sherborne Old Castle (ware S1 and S2), Southampton (ware S3 wasters and ware S1 sherds together), Woolcombe (wares S1 and S4/C2, possibly together), Whitcombe and Winterborne Houghton.

Sites where more disjointed distributions and/or classifications suggest the presence of Hermitage material alongside other groups and outliers include Dorchester, Lodge Farm, Poxwell and Yondover. Of the two sites besides Sherborne from which ware S4 material was studied, the five sherds from Shaftesbury are all comparable with the Sherborne ware S4 group. The twenty ware S4 sherds from Kington Magna form a less compact group, but at least seventeen of these are clustered with the Sherborne sherds and can probably be taken as similar.

The ware S2 sherds from Sherborne Old Castle are chemically very similar to the ware S1 material from the same site. A common origin for these two groups is very likely, although the former is dated to a period approximately 100 to 150 years later than the latter on stylistic grounds. Although internally quite homogeneous, the ware S2 sherds from Milton Abbas are not chemically comparable with the ware S2 group from Sherborne. The Milton Abbas group is undisputedly distinct and probably represents material from another production source. This group is also not comparable with the ware S2 sherds from Lodge farm. The latter group varies quite greatly internally in its chemical composition and is probably the product of more than one production source. There is also some similarity with the Hermitage ware S1 wasters here, which must not be overlooked.

Variation derived from post-depositional changes in elemental concentration

These suggestions of provenance and similarity have all been made without considering the possibilities that post-depositional chemical changes may have occurred in material from some of the sites studied. Such effects could alter the explanation of inter-group variation considerably, but unfortunately it is extremely difficult to identify when such changes have taken place.

An area where post-depositional effects may have confused the provenancing issue is concerning the sites described above which possess group fingerprints which are very similar to, but not the same as, the Hermitage ware S1 group. The material in question includes the ware S1 sherds from Compton Valence, Holworth, Portland St. Andrews, Sherborne Old Castle, Southampton, Woolcombe, Whitcombe and Winterborne Houghton, the ware S2 groups from Milton Abbas and Sherborne Old Castle, and the ware S4/C2 sherds from Woolcombe. The slight differences that exist between these groups and the Hermitage wasters can be seen most readily in the relevant discriminant analysis scatterplots for each site, as described in section 5.2. With the Compton Valence, Holworth, Milton Abbas and Winterborne Houghton groups slightly lower values for both DF1 and DF2 are evident for the majority of these sherds in comparison with the majority of sherds from Hermitage. Lower values are also present in the principal components plots for these groups, specifically, PC1 and PC2 for the Winterborne Houghton material, PC2 and PC3 for the Milton Abbas ware S2 sherds, PC1 for Compton Valence and PC2 for Holworth. Lower DF1 and DF2 values are also identifiable in the groups from Portland and Whitcombe, when compared with the Hermitage wasters. In these cases, where difference in values is evident on a number of axes, it is very difficult to identify specific reasons for this. All the factors and functions derived from the sandy wares data, with the exception of PC3, have positive relationships with the most heavily loaded elements for that particular axis, and this therefore indicates that the use of the observed 'between-groups' differences is nearly always a result of lower concentrations on the part of 'settlement' site groups when compared to the Hermitage products. With the groups of sherds mentioned above, lower values for at least Fe, Mg must surely be expected, as these factors are heavily loaded on both DF1 and PC1. Those groups that also exhibit low PC2 scores will probably also possess Ni values that are broadly lower than those for Hermitage. Sites where both DF1 and DF2 values are low probably have lower values for all four elements as DF1 is reliant on Fe and Mg, and DF2 on Al and Ni.

The ware S2 sherds from Milton Abbas and the ware S1 sherds from Southampton are the only groups to exhibit lower PC3 values. As PC3 is inversely correlated with the Mg data, this suggests that these groups possess Mg values that are slightly higher than those for Hermitage. This does become confusing, however, as the Milton Abbas sherds have low DF1 values. This function is directly correlated with the Mg data resulting in a contradiction that is hard to explain.

The other site groups mentioned all have 'depressed' values for either DF1 or DF2. The former category consists of only the ware S4/C2 sherds from WF, whilst the latter includes the two Sherborne sandy ware groups and the ware S1 sherds from Woolcombe. The Woolcombe ware S4/C2 sherds probably exhibit lower Fe and Mg concentrations, whilst the other groups are liable to possess lower Al and Ni values. It would not be difficult to imagine that under certain soil conditions Fe and Mg concentrations could change in buried pottery. This has already been reported by Freath (1967). However, in this example Fe and Mg were being deposited on, rather than leached out of, pottery. This perhaps indicates that if such a process were to have produced the concentration differences seen when comparing the Woolcombe ware S4/C2 sherds or any other group with low DF1 values, with the Hermitage products, then it will have been the latter group experiencing elemental deposition that caused the difference. This, of course, starts with the premise that the ceramics all originally exhibited similar concentrations for Fe and Mg. Alterations to the elemental concentrations in ceramics at a kiln site is rather unfortunate, but it does conveniently explain the fact that all the other groups under consideration have lower values. If random alterations on a number of sites were the cause, the resultant pattern would perhaps be of some groups with higher values than for the kiln site sherds, and some with lower values. Such a situation is not evident here, lending support to the suggestion that it is the kiln group, not the marketed products, that has experienced post-burial elemental variations.

This does not, however, explain the lower Aluminium and Nickel concentrations that are found in sherds from many of the sites discussed. The elements that are generally found to be mobile under burial conditions tend to be derived from Groups 1 and 2 in the periodic table of elements. Less reactive elements such as Al and Ni are not recorded as varying under such circumstances in the established literature (see section 3.4). All of the groups of sherds discussed here, with the exception of the ware C2 sherds from Woolcombe, generally exhibit lower values of DF2 than those produced for the Hermitage sherds. If these sherds were all originally chemically consistent, and the identified differences were a result of post-depositional changes in one or other of the groups, then the variation in DF2 values will probably have resulted in changes in Al and Ni concentration. It is highly unlikely that the extremes of soil pH required for such alterations would occur naturally and it is therefore perhaps more realistic to suggest that all of these groups, with the exception of the Woolcombe ware C2 material, are exhibiting 'real differences' derived from differing provenance, when compared with the Hermitage products.

The sites situated on the most acid soils would be those at which post-depositional changes would be most likely. A quick indication of the sites which are located on the most acid soils can be gained through a study of soil maps produced by The Soil Survey of England and Wales. Of the fifteen sites from which sandy wares have been studied, only one, Southampton, is in part located on acid podzols (Sollom and Southampton series') and only Yondover is located on acid brown earths. Six other sites are also located on brown earths, but these are of higher pH and cannot be called 'acid soils'. Woolcombe is also located on quite acid soil, of the Hense series, which is a gley.

The two sites of significance out of these three are Woolcombe and Yondover. The Southampton material, by nature of some sherds being wasters, is known to be not Hermitage products. The Woolcombe material is definitely one of the groups which might have experienced slight chemical alterations, whilst

Yondover is one of the few groups which probably have not. The absence of any of the other sites with 'depressed' values and the presence of the Yondover material, for which there is no evidence of post-depostional changes, in the most acid environments of all those studied, again suggests that post-depositional changes are not a factor for consideration here.

Now that the possibility that post-depositional chemical changes on 'like sherds' are responsible for all these very similar groups has been discounted, another answer for this phenomenon must be found. The fact that all of these site 'fingerprints' are very close to that derived for the Hermitage wasters, perhaps indicates that quite similar raw materials were used in the production of these vessels, but that slight variation did occur. This could be a result of the clays being dug from a different part of the same macrogeological deposit, or it could result from different mixes of the same clays and temper being used. The sandy ware pieces are undoubtedly all related in the type of raw materials used, and to a lesser extent in the forms of vessels that were created. In this sense they form a 'tradition' of manufacture. Using the data provided by this study it is not however possible to group them all together as products of the one kiln at Hermitage. The slight between-sites variations described above are too consistent to be ignored, or dismissed as the product of post-depositional changes, or of sampling or analytical error. Thus it can be postulated that most of these groups were probably made at one or more kilns that shared a 'tradition' of raw material selection and manufacturing method with the Hermitage kiln, but the actual location of these possible producers remains, for the moment, unknown. The fact that so many of the sites discussed exhibited values that probably resulted from lower concentrations for all four elements, may suggest that a factor of fabric dilution must be considered. This could result from different amounts of temper being added by potters at different sites, which supplied separate markets within the geographical zone of sandy ware occurrence. In such cases, where the 'tradition' dictated which type of clay and temper would be used, the resultant 'site fingerprint' would be differentiated from all others by the idiosyncracies of the individual potter, in terms of the mix of raw material used, rather than the actual material selected.

It is by no means certain that the presence of a 'tradition of pottery manufacture', including at least one other kiln besides that known from Hermitage, is responsible for the existence of all these well-clustered site groups of sherds, with similar, but not identical 'fingerprints'. Other explanations available all seem more unlikely, but none can be dismissed entirely. It is only when the archaeological and historical information is again considered that this suggestion assumes particular significance. In Chapter 1 a review of the documentary and archaeological evidence for medieval and post-medieval ceramic manufacture in Dorset was carried out. One of the results of this survey was the suggestion that the kiln site at Hermitage is surrounded by many other parishes in which oblique, and occasional more solid, references to previously unidentified ceramic manufacture exist. These parishes are mostly in contact with the raw materials used at Hermitage, namely Oxford Clay and Greensand, and they lie within that region of Dorset whose ceramic collections are dominated in the thirteenth to sixteenth centuries by sandy ware types. This evidence, when considered alongside the results of the statistical analyses described above, provides a compelling 'manifesto' for the existence of a 'tradition' of sandy ware production in central West Dorset, from the thirteenth century onwards. This postulated 'industry' is placed within the wider context of ceramic manufacture and distribution in the next chapter, where attempts are made to attach archaeological significance to the results that have been discussed here.

Table 5.12 is a subjective grouping of the sandy ware products studied, into like and unlike types, based on the positions of the groups of sherds in the discriminant analysis scatterplots described earlier in this chapter. This differs from Table 5.11 in that; here attempts have been made to classify material from each site into as few groups as possible. Thus, if a group of sherds are located in a cluster that partially overlaps with the Hermitage cluster, the overlapping sherds are not classified as 'like Hermitage' as they are part of an identifiable cluster of their own. If these same sherds were located in these same positions, but as outliers, rather than representative examples of a larger group, they would then be classified with the Hermitage material as no alternative exists.

This table results in many sites having high values in the third column, which indicates the possible presence of material from other sandy ware production sites. Only six sites have material that is 'like Hermitage', three of these being groups that are not of ware S1, which can therefore be identified as non-Hermitage. Thus the only sites where it is reasonably certain that ware S1 products from Hermitage exist are Dorchester Prison, Poxwell and Yondover. This does not mean that all other groups are definitely not from Hermitage, some, for example the Sherborne material, is still very similar and may well be in fact Hermitage products as well. The majority of the large groups identified in the third column are, however, well clustered and quite distinct, and most of this material may well derive from one or more as yet unlocated kilns.

The spread of entries across several columns that is evident for the Dorchester Prison, Lodge Farm and Yondover groups suggests a number of production sources for these groups. whilst the ware S4 sherds can nearly all be closely matched with the Sherborne derived groups of this type.

Coarse wares

(as defined in Chapter 1)

The coarse ware sherds that were studied were mostly of ware C1. Ware C2 sherds were also studied but the largest group of these, that deriving from the excavations at Woolcombe, had already been found to be more truly a flint-gritted sandy ware (S4 type), rather than a flint-gritted coarse ware. The distinction between 'sandy ware' and 'coarse ware' is purely one of the size of inclusions. The sandy wares are tempered with quartz of less than 0.2mm, whereas ware C1 is tempered with quartz of a larger size (usually upwards of 0.5mm). If occasional coarse quartz and flint inclusions are also present, the former ware becomes S4, and this is easily confused with the flint-gritted version of the latter, C2, which is fundamentally the same type of ware. The Woolcombe ware C2 sherds were found to be chemically related to the sandy wares, and not the coarse wares, early on in the study (section 5.1).

The coarse ware kiln product that was used as the original basis for the coarse ware classification was the thirteenth century quartz-gritted cooking-pot fabric found at Laverstock. The twenty samples analysed derived from ten sherds, all of the developed scratch-marked ware, or type C (Musty *et al* 1969, 105). They are classified here as ware C1. In total, another 199 ware C1 sherds were analysed, many of which had decorated surfaces in the form of scratch-marking, glaze or paint. In addition, 14 sherds of ware C2 from Southampton were studied.

Initially, a principal components analysis was carried out on a data set that consisted of all coarse and fine ware sherds. The scatterplots from this analysis were considered on a site-by-site basis in section 5.2. In addition a discriminant analysis was also carried out, the results of which can be found in the same section of this chapter. The discriminant analysis used only one coarse ware group (LV ware C1 wasters) when deriving the functions, the other two groups separated being the LV ware F1, and SO ware F1, wasters. Thus, in the scatterplots the positions of the coarse ware sherds could only be considered in relation to one specified coarse ware group. This produced few meaningful results, as can be seen from the summary table of this analysis (Table 5.13) which is based on visual observations and information derived from the analysis group membership table. This table has not been shown here as due to the fact that comparisons with only one group relevant to the coarse wares can be made. The lack of information that is available results in most sherds being identified as either 'like Laverstock' or 'other'.

It was obvious from some of the scatterplots, however, that a number of groups of ware C1 sherds were chemically quite different to the Laverstock products. The most obvious of these groups were the sherds from Southampton (Figures 5.62 to 5.64) and the glazed sherds from Poole (Figures 5.35 to 5.37). The latter were not separable from the Laverstock fine ware sherds, but this was deemed to be not significant as the visual differences made confusion of these types almost impossible.

A further discriminant analysis was carried out on the same data set, but this time the groups of sherds that were used as the basis for deriving the discriminant functions were the Laverstock ware C1 wasters, the ware C1 sherds from Southampton, and the glazed ware C1 sherds from Poole. It had already been established by the earlier discriminant analysis, and through the principal components analysis, that these groups were statistically distinct, thus it was felt that no 'dangerous' statistical bias was being introduced through attempts to separate sherds of common origin.

The results of this analysis are presented as Figures 5.90 to 5.98. A summary table, based on visual observations and the analysis group membership table, is presented as Table 5.14.

In this analysis 100% separation was achieved between all three of the specified groups. The relative elemental loadings of the functions can be seen in Table 5.15, which lists the standardised canonical discriminant function coefficients. From this table it is apparent that Function 1 is heavily loaded with Al (negatively) and Fe, and Function 2 is heavily loaded with Mg (negatively), and to a lesser extent Fe and Ni.

The position of the Southampton ware C1 sherds high on the axis of DF1 indicates that these sherds possess low Al concentrations and high Fe concentrations, in comparison to the other two groups. The Laverstock sherds are separated from the Poole sherds by virtue of the former possessing higher scores for DF2. This suggests that the Laverstock sherds possess lower Mg concentrations, and perhaps higher Fe and Ni concentrations, than the glazed PL ware C1 sherds.

This next section considers the position of the coarse ware sherds in relation to the separated groups on the scatterplots of the second discriminant analysis. In an attempt to group together similar sherds from different sites, a number of areas within the scatterplots have been given letter codings. All sherds that are located within these zones are identified as members of a particular group. Although this is not strictly true, it does conveniently divide up the problem of conceptualising many individual points into one of comparing several groups. The areas with their letter codings are identified on Figure 5.89. The classification of all the coarse ware sherds into one of these categories, or as 'like' a separated group is described next. This data is summarised in Table 5.14.

Christchurch

Figure 5.90

Most of the unglazed ware C1 sherds from Christchurch show much similarity with the Laverstock material, with one sherd appearing as an outlier in area A in the centre of the scatterplot, and two occurring in area B. The glazed sherds are less compact in their distribution, two sherds showing affinity with the Laverstock material and three with the Poole glazed ware C1 sherds. The scratch-marked sherds show very variable concentrations, with only one sherd showing similarity with the Laverstock products, one appearing as an outlier, and three forming a group in area C.

Corfe Castle

Figure 5.91

The fifteen sherds of ware C1 from Corfe show a distribution that varies greatly on the DF2 axis, taking in the regions of both the Laverstock and Poole sherds. It is difficult to assign a specific group to at least four sherds by purely visual means. The group membership table locates six of the fifteen sherds within the Poole zone, the other nine being grouped with the Laverstock products. This may not be accurate for five sherds which, by nature of higher DF1 scores are located away from the Laverstock region towards the centre of the scatterplot and in area A.

Dorchester Prison

Figure 5.92

The ten ware C1 sherds from Dorchester Prison are fairly broadly spread over the regions of the scatterplot occupied by the sherds from both Laverstock and Poole, which results from widely varying DF2 scores. The group membership table places five sherds with the Poole material and four with the Laverstock wasters. One other sherd is very like the latter, but actually lies just inside area B.

Holworth

Figure 5.91

The ten unglazed ware C1 sherds from Holworth are rather more closely grouped than their counterparts from Corfe. That being said, four of the ten sherds do in fact lie away from the main body of material, which is located with the Laverstock products. Two of these outlying sherds are located in area B as a result of their high DF2 scores and the other two sherds are located with the outlying group of Corfe material in area A. The three glazed sherds all have values that place them firmly alongside the Laverstock products.

Kington Magna

Figure 5.93

The ten sherds of ware C1 from Kington Magna have extremely varied scores for both discriminant functions. Despite this they do form some clusters with a group of five matching the Poole sherds, two lying in area A (in a position similar to that for sherds from Christchurch and Corfe) and three sherds showing affinity with the Southampton material by virtue of their high DF1 scores. These are in fact located in area D.

Poole

Figure 5.94

Besides the glazed ware C1 sherds from Poole that have been used as a 'dummy' kiln group in this analysis, another five sherds of ware C1 with red-painted decoration were also examined. In Figure 5.94 it is quite obvious that these sherds separate well into two groups of two and three sherds respectively. The former group matches the Laverstock wasters very closely, whilst the latter is undoubtedly similar to the glazed sherds from Poole.

Portland, St. Andrews Old Church

Figure 5.95

Of the seven sherds of ware C1 from Portland that were studied, four are located on the scatterplot in the central area A, as with a number of sherds from elsewhere. Only one sherd can be matched to the Laverstock products and two show similarity with the Poole material.

Poxwell

Figure 5.95

The five sherds of ware C1 analysed from Poxwell have very varied locations on the scatterplot. One sherd is located with the Laverstock wasters, whilst two have high DF2 scores which places them at the top of the plot in area B. The other two sherds show similarity with the Southampton ware C1 material through their DF1 scores, but are located below this group on the DF2 axis which thus places them in area D. This area is however occupied by a group of the ware C2 sherds from Southampton (Figure 5.94).

Sherborne Castle

Figure 5.96

Only five sherds of ware C1 were analysed from the Sherborne Old Castle collection., these all being glazed examples. The position of four of these on the scatterplot is directly between the Laverstock and Poole groups, necessitating classification through use of the analysis group membership table. Here, only one sherd is likely to be a member of the Poole group, the other three being 'like Laverstock'. The fifth sherd is an outlier with a very high DF1 score and a very low DF2 score which together produce a location at the extreme edge of the plot.

Southampton

Figure 5.94

Alongside the seven sherds of ware C1, fourteen sherds of ware C2 were analysed from Southampton. It has already been shown that the ware C2 sherds from Woolcombe have no similarity with the Southampton group (section 5.1), so there is no need for further comparison here. The Southampton ware C2 sherds have high DF1 scores, which is in keeping with the ware C1 sherds. Their DF2 values are not all quite as well matched however. A group of eight sherds have high DF2 scores, resulting in a good degree of overlap with the group of ware C1 sherds. The other six sherds possess lower ware C1 scores, however, and are located just below the ware C1 sherds in area D. This does not result in confusion with any other known types, but it does indicate that any 'fingerprint' of Southampton coarse ware products in general would have to be more wide ranging than that derived purely from ware C1 sherds.

Shaftesbury

Figure 5.96

Fifteen glazed examples of ware C1 were analysed from the Shaftesbury collections. These included five sherds that were probably from tripod pitchers and thus liable to be of an earlier date than most other glazed ware considered. These sherds did not, however, show any obvious chemical differences with the other material and so they have not been separately identified on the scatterplot. Overall, the fifteen sherds show a distribution that closely matches those for both the Laverstock and Poole sherds, with two sherds being classified wth the former and another three being located close by, on the edge of area A. The other ten sherds all lie within the area encompassed by the Poole sherds. There is no similarity whatsoever with the material from Southampton.

Wimborne, the Leaze

Figure 5.97

Twenty unglazed and ten glazed sherds of ware C1 were analysed from Wimborne. Both groups overlapped considerably with the Laverstock products and, to a lesser extent, with the Poole sherds. The group membership table places five of the glazed sherds into the Poole zone, which is perhaps surprising on the strength of a solely visual consideration of the scatterplot. Only four of the unglazed sherds are similarly classified, with fifteen of the others being 'most like' the Laverstock products, and one being very similar to these, but located slightly lower on the DF1 axis.

Wareham, St. Martins House

Figure 5.98

In all thirty sherds of ware C1 were analysed from the Wareham collection. Ten of these sherds were undecorated and on the scatterplot it can be seen that four of these are very closely matched with the Laverstock products, whilst four other sherds have slightly higher scores on both axes and are located in area A. One other sherd is located in a different part of area A and the other appears in area C. The glazed sherds are widely spaced, five having values that classify them with the Poole sherds, although two of these have rather lower DF1 scores and may be completely separate. Two sherds are like the Laverstock products, whilst three have high DF2 scores, which place them away from all of the separated groups in area C. The scratch-marked sherds seem to be chemically very homogeneous and also similar to the ware C1 material from Laverstock. This is in keeping with the suggestions provided by the original scatterplots (Figures 5.71 to 5.73).

Winterborne Houghton

Figure 5.93

Ten unglazed sherds of ware C1 were studied from Winterborne Houghton. These separate into two groups which match the Laverstock and Poole material very well. Six sherds belong in the former group, although one is in fact in area A, and four belong in the latter.

Whitcombe

Figure 5.95

Five sherds from Whitcombe were examined. Two of these can be seen to be very like the Laverstock wasters, whilst one is matched with the Poole material. The other two sherds possess high DF2 scores, and are located in group B as a result of this.

Discussion

It is obvious that differences exist between the grouping of sherds in Tables 5.13 and 5.14. This is exemplified by the membership of the 'like-Laverstock' column, where great differences exist in the numbers of sherds assigned to this group from sites such as Corfe and Holworth. These differences are not echoed over all the sites, however, as the numbers for Christchurch ware C1 and Wareham scratch-marked ware C1 testify. This therefore suggests that some elements of variation, inherent in the factors derived in both discriminant analyses, are the same. This is to be expected as they all derive from the same basic data set, but the fact that only part of the results of the first analysis are found in the second does perhaps suggest that the latter has been more successful, in the sense that a different part of the total variation inherent in the data is being used to derive the functions. The original functions were derived to separate only one ware C1 group from two sets of fine ware wasters. Thus the functions tended to have little value in identifying variation between different groups of coarse wares because such variation was masked behind the more 'crass' distinctions between ware groups. With the second analysis the functions have been specifically derived to find differences between the elemental concentrations of different groups of coarse wares, that have already been shown to be not identical through use of the first discriminant analysis and the principal components analyses. Once the other coarse ware data are plotted on these axes, the increase in patterning in the data is self-evident and has proven most useful.

The data shown in Table 5.14 have been partially summarised in the form of percentage occurrences in the studied material which has then been plotted as Table 5.16. Using the data from these two tables some broad statements can be made concerning inter-site and intra-site trends in the coarse wares data.

It is evident that material that is chemically similar to the Laverstock wasters is common amongst the sherds studied. The only sites where no material that is similar to the Laverstock group occurs are Kington Magna and Southampton. At the former the sherds are either matched with the Poole material or located away from the three separated groups. Three sherds do in fact match some of the ware C2 Southampton sherds, which may well be significant. This group from Southampton is like the separated group from the same site and unlike either the Laverstock or Poole sherds. Only two other sherds show similarity with the Southampton material, however, these being from Poxwell. Whether or not either these sherds or those discussed from Kington Magna are actually derived from the same production source as the sherds from Southampton is open to question. Both these sites are located in the western half of Dorset and therefore a long way from the supposed production source 'near' Southampton. Neither of these sites is known to include structures of anything better than moderate social status which implies few long-range trading contacts. Thus it may be possible that the chemical similarity of these sherds with the Southampton group is purely coincidental. The Kington Magna group also happens to be the only site group which has chemical similarity with the sherds from Poole, but not with the Laverstock wasters. One other site does, however, show Poole dominance, in terms of numbers of sherds that are similar to this group. That site is Shaftesbury. The picture here is somewhat confused as a number of sherds that are classified as in area A on Figure 5.89 are rather similar to the Laverstock products as well. It is interesting, however, that the Shaftesbury coarse wares show similarity with the Kington Magna sherds, as the two sites are located close to each other in North Dorset.

Two sites in particular have groups of sherds that are very similar to the Laverstock products, but do not have sherds that are similar to the Poole material. This occurs with the unglazed sherds from Wareham, both scratch-marked and plain, and also with both glazed and unglazed sherds from Holworth. The former site assemblage does possess a number of glazed sherds that are in fact similar to the Poole material, as well as some glazed sherds that are very different to all the separated groups. The indications here are that the main body of unglazed material is perhaps from one site, whilst the glazed ware has more than one provenance. This cannot of course be said of the Holworth collection where all the sherds may be from Laverstock. This is not a statement that could easily be supported archaeologically or historically. It would be undoubtedly a peculiar distribution system that sent large quantities of coarse wares the great distance from Laverstock to Holworth when identical products also appear to originate from near Poole, which is much closer to the latter site.

All the other groups studied contain individual sherds that can be matched with both the Laverstock products and the group of glazed sherds from Poole. In general, the number of sherds like the former is greater than the number that closely match the latter; especially if many of the so-called area A sherds are included in the 'like-Laverstock' total. Little obvious spatial patterning is evident in these groups, in terms of their geographic location in relation to the Laverstock kilns and any possible production site near Poole.

There do seem to be large numbers of Laverstock-type sherds at Wimborne, which is the second nearest to Laverstock of the sites studied. There are very few Laverstock-type sherds at Shaftesbury, however, which is perhaps surprising as it is also near to Laverstock, in comparison to the other sites studied, and directly served by medieval main roads along which the products could have been transported.

The spatial dimensions of these data are shown in Figure 5.99. Here pie charts have been located onto a map of the study area, one for each site from which coarse ware sherds have been analysed. The segments of the charts are proportional to the percentage of coarse ware sherds analysed from each site that can be matched to one or other of the groups discriminated between in the second analysis. It must be stressed that these charts do not represent the proportion of sherds in the actual assemblage, although the data can be used as indicators of the latter to a certain degree. This figure shows very clearly the positions of the sites with possible Southampton type sherds, and how unlikely it would perhaps be for such products to 'travel' that distance, except under very unusual circumstances.

Neither the Poole-type nor Laverstock-type sherds occur at Southampton and, although these data, deriving from only one site, are not very comprehensive, it does perhaps suggest that these types were not distibuted into south Hampshire. The primary reason for this must be the presence of locally-made alternatives, represented by the ware C1 and ware C2 sherds studied here.

An interesting feature of this figure is the distribution of the Poole-type sherds. These seem to be more abundant inland, in central and north Dorset, and less common in the coastal collections.

If all the Laverstock-type sherds do indeed originate from that industry, Figure 5.99 represents a very extended distribution for a coarse ware. This problem can only be taken further by comparison with the distribution of Laverstock fine ware sherds, and through consideration of the ware C1's actual contribution to the total assemblage at each of these sites. This will be considered in Chapter 6.

Fine wares

(as defined in Chapter 1)

The fine ware sherds that were studied were mostly of two ware types,those being ware F1 and ware F4. The former is exemplified by the Laverstock fine ware products, the latter is a much lighter fabric found elsewhere and could in fact be called a white ware. Besides these two types some sherds of a darker fine redware (ware F3) were also studied, the majority of these deriving from the Southampton collections. There was also one sherd from the Laverstock collection of a flint-gritted fine ware, ware F2. This intrusive sherd was discussed in Chapter 1 and has not been included in the analysis here.

As with the sandy wares and coarse wares the 'between ware' distinctions are not always straightforward. There is no problem in separating wares F3 and F4, due to their obvious colour differences, but examples of both of these types can on occasion be confused with ware F1 sherds. Widely varied hues are exhibited by many sherds within these groups and there are unavoidably occasions when a light ware F3 sherd could also be classified as ware F1, or a dark F4 sherd confused in the same way. Most sherds are however representative of one particular group, and so classification is generally not difficult for the majority of fine ware sherds within one assemblage. Similar classification problems also exist due to the tempering agent quartz sand.

Most sherds of fine ware types show evidence of quartz sand tempering, although usually it is very fine. When the grains are larger (above 0.2mm) it is sometimes difficult to decide whether a particular sherd should be classified as ware S1 or even C1 rather than a fine ware. Again, such problems are difficult to avoid, but can be accepted when only a small proportion of the sherds studied are beset by such classification difficulties. Chemical analysis can of course help in such cases, providing statistically identifiable chemical differences occur between the ware types. Even if a sherds chemical constitution echoes it's physical appearance; for example, if it lies on the borderline between two groups when classified using both visual and chemical analysis, the chemical information can still be useful. This is particularly evident with discriminant analysis where the probability of that sherd being a member of each group can be calculated, with a classification made accordingly.

Table 5.17 is based on visual classification of the results of the discriminant analysis and the principal components analyses on the fine and coarse wares data set, as described in 5.2. The fine ware sherds from each site have been classified into a number of groups, including those sherds that seem to be chemically 'like' the Laverstock and Southampton fine ware wasters. The other classifications listed are groups of sherds that seem to possess mutual similarity, and are also chemically unlike the two sets of fine ware wasters. Two specific groups have been identified, one of these being called Group Y and one Group Z. The former is a group of sherds that seem to possess high Iron and Nickel concentrations, the latter having low Iron, Magnesium and Nickel values. These two groups are, in fact, quite representative of the ware F3 and ware F4 sherds respectively. Of the 30 ware F3 sherds that were analysed from all sites, 22 have been classified into Group Y using the data from these analyses. Similarly, of the 62 ware F4 sherds, 52 have been classified into Group Z. There is still between-groups confusion, particularly the 8 sherds of ware F1 that are also included in each of the two new groups. Attempts have therefore been made to clarify the situation, enabling all sherds to be grouped, with a good degree of certainty, into one of these three groups, or be placed as 'other'. To this end a further discriminant analysis was conceived, but, this time, instead of using the Laverstock ware C1 sherds as a group whose separation would determine the nature of the functions, this material was replaced by some ware F4 sherds. To ensure that these sherds were not of doubtful classification it was decided that the largest and most visually certain group of ware F4 sherds would be used, that being the group from the Corfe Castle collection. Of these 15 sherds, only one could possibly be chemically confused with the Laverstock material, and so this sherd was not included in the analysis. It was hoped that, through the creation of discriminant functions that separated three fine ware types, including a fully homogeneous set of ware F4 sherds, other sherds of similar origin to the Corfe material would be instantly recognisable through their similar discriminant scores. If some classification of the Group Y members was also achieved, then the archaeological statements that could then be made regarding this material would sit on much firmer foundations.

The classifications achieved through this analysis are discussed on a site by site basis next, followed by discussion of between sites and 'within wares' trends. The result and group memberships are shown in Table 5.19.

The standardised canonical discriminant function coefficients for the analysis can be seen in Table 5.18. The absence of Nickel from this table indicates that it did not provide any extra separation that could not be achieved using the data from the other 3 elements. It is evident from this table that, perhaps surprisingly, Iron is not heavily loaded on either function. Considering that colour is quite a powerful identifier of these groups, Iron would have perhaps been expected to contribute heavily to any function that separated the ware F4 sherds as Iron is often responsible for the dark or red colouration found in ceramics. Discriminant Function 1 is most heavily loaded with Magnesium and, inversely, with Aluminium, whilst Discriminant Function 2 is heavily loaded with Aluminium and then Iron.

The three groups are separated using Discriminant Function 1, with the ware F4 sherds from Corfe having the lowest scores and the Southampton sherds the highest. This could be taken to indicate low values for Iron and Magnesium, and high values for Aluminium in the former group, with the inverse being true of the latter.

Post Medieval kiln site material

Figure 5.100

For comparative purposes the three groups of wasters from post-medieval kilns at Alderholt, East Holme and Horton were added to the analysis as 'unknowns'. The resultant positions of these sherds can be seen on Figure 5.100, where they are plotted alongside the three separated groups of medieval sherds.

This scatterplot indicates that the ware F4 sherds from East Holme are similar to, but not the same as, the ware F4 medieval sherds from Corfe. The similarity is achieved by virtue of similar, low DF1 scores suggesting low Iron and Magnesium concentrations. The East Holme sherds are separated from the Corfe medieval through DF2, however, which probably indicates some difference in Aluminium concentrations. As in section 5.3, the Alderholt and Horton sherds are shown to be very different from each other, with the latter possessing higher DF1 scores and being located near to the Southampton wasters.

Christchurch

Figure 5.101

As with the original discriminant analysis, a great deal of variation is visible between the sherds from Christchurch. The three ware F4 sherds all, perhaps surprisingly, show similarity with the Laverstock wasters, whilst four of the ware F1 sherds are similar to the Corfe ware F4 material. One other ware F1 sherd does in fact match the Laverstock group, with the other two sherds of this kind showing difference with the latter group on the Discriminant Function 2 axis. These two sherds are, in fact, quite well matched with the post-medieval sherds from kilns at Horton, although this may of course be purely by chance.

This distribution in parts sharply contrasts with that produced from the first discriminant analysis, the classifications from which can be seen in Table 5.17. This latter did not indicate any similarity with the Laverstock group except for one sherd of ware F4. Instead 5 sherds were identified as possibly of Group Y, a comparison that can be made here if the general position of the ware F3 sherds from Southampton in Figures 5.107 is studied. It is evident that two of the Christchurch sherds show similarity here, but the separation from the Laverstock wasters is not perfect.

In summary, the only useful statements that can be made about this material from the analytical data are that between 2 and 4 of the ware F1 sherds are like the ware F4 material from Corfe, whilst occasional sherds from Laverstock are also present. It is also probable that at least two of these sherds can be matched with ware F3 sherds from Southampton (the core of the Group Y material).

Holworth

Figure 5.102

The nine fine ware sherds, two of ware F4 and seven of ware F1, all show similarity with the group of ware F4 sherds from Corfe. This is entirely in keeping with the results of the first fine wares discriminant analysis, and confirms that all seven sherds can be placed in Group Z.

Poole

Figure 5.103

As with the Christchurch material, the fine ware sherds from Poole show widely varying locations on the scatterplot. The ware F1 sherds generally show similarity with the Laverstock ware F1 wasters, except for one sherd which is like the Southampton material, whilst the ware F4 sherds generally show similarity with the ware F4 material from Corfe. The ware F3 sherds are not obviously grouped, but three sherds are possibly similar to the Laverstock material, one is possibly like the ware F3 sherds from Southampton, and two are outliers. Almost all these classifications are identical to those suggested by the first discriminant analysis (Figure 5.37, Table 5.17).

Salisbury

Figure 5.104

In general, the sherds from Salisbury show similarity with the Laverstock wasters. The exceptions to this are four ware F4 sherds, which are located in the zone between the Laverstock and Corfe sherds, with perhaps more similarity with the latter, and four or five ware F1 sherds which have values close to those for Laverstock, but which are not perfectly matched. The distribution seen here closely echoes that from the first discriminant analysis and does perhaps confirm that the Salisbury ware F1 material is generally similar to that from Laverstock, whilst at least some of the ware F4 sherds are different, although they are not identical to the ware F4 material from Corfe either.

Shaftesbury

Figure 5.105

In Figure 5.105 four of the five sherds of ware F1 from Shaftesbury are similar to the Laverstock products, whilst one sherd is like the Corfe material. This situation is exactly that suggested by the first discriminant analysis, as described in Figure 5.52.

Sherborne old Castle

Figure 5.106

The ware F1 sherds from Sherborne have a widely varying set of locations on the scatterplot, with examples that show similarity with all three separated groups. At least seven sherds are similar to the Laverstock wasters, whilst two are located near to the Southampton products and one or two are found with the Corfe ware F4 material. This partially matches the classifications derived from the first analysis (Figure 5.58, Table 5.17), where eleven sherds are matched with the Laverstock group, and none with the Southampton wasters. As with the earlier analysis, all but one of the fifteen ware F4 sherds are matched with the Corfe material, whilst the remaining sherd is 'like Laverstock'. Two of the ware F3 sherds are also similar to the Laverstock products and one is like the Corfe sherds, which matches the classifications derived from the first analysis. The exception to this is the remaining sherd which is identified as an outlier this time, whereas it was orginally labelled Group Y.

Southampton

Figure 5.107

The picture for the ware F1 sherds from Southampton is almost identical to that derived from the first analysis, with only one sherd showing similarity with the wasters from Southampton and the rest matching the Laverstock products. There is some confusion with the ware F3 sherds, however, as in this plot they are only partially separated from the Laverstock material. This does not confirm the existence of ware F3 sherds as a separate group (Group Y), as suggested by the data discussed in section 5.3, although it does not refute this suggestion either. This group can probably still be accepted as genuine, however, as it was almost completely separated from the Laverstock and Southampton wasters in the original discriminant analysis (Figure 5.67), and also through the use of the principal components scores (Figures 5.65 & 5.66).

Wareham

Figure 5.102

The ten sherds of ware F4 from Wareham are all located with the ware F4 sherds from Corfe in the scatterplot. In the original analysis, at least eight of these same sherds were similarly grouped.

West Grimstead

Figure 5.108

In the scatterplot the ware F1 wasters from West Grimstead are not seperated from the Laverstock wasters, indicating that they might all derive from similar raw materials, but also suggesting that unprovenanced sherds from either production site cannot be mutually separated. This matches the results from the first discriminant analysis. The same can be said for the non-waster sherds, where both ware F4 examples are, as before, located with the Corfe material, along with two of the ware F1 sherds. The rest of the latter are like the group of Laverstock products which again matches the first analysis.

Wimborne, The Leaze

Figure 5.101

The two ware F1 sherds from Wimborne have been located with the Laverstock products, whilst up to three of the ware F4 sherds are matched with the Corfe material. The rest of the ware F4 sherds, apart from one outlier, are similar to, but not the same as, the Corfe group. This roughly matches the conclusions drawn from the first discriminant analysis, where six of the ware F4 sherds from Wimborne are classified as 'other', with two or more being in Group Z. The major suggestion from this scatterplot is therefore that the majority , if not all, of the ware F4 sherds from Wimborne are of one group which is not directly comparable with the Group Z material. This perhaps indicates the existence of another unprovenanced type, although the evidence is undeniably vague. It is perhaps interesting, but probably only coincidence, that these sherds are matched closely with the ware F4 post-medieval wasters from East Holme in this analysis.

Cross-site trends

The classifications described in the site-by-site study have been displayed together in Table 5.19. By comparing these figures with their corresponding entries in the table derived from the first discriminant analysis on the fine wares data (Table 5.17), an indication of the maximum number of sherds that can, with a very good degree of certainty, be classified with one of the separated groups or into the Group Y or Group Z categories, can be made. Such figures have been calculated by simply identifying those sherds that have been classified as 'like' a specific group in both of the discriminant analyses on the fine (and coarse) wares data set. The numbers of sherds of each type that qualify in this manner have been calculated for each site, and can be seen in Table 5.20.

Southampton products and 'Group Y' type sherds

Only two sherds can definitely be matched with the Southampton wasters, these being one ware F1 sherd from Poole (PL24) and one from Southampton (SO36). The rest of the ware F1 sherds from Southampton were either 'like' the Laverstock products (4 sherds or more) or the ware F3 material from Southampton (1 to 4 sherds). The original discriminant analysis resulted in the ware F3 sherds from Southampton being quite well separated from the Laverstock products. The second analysis did not result in as good a distinction between these types and resulted in some confusion as to which sherds were actually like the ware F3 material, and should be classified as Group Y. Only 8 of the 20 ware F3 sherds from Southampton have been listed as Group Y in Table 5.19, but it is probable that most of this group are in fact different to the Laverstock products. Other sherds that can also be placed in this group include two ware F1 sherds from Christchurch (CH11 and CH16) and one ware F3 sherd from Poole (PL28). The first analysis suggested that some other sherds from Christchurch could also be attached to Group Y, but this was not borne out in the later analysis.

The picture for marketed products from kilns at Southampton, and for the extent of a Group Y distribution, is thus rather vague. There is a suggestion that Southampton-produced ceramics were transported to Poole and, if the first analysis is to be believed, also Sherborne Old Castle. The evidence for these types within fine ware sherds from Southampton itself is also rather slim, only one definitely similar sherd being identified here. The Group Y sherds seem to appear as isolated examples in Dorset, the most probable example of which is from Poole, with the suggestion of other Group Y sherds at Sherborne Old Castle. Better evidence suggests that at least two, and maybe as many as five sherds of Group Y origin have been found at Christchurch. The only site studied that characteristically has large amounts of this material is Southampton. This may be because this type is generally found outside the study area. D. Brown (Pers. Comm.) indicates that this material is common at Winchester and is probably a specific Hampshire fine ware type. This, therefore, perhaps explains the presence of small amounts of this material at Christchurch, which is historically in Hampshire and geographically the second closest to Southampton of the collections that were studied.

Laverstock Products

The Laverstock fine ware products were of ware F1. Examples of ware F1 sherds were studied from 9 other sites, totalling 70 sherds in all. Of these, 39 sherds are classified as chemically matching the Laverstock kiln group in Table 5.20. No ware F1 sherds from Christchurch or Holworth are included in this group, the sherds from the former site being very variable and those from the latter being classified into Group Z. The majority of the sherds grouped with the Laverstock wasters come from sites in the north of the region, eg; Salisbury, Sherborne and West Grimstead. Although these sites were those from which largest numbers of ware F1 sherds were actually analysed, they do generally show much similarity with the Laverstock wasters, with 10 out of 15, 9 out of 15, and 7 out of 10 sherds being grouped with Laverstock respectively. Of the sites in the south of the region, as has already been stated, none of the 9 sherds from Christchurch and Holworth could be matched with the Laverstock kiln group, although both sherds from Wimborne could be, as could 3 of the 5 sherds from Poole. The situation at Southampton is rather confusing over the two discriminant analyses but certainly at least 4 of the 9 ware F1 sherds studied match the Laverstock products.

A few ware F1 sherds are also grouped in with the Laverstock material, including odd sherds from Christchurch, Poole and Sherborne, and six of the ten sherds from Salisbury. Those from the first three sites probably represent sherds of untypical colouration that were misclassified. The Salisbury group may possibly be another variant of the Laverstock products, or perhaps a lighter, but chemically similar product from other kilns near Salisbury. This material was identified early on as probably a late medieval Surrey white ware type.

Overall a number of regional generalisations can be detected. In the north of Dorset and South Wiltshire most of the ware F1 sherds studied are of the Laverstock type. This definition of 'Laverstock type' may actually include material from other kilns in the immediate area of Salisbury as, as has already been discussed, the wasters from West Grimstead are not separable from their counterparts from Laverstock. Salisbury also has ware F4 type sherds, of a somewhat later date (i.e. Surrey-type white ware), about half of which are chemically matched with the Laverstock products. The indications are perhaps that there is more than one type represented in this group of 10 sherds and that the 6 sherds discussed here may indeed be of local, rather than Surrey, origin.

The ware F1 material from South Dorset is not as likely to be of Laverstock origin as that from further north, if the examples from Christchurch and Holworth are to be believed, but the distinction is not very marked. This difference is not very surprising as the kiln site itself is nearer to the sites further north. The occurrence of at least 4, and maybe 7 sherds of Laverstock type in the group of 9 ware F1 examples from Southampton is definitely surprising. Most of this material would perhaps be expected to be like the wasters from the same site, and the reason why this is not so is not obvious. It is of course possible that the 9 sherds selected were not representative of the general mass of glazed wares from Southampton, but despite this, the indication may well be that Laverstock products were arriving at that port in numbers.

The fine ware sherds from three sites; Christchurch, Poole and Sherborne Old Castle, can be said to be chemically more varied than the other collections. This is evident from the entries in many columns for these sites in Tables 5.17 and

5.19. Many of these sherds can be matched with some of the groups that have been defined, but others are very different indeed and appear on the scatterplots as outliers. It is probable that a collection like that from Sherborne Old Castle, where such a variety of chemical concentrations exists in the fine wares, derives from several kiln sites. Identifiable suppliers here include Laverstock and the Group Z source, but a number of other provenances for small numbers of fine ware sherds from this site must also exist.

Group Z sherds

Using 14 of the Corfe Castle ware F4 sherds as a 'dummy kiln' group the ware F4 sherds from other sites can be compared with a tightly defined group instead of simply randomly selected from a region of the scatterplots. The data in Table 5.20 is still based on a visual interpretation of the plots, but, where the two discriminant analyses give conflicting classifications for a sherd, the second analysis classification table has been used to identify those sherds that are closest to the mean of the Corfe group. This does not produce absolute 'answers', but such stringent precautions greatly reduce the chances of producing a composite group of sherds of more than one provenance.

It is apparent from Table 5.20 that most of the ware F4 sherds, excluding those from Corfe, (56 out of 63) become part of Group Z, even when the measures above are used. The only sites where none of the ware F4 sherds are so grouped are Christchurch, Wimborne and Salisbury. The first of these only had three sherds of ware F4 analysed, thus making any statements based on this information rather meaningless. At Wimborne the picture is rather confused, but the indications are that most of the ware F4 sherds from this site derive from another unknown kiln site which produced products that are quite similar to the Group Z material, but which are not exactly the same. The possibility that this difference results from post-depositional alterations in elemental concentrations in the sherds must also be considered, although it is difficult to say which elements would have experienced this, given the 'loadings' for Discriminant Function 1 in Table 5.18. Aluminium is not known to be mobile under relatively normal soil conditions and so it would probably be Iron and/or Magnesium which had altered. It is, however, doubtful whether alterations in elemental concentrations are in fact to blame for the differences here as no similar effects can be discerned for other wares from the same site.

The Salisbury group is discussed in the previous section concerning Laverstock products. It is possible that these sherds derive from two sources, one of which is chemically similar to the Group Z material, and one of which is like the Laverstock products. As all these ceramics have been dated to the fifteenth century on stylistic grounds, and were thus classified by the author of the site report as 'Surrey-type white ware', the comparison of these sherds with the material from thirteenth century settlement sites is not critical. What is significant, however, is that some of this material cannot be easily differentiated from the Laverstock sherds. Although this problem does not cause difficulties here because the sherds are visually separable, it does not bode well for any study using 'Surrey-type' and South Wilts fine wares of a similar, or uncertain, date when the visual classification is not so easy.

The two sherds of ware F4 from West Grimstead have been found to be chemically similar to the Group Z Corfe sherds, which is perhaps surprising considering the geographical location of the former site. It had been considered that these sherds might show chemical similarity with the ware F1 wasters from the same site, and the difference between these sherds that is exhibited in ,for example, Figure 5.108 perhaps suggests that in actual fact they derive from the same source as the Group Z material.

The other sites from which ware F4 sherds were analysed all have over 80% of these sherds matched with the Corfe group. This is perhaps not surprising in collections from southern Dorset, of which all but one of these are. The exception is the Sherborne Old Castle collection, from which 15 ware F4 sherds were analysed, 14 of which can be classified as Group Z.

A few sherds of ware F1 from a number of these sites are also classified with the Group Z sherds. These were all probably originally visually misclassified and the presence of these sherds does not affect any of the suggestions made here.

The broad trends are therefore very simple, as far as the ware F4 sherds that were studied are concerned, with most sites that possessed thirteenth or fourteenth century ware F4 material deriving the majority of their vessels from the Group Z source. Sites which do not fit this rule are Wimborne, where an alternative, but perhaps related source is evident, and possibly Christchurch, although the evidence is too scanty to make any real sense here. The later white wares that were analysed from Salisbury are in fact chemically different to the Group Z material, but about half of these show similarity with the Laverstock products. This is surprising as these sherds were supposed to originate from Surrey. The seventeenth century white ware wasters from East Holme show similar traits to the Group Z sherds, but are definitely not the same, which was to be expected.

In the next chapter these trends will be discussed in comparison with those seen for other medieval pottery types in the region. Attempts will also be made to qualify some of these statements through use of information concerning the make-up of the assemblages these sherds derive from, as described in Chapter 2.

Chapter 6

Interpretation of the analytical results as archaeological data: Evidence for the production and distribution of ceramics in medieval Dorset and its region

6.1 The percentage occurrence of ware types (as identified in Chapter 1) in relation to spatial factors

In Chapter 2 'assemblages' for all the excavated groups studied, except for Salisbury and Yondover, were defined. These are exhibited as Tables 2.7 to 2.26, and were discussed in section 2.6. The Salisbury assemblage was unfortunately not recorded in a manner that allowed comparisons to be made with the other groups studied here. The Yondover collection was all of one type, that being ware S1, and thus there was no need to tabulate these data.

Sandy wares

If the percentage values for the major sandy ware variants are taken from these tables and each one is plotted as a pie chart, these charts can then be located on a map of the study region as in Figure 6.1. This illustrates both the spatial and quantitative variables for these ceramic types, indicating the areas within which the wares were dominant.

It is apparent from this figure that ware S1 is most common in the sites studied from south west Dorset, with three of the eight sites studied in this area possessing assemblages, as defined in Chapter 2, which have over 25% contributions from ware S1. The other five sites possess between 50% and 100% of their assemblage in the form of ware S1 sherds. These sites are located in part of three of the natural regions identified on Figure 2.5, there being no discernable important differences between the assemblages from each natural region within this group. East of Holworth there seems to be quite a dramatic drop in the importance of ware S1 in the site assemblages, and it virtually ceases to occur altogether from Poole eastwards in the south of the county. A similar picture is evident further inland, but with perhaps a less abrupt cut-off in the presence of this ware type. A fairly constant occurrence of between 10% and 20% of medieval assemblage totals is registered in central north Dorset, although this in turn drops to zero in south Wiltshire. This is presumably due to the presence of more local Laverstock-type coarse wares in this region.

As the Hermitage kiln produced ware S1 products, it is perhaps surprising that these eight sites where ware S1 is most common are all south of the kiln whereas sites to the north and east of the kiln, which are just as near to it as the former group, possess assemblages with much lower ware S1 contributions. This indicates that Hermitage was not at the spatial centre of the primary distribution zone of ware S1 sherds, and that if all of these sherds did in fact originate from Hermitage, as is one of the suggestions for the data as discussed in Chapter 5, then a very southerly-skewed market was being supplied by this one kiln.

The occurrence of ware S2 is rather confusing as this type has not yet been dated accurately. Ware S2 pottery is very common in late fourteenth century and fifteenth century contexts at Sherborne Old Castle (Harrison and Williams 1979), and it has also been identified by the author in late medieval contexts at Shaftesbury, although this material is not recorded in the relevant section in Chapter 2 as it derives from another site within the town. It is quite probable that some of the ware S2 sherds from Lodge Farm and Milton Abbas may also date to this later period because both sites also possess a few sherds of fine wares of this date. However, both site assemblages also include definite late twelfth-century or thirteenth-century material in the form of ware S4 sherds, perhaps indicating an earlier date for the ware S2 sherds after all. It is certainly interesting that most of the sites where this ware type has been found are in central and north Dorset, in Natural Regions 2 and 4, although it does also occur at Corfe Castle and Poole (Jarvis *et al* unpub.). It is therefore possible to identify a specific region where this ware is very common, notably on the central chalklands, and to indicate that it was also distributed southwards and northwards, with perhaps the latter being the more common movement. The date of occurrence of this ware must still remain vague and, although it is perfectly possible that it first occurs at the end of the thirteenth century, generally when it is found in collections away from the 'core' of its distribution, the ware tends to be dated to the late fourteenth or fifteenth centuries. This is exemplified by its occurrence at Sherborne Old Castle (Harrison and Williams *op. cit.*).

The ware S3 distribution can also be seen on Figure 6.1. It is not a very common type, only occurring at four sites. The ware S3 wasters from Southampton are not likely to be related to the ware S3 material from the other sites, at Portland, Poxwell and Whitcombe, because of the great distance (about 80 km) between the former and the latter three sites. It is also possible that the ware S1 sherds from Southampton have a common origin with the ware S3 wasters from the city, and not with the ware S1 material from Dorset. The other sites where ware S3 sherds were identified are all closely grouped in Natural Regions 3 and 4 in south Dorset. The occurrence of this type here, and nowhere else in the county, does perhaps suggest a local origin for the manufacture of this pottery. The forms it is present in at all three sites are not very diagnostic, but they broadly match the forms of ware S4 and earlier ware S1 vessels. This therefore suggests that the ware S3 industry was active during the mid-thirteenth century, although the actual span of its production period is difficult to ascertain. Certainly this ware could not have been a truly wheel-made type, as the flint temper would not have permitted wheel throwing without severe consequences for the potter's hands. This does not preclude some slow wheel or turntable work, particularly when adding everted necks for cooking pots. As ware S1 sems to have been always made on at least a slow wheel, from the forms it is known in, the suggestion can be made that the ware S3 production probably started slightly earlier than that of the 'pure' ware S1 sandy ware, and also that the former ceased to be made some time before the latter dissapeared. A date range somewhere in the region of 1180 to 1280 does not seem inappropriate for the use of ware S3.

The distribution of ware S4 or ware C2 sherds is much more extensive than that for the ware S3 material. This seems to be most common in north and west Dorset, which is not perhaps surprising as it has already been noted that a production source for this material is believed to have been active in the Yeo valley near Ilchester and Sherborne (Pearson 1982). A discussion of the problems encountered in differentiating between ware C2 and ware S4 sherds has already been carried out (in Chapter 5), but it is still perhaps necessary here to elaborate one or two points further. In the region of north-west Dorset already mentioned, the sherds of this type were originally identified as ware S4, probably because they are found in assemblages which also have large amounts of ware S1 sherds. Thus the perception of this material was initially as a variant on the sandy ware theme. Conversely, at Salisbury and Southampton, little ware S1 material was found and the ware S4/C2 sherds were originally perceived as flint-tempered variants of the coarse ware type C1, which is abundant at both of these sites. The relative merits of such classifications are only found through the chemical analysis of the material. Such analyses were described in the previous chapter and the resultant classifications are discussed later in this chapter.

Returning to Figure 6.1, it is therefore apparent that the ware S4/C2 material that is common in north and west Dorset ceases to be a significant part of collections east of Winterborne Houghton and this type is not evident at all in the assemblages at Corfe Castle, Poole and Wimborne. The indications are therefore that this type was not used in the south-east of the county to any great degree. If the probable production zone in the Yeo valley on the Dorset-Somerset border is accepted as highly likely, then this distribution is not surprising, although it is perhaps interesting to note that this type seems to have been more common in parts of south-west Dorset than might have been expected.

In the east of the study region, ware S4/C2 sherds are common at Salisbury and Southampton, and also occur ar Christchurch. This latter may still relate to the general distribution in Dorset, but the sherds from the former two sites are likely to have differing provenances, owing to their distance from the supposed kiln sites and the proximity of local producers in both cases. Although the only wasters that are known from Southampton are in fact in wares F1 and S1, it would also be expected that the coarse wares found in the city would not have been imported great distances when there was already the ability to make alternatives locally. Salisbury was the most likely market for Laverstock coarse wares, which are known to have been produced in ware C1. Ware C2 pottery was also found on the Laverstock excavations, but it was mostly identified as dating to a period earlier than that assigned to the excavated kilns. There are, however, great stylistic similarities between the ware C2 and ware C1 material from the Laverstock excavations. The former is usually present as scratch-marked cooking vessels, whilst the latter has similar forms but carries the so-called 'developed' scratch-markings (Musty *et al* 1969). It is therefore probable that the earlier ware C2 material was also produced locally as this material represents an earlier phase in stylistic developments seen in the wasters of ware C1.

The indications therefore support the existence of Pearsons Yeo valley production source (1982), which supplied sites in the north and west of Dorset, and presumably further north into Somerset and south Wiltshire as as well. There is also evidence indicating that these types reached the coast, with the collections at Holworth, Portland and Poxwell providing the basis for such suggestions. It is probable that visually similar material was also manufactured near Laverstock, and also it would perhaps be expected that ware S4/C2 vessels were made in the Southampton area. Later in this chapter the analytical evidence supporting such suggestions will be considered, first, however, the dating of these types must be scrutinised. To enable comparisons of the dating of the sandy wares and the ware C1 material to be made, the dating of all these types is dicussed together after the next section.

Ware C1

Figure 6.2 is derived in a similar fashion to Figure 6.1, with the difference that the ware S2 and S3 data have been omitted and the ware C1 data have been added. In a number of cases the percentages derived for ware C1 sherds have been based on a composite of information concerning unglazed, glazed and/or scratch-marked sherds, all of this ware type. These data have been displayed here with the ware S1 data because it was felt that the interrelationship between the two distributions would be particularly interesting. The ware S4/C2 data has been included because this type shows visual similarities with both the other wares illustrated on this figure.

The ware C1 distribution provides an interesting contrast with the ware S1 and ware S4/C2 groups, as it seems to occur in abundance in nearly all the collections where the other two types are not present, or only present as minor contributors to the assemblage. This results in all the sites studied from Dorset, from Winterborne Houghton eastwards, having ware C1 present as the dominant type. Of these eight assemblages, all have ware C1 contributions that are more than 35% , and four have ware C1 values of 89% or above. This trend is continued at West Grimstead, with 48% ware C1, and this same type is also very common at Salisbury (from visual appraisal of the collection) and Southampton, although here the actual percentage in any one collection is not known.

As ware C1 vessels were produced at Laverstock, it is not surprising that this ware type is common at Salisbury and West Grimstead. It is, however, unlikely that the distribution of vessels from this same site could also result in over 90% of the assemblages from Christchurch and Poole being Laverstock material. Even more unlikely is the situation where villages in central south Dorset, e.g. Holworth and Whitcombe, also received large amounts of Laverstock coarse wares, as represented by the large ware C1 components in the assemblages from these sites. As these latter two sites possess 36% and 41% ware C1 in their assemlages respectively, it is perhaps more likely that a more local source was supplying visually similar vessels to these villages, bearing in mind that they are located over 60km from the Laverstock industry. It may also be that the ware C1 material found at Southampton is a locally produced type, visually similar to the Laverstock products and thus sharing a degree of tradition of manufacture with this industry. These problems have been studied through the use of chemical analysis and subsequent statistical interpretation of the results. This was described in Chapter 5, but further consideration of the importance of the results of the chemical analyses, in the context of the suggestions made above, is discussed in section 6.2.

From Figure 6.2 it is therefore apparent that the region of ware C1 dominance in medieval ceramic assemblages not only covers all of east Dorset, but it also extends into south Wiltshire and Hampshire as well. Furthermore ware C1 material is still common in central Dorset as far west as Dorchester, and in north

Dorset as far west as Sherborne. It would seem that the ware C1 material was not transported or used west of Dorchester to any great degree, and this must surely be to a great extent as a result of the presence of the locally made ware S1 vessels. Certainly both these wares are commonly found in cooking pot forms, suggesting the potential for competition by the relevant producers. This is even more true with the ware S4/C2 material in west and north Dorset which, like the ware C1 material from Laverstock, was not generally present in jug forms, but nearly always present as cooking pots. The same cannot be said of the ware C1 material from south-east Dorset, however, which is frequently glazed and identifiable as jug or tripod pitcher sherds.

Interrelationships of the Ware C1, Ware S1 and Ware S4/C2 distributions

The interrelationship between the ware C1, ware S1 and ware S4/C2 distributions has been represented in Figure 6.3. On this map of the study region, part-contours have been drawn, at the 25% of assemblage level, for all three of these wares. The only area where these contours can be drawn, and are in fact of significance, is across central Dorset. It must be stressed that these contours are by no means extremely accurate in their positioning as they were positioned in a fairly arbitrary manner, utilising the data from the assemblage tables in Chapter 2 to indicate the 'background' level of occurrence at a particular point. Furthermore the selection of 25% as a cut-off point is purely arbitrary. Vince (1981) selected a level of 10% of an assemblage as indicative of a site being regularly served by a production centre (Vince 1981, 310) and admitted that this was also a purely arbitrary level. Ten per cent was not used here because, using this level, the resultant contours do not illustrate the mutual variation exhibited when a higher percentage is used.

It is apparent from this figure that the ware C1 and ware S4/C2 '25% territories' are only partially represented here, whilst most of the ware S1 territory is probably identified. The shape of the latter is significant in that the territory is almost exclusively south of the Hermitage, ware S1 producing, kiln. This phenomenon was discussed earlier in the chapter and the most probable explanations included that there may have been further kilns which were better placed to supply the south-western part of this territory, the Hermitage kiln being perhaps located on the periphery of the 'tradition' of manufacture. The competition from the other two wares must also have been significant, the presence of the ware C1 products preventing the further eastwards distribution of ware S1 material, and the presence of the ware S4/C2 producer(s) in the north, preventing the exploitation of markets in that direction to any greater degree than that seen at, for example, Sherborne Old Castle. The dating of the interrelationships seen on Figure 6.3 is the second half of the 13th century, when all three pottery types were common. Any system of this kind is of course dynamic, and a temporal analysis of the interrelationships must also be considered. This is carried out in the next section. A discussion of the fine wares and their occurrence, in a spatial sense, will be included afterwards.

The ware C1 contour in Figure 6.3 represents only the western extremity of the distribution for this type. The full area of the ware C1 'territory' is therefore unknown, but it is undoubtedly much larger than that for the ware S1 material. It is, however, probable that the ware C1 material illustrated here is from three or more production centres and thus the data represent a composite, rather than true, distribution.

The ware S4/C2 contour is rather elongate in a southerly direction, with again much of the territory of this ware being unknown. If a source for this material in the Yeo valley near Ilchester is accepted (Pearson 1982), then the resultant distribution would not perhaps be expected to appear as it does on Figure 6.3. The information that this distribution derives from is mostly from sites well to the south of Ilchester and it must therefore be considered that the presence of so much of this material in the Dorchester to Woolcombe area may actually indicate the presence of a further production source. Certainly, the ware S4/C2 material from these sites is generally oxidised and of a lighter hue to that found at sites further north; e.g. Sherborne, Kington Magna and, perhaps, Shaftesbury. The material from these sites tends to be dark brown or, more commonly, a reduced dark grey. It does contain similar inclusions to the material from further south, however, and both types are present in the distinctive folded rim forms as described by Pearson (*op. cit.*). This does therefore indicate the close links betwen the sherds of ware S4/C2 from these two groups of sites.

Dating the coarse ware and sandy ware production

Concrete dating evidence for any of the material studied here is very hard to come by. In fact, for many of the collections studied, no evidence as to the date of the material was collected, or was available, when the initial fieldwork was carried out. Thus for many of the collections the dating of the material is based purely on typological grounds. Regularly such information is itself based on parallels with uncertainly dated material from sites at some distance to the collection in question and it soon becomes apparent that assigning close dates to much of the medieval pottery from the region is very difficult indeed.

Some collections did however benefit from the presence of other dating information. Of particular interest are sites such as the two castles at Dorchester Prison and Sherborne Old Castle. Here varying degrees of success was achieved in matching specific references to castle works and building programmes, with features on the ground. At Dorchester attempts to match a known twelfth-century re-fortification with one of two large external ditches proved fruitless, as the pottery assemblages from both ditches were of late thirteenth century date (Draper and Chaplin 1982, 92). At Sherborne information concerning the various phases of building and use at the castle is available (Harrison and Williams 1979, 91). In the pottery report this was used, alongside archaeological evidence, to assign broad period dates to material from specific parts of the site.

A number of the collections studied were well stratified and some form of dating seqeunce for the pottery can be ascertained. Although the 'occurrence brackets' are usually quite wide, much of the dating information available for the sites from which material was studied has been collected together and summarised in Tables 6.1 to 6.3. These tables give rough indications as to the date ranges that the ware types were given by the excavators. The vertical axis indicates the site collection in question, and these have been ordered by the date the type first appears at that site. Horizontally, a solid line indicates the period in which the ceramic type was present at a site, with a dashed line indicating areas of uncertainty.

Ware S1

Reasonably reliable information concerning the dating of ware S1 vessels and sherds is very hard to come by indeed. Table 6.1 illustrates that information identified as being of some use. It must be appreciated, however, that the Holworth dates have been re-defined, with the benefit of hindsight, from the original suggestion of the excavator (Rahtz 1959). Thus the new dates are based on only that information provided in the site report and from parallels with material from more recently excavated sites. As this includes the sites in the table, the argument does seem to have become rather cyclical, and it must therefore be stressed that the Holworth date range ought not to be used in isolation as an indicator of likely date of ceramics from other sites.

The excavators dated the Hermitage kiln to the period 1250 to 1300, with the initial date being possibly rather earlier (Field 1966). This was solely based on pottery and tile typology, through comparison with sherds found elsewhere. This did indeed cause problems, as described in Chapter 1, with some indication that two periods of ceramic manufacture may have taken place at the site. This latter suggestion has been avoided in the date range assigned in Table 6.1 but it must be stressed that even this kiln group is not sufficiently well-dated for concrete assumptions, as regards the date of the industry, to be made.

A roughly similar initial date has been suggested for the start of ware S1 usage at Woolcombe, although the lower bracket has been placed a possible 20 years earlier here, at around 1200. At Woolcombe the suggestion is for a steady replacement of ware S4/C2 by ware S1, over most of the 13th century. No direct dating evidence does however exist, and the extremes of the occurrence brackets on Table 6.1 have been left as dotted lines as a result of this. At Woolcombe the sandy ware ceramic sequence has not yet been confirmed as a medieval to post-medieval continuum, as has been shown for Sherborne Old

Castle. There are very few sherds of immediate post-medieval date from the main hamlet site and this suggests some sort of hiatus in ceramic supply, and presumably also in the history of the site, in the fourteenth century.

At Sherborne the ware S1 and ware S2 sherds have both been classified as ware E (Harrison and Williams 1979, 94). This material is not apparent in definitely thirteenth century layers but does appear in layers of thirteenth to fourteenth century date. Thus the lower occurrence bracket has been placed as a dashed line between 1240 and 1260, and as a solid line thereafter. The ware S2 bracket is also shown for the Sherborne Old Castle collection. This is not identifiable as separate from the site pottery report, but the change to, and dominance of, ware S2 in fourteenth and fifteenth-century layers is well illustrated in the collection itself.

At Dorchester Prison the ware S1, and possibly some ware S2 sherds, were identified as group C (Draper and Chapter 1982, 85). The date of this material does not reasonably represent the total span of this type's occurrence at the Castle in Dorchester (The Prison Site), or in the town itself. It is quite well dated, however, from documentary references to fortification building that can be matched with some of the excavated features. This suggests that ware S1 was definitely present at this site between much of the period 1250 to 1350, with some ware S2 sherds also being present. It is likely that the study of other sites in the town could extend these brackets considerably if other good dating evidence could be found.

The sandy ware industry at Southampton is spatially detached from the whole of the central/west Dorset phenomenon, that constitutes the excavated material discussed so far. Whether this material was in fact distributed from Dorset to Southampton is open to question, and is discussed elsewhere in this chapter. The sandy ware types (SOU fabrics 1120 and 1150) are present in phases 2 and 3 of the ceramic progression at Southampton, which have been assigned the dates 1250 to 1350, and 1350 to 1450 respectively (D.Brown pers. comm.). The general period of occurrences does indeed fit in with that assigned to sites from

Dorset in general, but the presence of ware S3 wasters in Southampton does suggest some degree of local sandy ware manufacture.

The ware S1 industry in Dorset can, from Table 6.1 be seen to be a phenomenon that occurs throughout much of the thirteenth and fourteenth centuries. The suggestion is perhaps that the industry's origins are in the west of its zone of occurrence, and that a natural progression to ware S2, with continuity in style and some raw materials, can be identified in the larger urban collections. This type is still present in the fifteenth century in Sherborne and may well continue even later.

Ware S4/C2

Table 6.2 illustrates the dates of occurrence of ware S4/C2 ceramics at some of the sites studied in a similar fashion to that shown in Table 6.1. It is immediately apparent that this type is generally earlier than ware S1, being first identified at Wareham in the mid eleventh century. It is also found at Christchurch, Ilchester and Southampton before 1100, indicating that at least as wide a variety of producers may well have been operating in the earliest period as there were later on.

At all the other sites studied , except Dorchester Prison, the indications are that ware S4/C2 sherds appear soon after 1100. The dates for the demise of this material at these sites are not so uniform however, with the type being absent from Wimborne by 1200, at Holworth by1250, and at Woolcombe by 1300. None of these dates are, however, necessarily very precise as they are all based on typological comparisons with other assemblages. At Woolcombe, where it is believed some habitation areas went out of use by the early fourteenth century, it would seem that the ware S4/C2 material had already ceased to be used (Spoerry, forthcoming).

Ware S4/C2 sherds are known in contexts dating to the early fourteenth century at Sherborne Old Castle (Harrison and Williams op. cit., 96) and are also identified at Southampton in ceramic phase 2 (1250-1350) by D.Brown (pers.

comm.). At Dorchester Prison the material derives from a closely dated series of deposits in the castle ditch, and, as with the ware S1 material, this is not likely to represent the full period of this type's occurrence at Dorchester, although it does indicate that the ware S4/C2 is here present into the fourteenth century.

As with the ware S1 material, it is probable that the ware S4/C2 sherds from Southampton are not directly related to those sherds found in west Dorset. Despite this, their dating is comparable with the broad spread of dates assigned in Dorset assemblages, excluding the rather early start suggested for the Wareham sherds.

At Laverstock ware S4/C2 sherds are first found in early twelfth century contexts in association with glazed Stamford ware sherds (Musty *et al* 1969, 101). The authors here report also having found this type with a coin of comparable date when excavating in the east suburbs of Old Sarum. At Laverstock this fabric does not seem to have been produced at the excavated kilns which were dated 1230 to 1275. In fact it seems to disappear from contexts by about the start of the thirteenth century.

Ware C1

Table 6.3 illustrates the dates of occurrence of ware C1 ceramics at some sites studied. Again, the Southampton data must be considered to be in part a separate problem to that concerning sites from Dorset. It is apparent that ware C1 products are identifiable in Southampton excavated collections for a very long period which encompasses the whole of the period of occurrence of the type from sites in Dorset. As with the ware S4/C2 material the site at St. Martins House in Wareham has the earliest occurrence of ware C1 vessels identified in Dorset, with no evidence for the type at any other site in the county prior to 1100. This type is generally common in the twelfth century, with only Dorchester Prison starting later than this. This is probably due to a lack of earlier contexts within the excavated area, rather than being a true reflection of the introduction of ware C1 vessels into the town. At all the sites studied, the ware C1 material ceases to occur shortly before or after 1300. Ware C1 occurs at Laverstock in twelfth and thirteenth century contexts, in this form it is typically described as 'micaceous sandy ware' (Musty *et al* 1969, 101), whereas, in the latter, where it is associated with kiln wasters it often carries the so-called developed scratch-markings (*ibid.* 105). This type has also been identified in abundance in thirteenth century contexts at the village of Gomeldon (Algar and Musty 1986).

The fine wares

An assessment of the percentage of the studied assemblages that is contributed by the fine wares is rather difficult to make because of; a) the generally small numbers of sherds involved and b), a lack of identification of fine wares, as opposed to 'glazed wares' by many of the authors of the relevant site reports.

In this thesis the term 'fine ware' has been used to describe primarily pottery with a relatively smooth fabric. All of this material is glazed or decorated in some other fashion (painted), but not all the glazed sherds found on any site will necessarily be fine wares. Such usage of terminology has never been universal, nor has the identification of fine ware sherds often been separated from the identification of 'glazed wares'. Thus much information concerning the percentage of fine wares in the assemblages studied is unavailable, although usually the percentage of glazed wares is calculable.

Figure 6.4 illustrates the presence of fine ware types within the assemblages that were studied. It is apparent that those assemblages that possess no fine ware are all rural sites and the fact that assemblages in this category are present in all the natural regions from which rural sites were studied, illustrates that the lack of fine ware sherds is not in this case a spatially dependent factor. The rural sites that do in fact possess fine ware sherds are generally the larger excavated collections, rather than the smaller groups. As sherds in these categories are usually rare in comparison to the coarse wares and sandy wares, it may well be that the absence of examples of fine wares in these groups is a result of the small number of sherds available for study, coupled with the rare nature of these types in the first place, rather than evidence that such material did not occur at all at these settlements. The one large group that did not produce any sherds of this type is Kington Magna. Here, out of 2010 excavated sherds, no fine ware examples are present, although about 4% of the total is made up of decorated ware C1 sherds.

Ware F1 sherds are present at ten of the 22 sites studied. This group includes only two of the eleven rural sites, again illustrating that the fine ware types are more common in urban assemblages. The urban sites which do not have ware F1 sherds present are Christchurch, Corfe Castle and Wareham. These sites are all located in south-east Dorset and the lack of ware F1 sherds here must surely be due to the presence of larger numbers of ware F4 sherds in these collections, suggesting a ware F4 production source close by. Ware F4 sherds are in fact found at all the urban sites studied except Milton Abbas and Southampton. Thus little can be made of the distribution of this material based purely on presence and absence data. It does, however, illustrate the importance of this ware in all of Dorset except for the far west, with only the ware F4 material from Salisbury being from a probable source elsewhere. Some of this latter material has been identified as late fourteenth or fifteenth century Surrey white ware-type products, which distinguishes it from the other white wares found elsewhere.

The few ware F3 sherds identified at Poole and Sherborne are not indicative of local production sources themselves. They may be related to the large amounts of ware F3 material that is known from Southampton and other sites in central Hampshire (D. Brown, pers. comm.). It would perhaps be expected that a flourishing port such as Poole, or an important royal castle such as that at Sherborne might have significant long-range contacts, the former by sea and land, the latter by land only, which could result in ceramics such as Hampshire red wares being assimilated into the site collections. It is certain that many varied trading contacts did exist for these sites, with large quantities of English and Continental ceramics being found at Poole (K. Jarvis, pers. comm.) and Ham Green and Laverstock sherds being identified at Sherborne Old Castle (Harrison and Williams 1979).

An interesting aberration from any broad assumption that high status urban sites received pottery from great distances away and low status rural sites did not, is the one sherd of Aardenburg ware found at Woolcombe (Poulsen 1983). No satisfactory explanation has yet been produced as to why this particular sherd was discovered at Woolcombe, although perhaps no explanation is needed in the case of only one sherd the presence of which is more likely to indicate casual, indirect contact, rather than deliberate trade. The recent excavations at Woolcombe have yet to produce any further foreign imports of a medieval date, thus leaving the problem open for the time being. Certainly, comparable occasional sherds of foreign origin have been found at relatively isolated rural sites studied in other regions, including two sherds of maiolica and one of Saintonge polychrome found on Site 10 at Wharram Percy (Hurst 1979).

Glazed sherds

In an attempt to understand the problem of the fine ware distributions further, the percentage of glazed sherds at each site has been calculated where possible (Table 6.6). These data are not complete, in the sense that, for a number of sites a figure of X%+ has to be given, indicating that more glazed material is known to exist in the assemblage than that shown, but the amount was not quantified. Furthermore, at Salisbury it is only known that glazed sherds were present, the actual figure being unknown. It can, however, be stated that in general the rural sites possess much less glazed material in comparison to the urban sites. Most have less than 2% of their assemblage glazed, as opposed to the urban sites which range from 2% (Milton Abbas Abbey) to 85% (Shaftesbury). This last figure is probably not reliable as there were indications that not all the sherds excavated at the Shaftesbury sites were studied by the author. Despite this, the indications still are that as many as one in three or even one in two medieval sherds from the sites studied in Shaftesbury were glazed. This is a very high ratio indeed and the assumption must be made that if large scale excavations were carried out elsewhere in the town, in a wider variety of medieval contexts, then many more unglazed sherds would in fact be found. This would result in a ratio of glazed to unglazed material more in keeping with that found at, for example, Sherborne Old Castle (19%+glazed) or St. Martins House, Wareham (15%glazed).

The portion of these glazed ware figures that is not a measure of the number of fine ware sherds present, is almost all taken up by glazed ware C1 material. The sites where a large body of glazed ware C1 sherds were found are generally those sites at which ware C1 is most abundant e.g. Christchurch, Corfe Castle, Poole, Shaftesbury, Wareham and Wimborne. This suggests that the glazed ware C1 sherds were not distributed in bulk outside the general ware C1 market area (roughly the terrain to the right of the contour in Figure 6.3). Furthermore this glazed material was not very common in all parts of the ware C1 'region' as illustrated by the few glazed ware C1 sherds that have been found at Salisbury (J. Hawkes pers. comm.) and Southampton (D. Brown pers comm.). It therefore seems likely that this type is a particular east Dorset phenomenon, and a production source in this area seems very possible.

The dating of the glazed wares

The dating of the glazed wares is regularly a very difficult exercise due to the small amount of material that is usually involved resulting in only a fragmentary picture being possible at many sites. Furthermore, in the past many excavators have tackled the problem of dating glazed pottery in a very simplistic way, with large bodies of glazed material quickly identified as of 'late thirteenth or early fourteenth century date', without perhaps the proper consideration to form, or comparisons with other sites being made. Thankfully this rather dismissive attitude has not been so common in recent years, but the unfortunate legacy is that the available data are, as ever, not as good as one would wish.

To tackle this problem a study was made of the dating of glazed wares in the published and unpublished reports relating to many of the collections that were studied analytically. Unfortunately not all of this information could be used as some of it was, with the benefit of hindsight, not correctly dated anyway. Furthermore, for a number of the collections, particularly those that were not in fact of excavated material, no proper dating evidence other than the forms of the vessels themselves, was available. The date ranges of the occurrence of the major glazed ware types were identified at each site and have been displayed in a similar fashion to that employed for Tables 6.1 to 6.3. The occurrence brackets used here, however, are even less accurate than with the unglazed material, reflecting perhaps the broader dates that can usually only be afforded to smaller groups of diagnostic sherds. In these tables (Table 6.7 to 6.10) information from several other sites has also been included in some cases, in an attempt to fill gaps in the information provided by the studied collections.

For example; the two collections from Dorchester combined, The Prison (Draper and Chaplin 1982) and The Old Vicarage, Fordington (Draper, in Startin 1981), give a much more acceptable time-span for the presence of ware C1 sherds in the town than that which was suggested by only the Prison material.

Glazed ware C1

The occurrence brackets for glazed ware C1 material are shown in Table 6.7. It is immediately apparent that the data for this table are of lesser quality than that used previously because most of the brackets encompass periods of fifty or one hundred years, often starting at the turn or middle of a particular century. This reflects the degree of vagueness that usually surrounds the dating of these types. Despite such shortcomings some interesting information is present here. There is a suggestion that glazed ware C1 was present in the north of the region, before it was in the south, with perhaps west Dorset being the last of the areas considered to receive decorated ceramics of this type. This perhaps indicates that the 'branch' of the ware C1 industry, that was later represented by the Laverstock kilns, was underway in the late eleventh century, with the Poole area ware C1 industry not getting underway until the start of the twelfth century. At the Christchurch and Wimborne town centre excavations, the glazed ware C1 material is identified as tripod pitchers, with an occurrence cut-off date at the end of the twelfth century. This latter may well be purely a re-iteration of an accepted version of the demise of this particular form type, but it also serves to indicate the most common form that glazed C1 sherds occur in, prior to the early-mid thirteenth century. Glazed ware C1 tripod pitchers make up most of the material described on this figure in collections dated to the twelfth century. These are usually fairly crudely glazed and often there are combed wavy lines on the body of the pot, underneath the cracked and degraded yellow-green or orange glaze.

It is perhaps only in the Poole area industry that glazed ware C1 jugs continued to be manufactured, as these are generally only commonly found in collections in this part of Dorset. Similar material from Dorchester and Sherborne is possibly of this same provenance, on stylistic grounds, despite these sites distance from the probable production source. A characteristic of some of the Poole products is an off-white fabric, which has been identified in glazed ware C1 jug sherds in collections from both of these sites (visually identified by the author), as well as being identified in all of the collections shown from sites nearer to Poole Harbour. The culmination of this industry, in terms of technique and decoration, must be the ware C1 Poole red-painted vessels of the late thirteenth and early fourteenth centuries.

Glazed ware S1

Information concerning the date of glazed ware S1 sherds was only available from three sites. The occurrence brackets for these groups are shown in Table 6.8. As described when considering the unglazed material, it is probable that the Dorchester Prison occurrence bracket does not represent the true full extent of this type's occurrence in the town, with a more likely end-point being around 1400. At Woolcombe the largest group of ware S1 sherds ends in the mid fourteenth century, and very few of these vessels were glazed. There are, however, indications that glazed ware S1 and ware S2 material were both present in greater quantities elsewhere in the settlement at a later date, from small assemblages from other excavations, particularly those nearer to the surviving farmhouse (Spoerry forthcoming). On Table 6.8 the information concerning the date ranges of all the sandy ware types found at Sherborne Old Castle has been given. This shows the accepted temporal progression from ware S4/C2, through ware S1, to ware S2. It is rather surprising, however, that the first of these three types is present as a glazed ware, but the site report (Harrison and Williams op. cit., 100) as well as the collection itself does reveal examples of glazed tripod pitchers in this ware. In general, however, the ware S4/C2 material was not glazed and no other examples are yet known outside Sherborne and Ilchester. Ware S1 was also not commonly glazed, but some examples are nearly always found in the larger collections, these usually being jug forms. Ware S2 is much more commonly glazed, regardless of the ware type.

Ware F1

The fine pottery grouped into this ware encompasses all those sherds that are not of very light or dark colouration. Material corresponding to the former group is instead classified as ware F1, whilst fine pottery of very red (if oxidised) or sometimes dark grey (if reduced) colouration is usually classified as ware F3. These classifications were discussed at length in Chapter 1. Table 6.9 shows the occurrence brackets for ware F1 in six of the collections that were analysed, and also at the Old Vicarage site at Fordington. Furthermore a bracket has been shown for the ware F3 material found at Ilchester. This was all identified as Donyatt fine wares by Pearson in the site report (Pearson 1982) . Other sites in south Somerset show a similar appearance and growth in importance of the Donyatt products, but sometimes at a somewhat later date than is evident at Ilchester. At Stoke sub Hamdon (Leach 1976) the Donyatt wares appear and become dominant in the early fourteenth century, whilst on the Wincanton bypass route (Ellison and Pearson 1981) they are dominant sometime before the sixteenth century. These dates are all consistent with the initiation of the industry at the end of the thirteenth century, subsequent growth in the fourteenth and fifteenth centuries, with even greater production at a later date, as described in the site report (Coleman-Smith and Pearson 1988). Prior to the growth of the Donyatt industry, the glazed pottery at Ilchester derives from a wide set of sources, as spatially diverse as Bristol, Dorset, Laverstock and occasionally further afield. The ware F1 bracket for the Ilchester assemblage is therefore probably representative of material of more than one provenance, which, as elements of the site ceramic assemblage, interacted in a dynamic way over the total 200 year period represented.

The same is probably true of the material from other urban sites, eg. Dorchester, Sherborne and Southampton, although the occurrence brackets for the former two types probably do not represent the full period of the ware's usage at these two centres. This is perhaps illustrated by the mutually exclusive nature of the brackets shown for the Dorchester Prison and Fordington collections, which represent two collections from opposite ends of the same urban centre. Neither assemblage derives from a large number of medieval contexts and each therefore represents only part of the true lifespan of any ceramic type represented in the collection. This serves as a reminder as to the potential problems that arise from inferences made with very incomplete data sets. The Southampton bracket illustrates a contrasting situation where the large amount of ware F1 material deriving from a variety of sources is such that a 200 year bracket is created spanning most of the period of usage of decorated English fine wares. This bracket includes the period when ware F1 material, as represented by the High Street wasters, was locally made, but the actual duration of this industry is unlikely to include the whole of the period 1250 to 1450. A date within the region 1250 to 1350 is indeed more likely (Brown pers. comm.).

Ware F4

The clays necessary to produce white ware ceramics are not common and thus the number of producers of these types at any one time is liable to be less than for the more commonly available ware F1 material. Thus, both temporally and spatially, any attempt to isolate specific producers should be easier than for the ware F1 products. Table 6.10 indicates a steady progression with ware F4 material present at some point within the region throughout the period 1150 to 1550. The sites where this type is first present are Ilchester and Sherborne Old Castle, both with ware F4 material present in twelfth century layers. This may well signal the presence of a previously unidentified ware F4 producer in the twelfth and thirteenth centuries, supplying south Somerset, but nowhere else within the study region. At some time in the thirteenth century ware F4 material is found at sites across most of Dorset, with perhaps the earliest examples being around Poole Harbour, with sites further west receiving these products a little later.

In the fourteenth century the well documented Surrey White ware industry started with the earliest known kilns at Farnham (Cole and Timby 1982). Supposed Surrey products were identified by the excavators at sites in Salisbury

(Underwood unpub.) and the date of the contexts these were found in has been used here to construct the Salisbury occurrence bracket in Table 6.10. This is undoubtedly separate to the brackets for all other sites studied although the actual total duration of this industry, as shown by the bracket above in Table 6.10 (labelled white ware industry), does overlap with material from Dorset. Despite this, the two types are usually visually distinguishable, from the type of glaze used and the forms produced.

6.2 The percentage of identified types that can be chemically matched to provenanced, or location-specific, groups

This section summarises and discusses the results of Chapter 5. In that chapter a large number of multivariate statistical tests were carried out on the four elements data from over 900 ceramic samples. Initial studies indicated support for visual separation and classification of the wares. Later analyses concentrated on identifying 'structure', or differences, within groups of broadly similar material. In keeping with the previous section these analyses fall naturally into three problems, which relate to the sandy wares, coarse wares and fine wares respectively. With each of these broad categories a number of visually identifiable subdivisions are known. Furthermore, it was found in section 5.2 that some chemical differences existed, not only between these groups, but also in some cases between 'like groups' from different sites, and within visually similar material from specific sites.

Sandy wares

Ware S1

As described in section 5.4, great differences arise when matching ware S1 material from many sites to the ware S1 wasters from Hermitage. This is because most groups of ware S1 sherds show chemical 'fingerprints' which are similar to, but not identical with, the Hermitage group. This could be interpreted in a number of ways, but the most likely explanation is that much of this material was manufactured at sites which were utilising similar raw materials to those used at

Hermitage, intending to produce pottery of a similar fabric and form as part of a regional 'tradition of manufacture'. This suggestion is given some support from the available documentary information, as discussed in Chapter 5, section 5.4. It is possible, but unlikely, that these small differences between groups of material from 'settlement' sites and the Hermitage kiln site are a result of post-depositional elemental concentration changes in one or other of the groups of material (as described in 5.4). Therefore, if the assumption is made that these groups of sandy ware sherds that are similar to the provenanced material, but not identical, are probably indicative of further production sites, then an attempt can be made to analyse the distribution of this material in more detail.

First it must be admitted that this hypothesis is complicated by the similarly close match between the wasters and other sherds, of wares S3 and S1 respectively, that were studied from the Southampton collections, and the Hermitage material. This can be seen in Figure 5.70 where all of these sherds are located in the area between the groups of Hermitage ware S1 products and the ware S4 material from Sherborne Old Castle. If the Southampton material was indeed manufactured near this town and not in Dorset, it is rather unfortunate that the two products are chemically so similar. At other sites the presence of groups of sherds in similar locations on the discriminant scatterplots, with relation to the Hermitage products, has resulted in the suggestion that the two groups represent different kiln products within a single manufacturing tradition, in terms of desired product and raw material used. This hypothesis cannot be upheld to explain the chemical constitution of the Southampton-derived sherds, however, as the raw materials available would have been, in terms of the definition of the parent deposits, different to those used in any industry that included the Hermitage kiln, although chemical similarities between the two obviously exist with regards to the elements studied. Despite this, the hypothesis will be adhered to, mainly because it corresponds to the suggestions provided by the documentary information (as discussed in Chapter 1).

As can be seen from Table 5.11, at all the sites where ware S1 sherds were analysed, some of these sherds can be perfectly matched with the Hermitage group. This is not taken as necessarily indicative of actual provenance, however, as in most of these cases these sherds are also part of a larger identifiable group of ware S1 sherds, usually including most of those analysed from the particular site, which as a whole have a 'fingerprint' only partially overlapping with the Hermitage kiln group. The only sites where it is therefore certain that Hermitage products exist are cases where an identifiable sub-group of sherds is centred on the Hermitage cluster. The only ware S1 sherds that fill this criterion are sherds from Dorchester Prison, Poxwell and Yondover. All three sites also possess other ware S1 sherds which are located elsewhere in the scatterplots and therefore liable to possess different provenances. Sites where the group of ware S1 sherds analysed has a definitely different 'fingerprint' to that derived from the Hermitage products, include Holworth, Sherborne Old Castle, Woolcombe and Winterborne Houghton. At a number of other sites it is difficult to make a suggestion either way in this particular matter. These include the collections at Compton Valence, Portland St. Andrews, Shaftesbury and Whitcombe. It is certain that at all these sites at least some of the ware S1 material is not of Hermitage origin, but whether any other sherds are in fact from Hermitage is difficult to ascertain. In these cases, as the presence of Hermitage-type material cannot be confirmed, this possibility has been omitted from the analysis summary in Table 5.12.

It may be of interest to note that of the four collections discussed above, all but one are located south and west of the Hermitage kiln. This corresponds to those collections where the presence of Hermitage products can be confirmed, which are also all located in the south of the county. This indeed also corresponds to the overall picture for ware S1 material generally, which is most common in collections in this area, as seen in Figure 6.3. It is therefore apparent that, if other ware S1 producers do exist, then they are supplying a market that is, in the spatial sense, not dissimilar to that which can be attributed to the Hermitage kiln alone. The exception to this is perhaps in the north where the large amount of ware S1 material found at Sherborne has been identified as probably not from Hermitage (Section 5.4, Table 5.12) and must therefore derive from another source. The Hermitage kiln is well-placed to take advantage of both the Dorchester and Sherborne markets, lying close to the major medieval road between the two centres. If, as the chemical evidence suggests, the latter population centre (or at least the castle) was not utilised as a market by the Hermitage pottery, then it is rather surprising. It is perhaps possible that a kiln further north near the same road could have prevented the exploitation of such a useful market by the Hermitage potter(s). Post-medieval potters are known from Holnest (Harrison and Williams 1979), which is located two or three miles north of Hermitage, indicating that any possible medieval precursor here may well have acted as the competition preventing the Hermitage products from reaching Sherborne in bulk. This is, of course, all speculation, but such answers are indeed necessary to explain why Hermitage products do not seem to figure in the Sherborne Old Castle collection. Large amounts of late medieval and post-medieval ware S2 material does occur on this site and a natural source for this must again be the Holnest pottery, which in this case is known to be of approximately the same date.

The collections where definite Hermitage material has been located are Dorchester Prison, Poxwell and Yondover. All three of these ware S1 groups also contain sherds that are chemically unlike the Hermitage group. This indicates that the Hermitage kiln was not the only supplier of sandy wares to these sites, which is probably not surprising as all are at some distance (15 to 20 km plus) from the kiln. Any other sandy ware producers would probably be located at a similar or lesser distance from these sites, if the location of the kilns is in the Blackmore Vale as suggested by the documentary evidence (Figure 1.5). The ware S1 sherds studied from Poxwell include three that might match the general body of ware S1 material identified as not from Hermitage in other collections. This material has been identified as Group V in Table 5.12. Also present on the discriminant scatterplot are two outliers about which little can be said. The indications are that the ware S1 sherds at Poxwell derive from Hermitage and at least one other source. The Dorchester Prison group is probably rather similar, with the majority of sherds being of Group V, whilst about a third of the material derives from Hermitage. One outlier is also present. It is likely that the ceramics present in a town such as Dorchester would derive from many more production sites than usually supplied minor settlements. This is due to the increased economic and social contacts of the larger and more varied population present in a market centre. Despite this there seems to be little difference here in the number of sources suggested for sandy wares in the assemblages studied from the village of Poxwell and the town of Dorchester. The same is probably not however true of the rural sites at Holworth, Portland, Woolcombe, Winterborne Houghton and Whitcombe, which all seem to be solely supplied with ware S1 vessels by the Group V production site. The rural hamlet site at Yondover seems to have a wider range of ware S1 suppliers, including one responsible for a group of five sherds (25% of those studied) which is distinguished from nearly all other ware S1 sherds analysed, and the Hermitage kiln which was responsible for over half of the sherds that were analysed. The presence of the former group may reflect this site's westerly position among those studied. It is possible that this particular supplier was not represented in any collections further east because its market area was outside that region included in this study. It is surprising, however, that such sherds have not been identified in any other sites close by. It is possible that one ware S1 sherd from Woolcombe has a similar provenance , but it is, as ever, very dangerous to make identifying statements when only one case is involved.

It was stated above that urban sites may possess greater numbers of contacts with ceramic manufacturers than is the case with rural sites. This, unfortunately, does not hold true if the indications provided by the data from ware S1 sherds studied at Sherborne and Shaftesbury are considered. Both of these groups of sherds seem to be almost exclusively provided by the Group V producer, a situation which was not originally expected. This may therefore indicate the particular importance of this producer in the north of the study region, and again suggest that a location to the north of the Hermitage kiln may be appropriate for this unknown production centre. A kiln located to the south of the known producer at Hermitage would not be expected to dominate these markets in such a way, at the expense of the Hermitage products.

In summary, the evidence available therefore indicates that the Hermitage kiln was not the only ware S1 production site in thirteenth century Dorset. In fact, it was possibly a minor site, with the majority of sherds studied deriving from the Group V producer(s). The possibility that the Group V material derived from one site is certainly acceptable, on the basis of the chemical analyses and subsequent statistical interpretation. It has been postulated, however, that this site may well have been located north of the Hermitage kiln. If this is the case then it is difficult to imagine how this producer could still supply 100% of the ware S1 material to sites in the south of the county e.g. Holworth, Portland and Whitcombe. One possible explanation is that the material defined as Group V does in fact originate from more than one producer, one of which is located to take advantage of the more southerly market, whilst another is located north of Hermitage as has already been suggested. It is impossible to confirm or refute any such suggestions with the present level of information concerning the medieval ceramic industry in Dorset. It is, however, certain that at least one further producer of ware S1 vessels existed which supplied the Yondover hamlet with some of its ceramics. The location of this kiln-site is unknown, but it is likely to be to the west of most of the sites studied. It is also possible that another unidentified producer supplied the two outlying sherds of ware S1 seen with the ware C1 cluster in Figure 5.19. This, however, may be purely a case of mis-classification and these two sherds may well be in fact ware C1 products.

The scale of these producers is another important consideration, but for the moment this will not be discussed as this subject can only be explored in relative terms through a comparison with producers of other wares.

Ware S2

Ware S2 material was analysed from only three sites, these being Lodge Farm, Milton Abbas and Sherborne Old Castle. The first two of these are not well dated, as was described in the previous section, and although they may well be post-medieval there is the suggestion from associated sherds that at least some of them might be thirteenth or fourteenth century in date. This is significant because this material was generally thought to be, at earliest, late fourteenth or early fifteenth century, from dating suggestions made in a number of site reports (Harrison and Williams 1979, Draper and Chaplin 1982). Ware S2 sherds have been identified in small numbers in several of the other collections that were studied e.g. Corfe Castle, Dorchester Prison, Holworth, Southampton and Woolcombe Farm but nowhere has very firm dating evidence been provided. If the ware S2 material identified at Lodge Farm and Milton Abbas is indeed of thirteenth or fourteenth century date, then they seem to represent two very site-specific types, both found only on the chalklands of central Dorset. This region has few raw materials for ceramic production and this, coupled with the ware's stylistic and fabric similarities with the ware S1 material, suggests common origins with the Hermitage-type products, and therefore a production site over the north-western scarp slope, rather than the south-eastern dip slope, of the chalk massif. A position in a 'clay vale' on the edge of the chalk is an ideal location for a ceramic producer wishing to exploit markets within the chalkland zone where local ceramic manufacture is usually not possible. Streeten suggests that such factors might dictate the location of medieval kilns on clay deposits on the edge of the chalklands in Surrey and Sussex (Streeten 1981) and they could also contribute to the creation and success of the Verwood and district industry on similar clays at the south-eastern edge of the chalk in Dorset.

Such factors would have been valid whatever the date of the ware S2 production., but at present this dating is uncertain. It is fairly certain that ware S2 vessels were being produced in central north Dorset by the late fourteenth or early fifteenth centuries (see section 6.1), with Holnest as a likely candidate for a production site. Whether there was in fact an earlier phase of production, sited further east and supplying such sites as Lodge Farm and Milton Abbas, will remain unclear until more accurately dated collections are published. If such a medieval phase of ware S2 manufacture occurred it was probably on a small scale as indicated by the presence of this material in only two of the collections studied, and also because these groups, although only located about 20km apart, seem to represent two separate kiln products. The later post-medieval phase of production was, however, on a much larger scale with examples of this type being found in such widely separated locations as Dorchester (Draper and Chaplin *op. cit.*), Sherborne (Harrison and Williams *op. cit.*) and Poole (Jarvis et al unpub.)

Ware S3

Ware S3 sherds have been found at three closely grouped sites in south Dorset as well as at Southampton, the latter in the form of wasters. These probably represent a totally separate industry and have already been discussed. The former material consists of sherds found at Portland, Poxwell and Whitcombe. This type is quite similar to ware S4/C2, but with the absence of large grains of quartz. There is also a suggestion, derived from a visual study of the collection, that some sherds of this ware occurred at Dorchester and sherds of this type have also been found in some trenches at Woolcombe. Ware S3 in Dorset seems to have a very well-defined area of occurrence, although no indication as to the location of a production source is presently available. In section 6.1 this ware was identified as being probably of late twelfth to late thirteenth century date. This places it slightly earlier than the ware S1 industry, although overlapping with this type from the mid-thirteenth century onwards. It also coincides with the last 100 years of the ware S4/C2 industry further to the north.

Ware S4/C2

The ware S4/C2 industry can in fact be split into three separate zones, the first two being properly identfiable as ware C2 industries, the latter being more truly a ware S4 industry. This information is in part derived from the chemical analyses which identified the material from Dorset as being chemically quite similar to the ware S1 sandy wares from Hermitage and elsewhere. The other two zones constitute ware C2 wares from the Salisbury (Laverstock) and Southampton areas. Some of the latter material was also studied chemically and this has been grouped with ware C1 sherds from Southampton, rather than with ware S1 material. This group is, however, also separable from the Laverstock ware C1 wasters, and so has been identified as a ware C2 type, but one that was probably different to the ware C2 scratch-marked material found at Laverstock.

If the ware S4/C2 material from Dorset is considered in isolation from the ware C2 groups elsewhere, it must not be isolated from other sandy ware types that are also found in Dorset. The interaction of these wares, in terms of the areas of the region in which they were dominant and secondly areas into which they were also distributed, was discussed in section 6.1, with particular consideration of Figures 6.1 to 6.3. It is apparent from these plots that the ware S4 material had a distribution which, not surprisingly, centred on north west Dorset, but which also extended into the south of the county. The only ware S4/C2 material that was studied from a site in this latter area were the forty sherds from Woolcombe. This is very interesting because this material is chemically different to all the other ware S4 sherds studied, with the exception of two or three sherds from Kington Magna. In section 6.1, when discussing Figure 6.3 it was noted that the ware S4/C2 material from sites further south in Dorset appears in generally lighter fabric hues than the material found at sites further north. It was thus suggested that the two types derived from separate production sources, with a previously unrecognised ware S4/C2 producing kiln located somewhere in south-west Dorset. This suggestion is entirely supported by the chemical data, in the sense that the ware S4/C2 material from Woolcombe is undeniably chemically different to the supposed Yeo valley ware S4/C2 products identified at Kington Magna, Shaftesbury and Sherborne.

This material from Woolcombe is of particular interest because the chemical fingerprint of these forty sherds is very closely matched to that derived for the forty ware S1 sherds that were also analysed from the Woolcombe collection. This therefore suggests that very similar raw materials were utilised for both types. Whether this means that both types were produced at the same kiln site is, however, open to question. At Woolcombe the ceramics from a long sequence of refuse/agricultural deposits indicate a steady replacement of ware S4/C2 by ware S1 as the dominant ware on the site, with the whole process occupying much of the thirteenth century (Spoerry forthcoming). It might therefore seem illogical to suggest that both types were produced at the same kiln as it is difficult to imagine a fifty year-plus run-down of one product in favour of another being executed by one group of potters. It is therefore more likely that the two wares were made using similar raw materials, but not on the same site. If this was the case, then, the chemical and physical similarity to Hermitage products that exists in this material suggests that a similar type of clay was used, in this case Oxford clay. Thus the location of the production site of this lighter-coloured ware S4/C2 would have to be near the Oxford clay deposits and therefore north east of those sites where it has been identified as most abundant (Compton Valence and Woolcombe).

The more northerly ware S4/C2 production source has already been postulated as being in the Yeo valley (Pearson 1982). Its date has also been discussed, which is generally twelfth to thirteenth century, with the type appearing in its latest form at Sherborne in the early fourteenth century. This is later than Pearson's suggested date for the end of this type in the sequence at Ilchester, but Harrison and Williams (1979) suggest that this earlier date is in fact due to the demise of Ilchester as a thriving urban centre in the late thirteenth century, rather than as a result of the end of the ceramic industry itself. They suggest that this type was still made and distributed to Sherborne Old Castle into the fourteenth century (*ibid*, 96). The peak of this industry does, however, seem to be earlier and its general demise must be seen in terms of the increased competition from the better-made ware S1 and S2 products, rather than as a result of the declining fortunes of one urban centre.

Coarse wares

Ware C1

In Chapter 5 it was shown that some of the ware C1 material that was analysed could be split into a number of chemically separable groups. The particular groups that were studied were the Laverstock ware C1 products, the ware C1 sherds from Southampton, and the glazed ware C1 sherds from Poole. These three groups of material have been shown to have mutual differences with respect to the initial set of multivariate statistical analyses. The next step carried out was a discriminant analysis of the coarse wares data, with the intention of separating these three groups. All other coarse ware sherds were added as 'unknowns' and their resultant positions on the discriminant scatterplots were discussed in section 5.4. The proportion of those sherds studied from each site that could be matched to the identified groups is indicated in Figure 5.99. This was discussed in Chapter 5 which raised problems in this interpretation of the data. It is difficult to explain the presence of Southampton ware C1 sherds at Kington Magna and Poxwell. The large number of possible Laverstock sherds at sites such as Holworth and Whitcombe is also noteworthy. Considering the great distance between these sites and the Laverstock kilns it is difficult to explain why so much Laverstock pottery shoulb be present in these groups, bearing in mind that these are small, rural settlements. Also of concern is the amount of 'other' or 'unknown' ware C1 sherds that are present, especially in assemblages from south-east Dorset. It may be that not all of the Poole-type sherds have been properly recognised as 'Poole-type', or perhaps a further south or south-east Dorset producer remains to be identified.

Despite the uncertainties surrounding these data it was still felt necessary to incorporate the values illustrated on Figure 5.99 (and Table 5.16) into estimations of the total medieval assemblages from the relevant sites, as described in Chapter 2. The result of these calculations is Figure 6.5, with the data tabulated as Table 6.6. Here the breakdown of the ware C1 sherds, as seen in Figure 5.99, has been condensed into that portion of each pie chart that represents the total occurrence of ware C1 in each assemblage (as seen in Figure 6.2). The indications from this figure are obviously very similar to those derived from Figure 5.99, but with the additional information concerning the importance of the type within each site assemblage. These figures must be used with caution, especially considering the small numbers of ware C1 sherds that were actually analysed from some site collections. Despite this, some new information can be gained.

Firstly, it is apparent that the occurrence of significant amounts of ware C1 sherds in collections from sites around Dorchester seems to owe more to the Laverstock kilns than to a more local source of these types, possibly one around Poole harbour. However, as the provenance of some of these sherds is difficult to determine in the scatterplots, these distributions are very uncertain and unreliable.

The concern that so many sherds from Holworth and Whitcombe were identified as 'like Laverstock' must still be expressed, but it is not so significant when the ware C1 contribution to each assemblage is put into perspective as part of the entire site assemblage. It does still seem surprising, however, that so many ware C1 vessels from Laverstock were used at sites in Christchurch, Poole and Wareham, and possibly Wimborne, bearing in mind the proximity of the Poole industry. It is probable that some confusion of classification has also occurred here. This suggestion is supported by the fact that two red-painted sherds from the Poole collection were chemically matched to the Laverstock products in the final discriminant analysis (Figure 5.94). As the red-painted ware is a characteristic Poole type, not found at all at Lavertsock, the indications are therefore that some error in the classification of the like-Laverstock and like-Poole groups has indeed arisen. The number of Poole-type sherds identified at sites well inland was also indicated as a cause for concern in Chapter 5. This has been put into perspective at Kington Magna and Winterborne Houghton where the 11% and 16% of the total respective assemblages classified as Poole-derived sherds do not seem particularly significant. The large proportion of Poole-derived sherds in the Shaftesbury assemblage may be due to two factors. First of all, the Poole products are regularly in the form of glazed jugs and tripod pitchers and in fact all fifteen ware C1 sherds studied from the Shaftesbury collections were also glazed examples. Secondly the Shaftesbury assemblage, as described here, is undoubtedly inaccurate, with all glazed types being vastly over-represented. It therefore seems that a large number of glazed ware C1 vessels found at Shaftesbury probably originated near Poole, but that the total contribution of this material to the Shaftesbury assemblage was much less than the 48% shown.

Glazed jugs and tripod pitchers in ware C1 are not found at Laverstock, other than a few examples which were identified as being pre-industry (twelfth century) by the excavators (Musty *et al* 1969, 99). Thus it is very unlikely that any glazed vessels of this type found elsewhere, which are not in specifically twelfth century forms, are Laverstock products. No vessels of this type in ware C1 were seen by the author in the Southampton collection either. The indications therefore are that all glazed jugs and pitchers ought to have been chemically matched with the Poole material, or identified as 'other'. This was not the case with the three glazed ware C1 sherds from Holworth, three of the five sherds from Sherborne, two of the ten sherds from Shaftesbury, four of the ten sherds from Wimborne and two of the ten sherds from Wareham, which were all grouped with the Laverstock material. It is certainly possible that some confusion exists here, resulting from difficulties in specifying whether some sherds are lightly tempered ware C1 or heavily tempered ware F1, a problem that has been noted by the author with Laverstock material other than that actually analysed.. The result of this problem is again to underline the need for caution when making statements based on the separation of the ware C1 data seen in Figure 6.5 and Table 6.6

The few sherds of ware C1 from Kington Magna and Poxwell that showed chemical affinity with the Southampton material in the discriminant analyses are represented as only 7% and 10% of the respective assemblages in the pie charts on Figure 6.5. It is certainly possible that these do in fact represent the occasional long-distance movement of low-status ceramics, as these were all unglazed sherds. This must be deemed an unlikely possibility, however, especially as only five sherds indicate this. Whatever the real provenance of these few sherds, the Southampton ware C1 distribution is difficult to substantiate. The indications are only based on incomplete data, as no sites nearer than fifteen miles to Southampton have been considered. Thus the 'hinterland' of this distribution has not been studied. The indications are, however, that this type was confined to the Southampton area, certainly in an easterly direction, and it was not distributed across the New Forest, as would perhaps be expected. Furthermore, the presence of the strong Laverstock ware C1 industry in south Wiltshire may have prevented such Southampton products travelling in that direction as well.

The portion of the ware C1 material that appears as 'other' in the scatterplots is a confusing issue. This is represented by the white portion of the pie charts in Figure 5.99. As can be seen from the discriminant scatterplots summarised in Table 5.12, this material is by no means one specific 'unknown' type, but probably represents two or three identifiable groups, with many overlapping sherds and outliers. Whether these groups derive from other 'unknown' kiln sites, or whether they are part of the probable 'Poole area' industry is not clear. The fact that this blank portion is generally greater in assemblages from the south and east of Dorset, and generally less in the north, may possibly indicate that failure to characterise the whole range of 'Poole area' products has resulted in much of this 'unknown' material. This statement is very speculative and without the discovery of a production site in south-east Dorset it is difficult to see how such a problem can be clarified.

It is undoubtable that the three known variants of ware C1 (Laverstock, Poole and Southampton) do represent parts of a regional pottery tradition that is distinct to that seen in west Dorset. Scratch-marking is known from both Laverstock (Musty *et al op. cit.*) and Southampton (Brown, pers comm.). Its occurrence in ware C1 sherds from Wareham seems to indicate the presence of market-distributed Laverstock products (Figure 5.98, Table 5.16), but the same cannot be said of those examples from Christchurch (Figure 5.90, Table 5.16) which are, apart from one sherd, undoubtedly not from Laverstock or Southampton, although they are not comparable with the group of ware C1 sherds from Poole either. The Poole area products are visually the most readily distinguished of the three. They often occur in lighter-hued fabrics, and regularly in the form of glazed jugs or pitchers, as opposed to the ware C1 material from the other two sites which is almost exclusively in cooking pot forms. Some of the cooking pots from Laverstock are in fact glazed, but this is not decorative, in the sense that the applied strip and painted ware C1 vessels from Poole are decorative.. Laverstock/Salisbury and Southampton both possess fine ware industries producing decorated table wares, which fulfill the same function as the ware C1 jugs and pitchers made near Poole. Why the Poole area industry should produce its decorated wares in such a coarsely tempered fabric is difficult to explain. There are certainly very fine pipe-clays available as alternatives nearby, and the Reading Beds and London Clay also outcrop locally, providing the same raw materials as were available to the fine ware producing potters at Laverstock. There seems to be no answer to this problem at present.

A local medieval pottery industry that has not been represented so far is the precursor of the post-medieval Verwood industry. The industry is known to have been active in thirteenth century Damerham (Le Patourel 1969) and fourteenth century Alderholt (Algar et al 1987), but as yet no medieval products have been identified, nor have any kiln sites been found. It is likely that, as this industry used the same clays as those exploited at Laverstock, the ceramic product may well have been further ware C1 and perhaps ware F1 types. Ware C1 sherds are certainly the dominant type at some medieval sites in this area eg. Wimborne (Table 2.24) and also at Lodge Farm if the ware S2 material is deemed to be of a later date (Table 2.13). Furthermore, occasional medieval sherds from fieldwork and excavations at Alderholt, Holt and Horton have all been of ware C1. The identification of the ceramic types manufactured in the early stages of the Verwood industry, and the location of at least one medieval kiln site here, may eventually prove crucial to the understanding of the ware C1 pottery of east Dorset.

Ware C2(S4)

The ware S4/C2 pottery from west Dorset has already been discussed under the ware S4/C2 heading. The ware C2 sherds from Southampton are chemically similar to the ware C1 material from this same site and are, like the latter, a totally indigenous phenomenon which cannot be studied further with the data available for this project.

No ware C2 sherds from Laverstock were actually studied and according to the excavators none of this material was produced at the excavated kilns. Despite this lack of direct study, as has already been discussed in the previous section, the ware C2 material from Laverstock has stylistic similarities with the ware C1 material from that site, the scratch-marked ware C2 being eventually replaced by developed scratch-marked ware C1 vessels.

The Fine Wares

As was discussed in section 6.1, there are difficulties concerning the study of fine ware sherds resulting from the often small number of sherds available from any one collection. Thus the number of fine ware samples analysed was often small and certainly in many cases not large enough for great value to be placed on any statistical inference drawn from the results of the chemical analyses. Despite this some useful information was indeed provided through the analysis of the ware F1, F3 and F4 sherds.

The lack of figures demonstrating specific percentage occurrences for the visually identifiable fine ware types in many assemblages, coupled with the problems inherent in a study of small assemblages, renders impossible the calculations of chemically separable sub-types of wares, as used in the consideration of the coarse wares.

As indicated earlier this problem is rooted in a failure to differentiate between glazed wares and fine wares by many of those who compiled the various site reports. The result of this is that little information can be gained concerning the contribution of each chemically defined fine ware type to the total fine ware assemblage at a particular site. Instead the relative importance of these types within the total glazed assemblage from a site is probably the only figure that will ultimately be of use.

This state of affairs may not, in fact, be a serious problem. Much of the glazed material in non-fine ware fabrics is of vessel types that match those of the actual fine ware material, namely jugs and other liquid containers. There are also present ware S1 and ware C1 cooking pots with glaze, but these are not generally common. By the late fourteenth century glazed cooking pots and cisterns in ware S2 do appear more frequently, but this later period is not significant in most of the assemblages being discussed.

Thus in the study region most glazed wares of the thirteenth to early fourteenth centuries fulfil a similar function, regardless of their ware type. Prior to this period most of the fine ware types do not exist, and the typical twelfth century glazed assemblage, certainly in east and north Dorset, is almost entirely composed of ware C1 tripod pitchers.

It seems then that a consideration of only the fine ware portion of a thirteenth or early fourteenth century assemblage, based purely on the fabric type without considering the actual function of the vessel, is perhaps not the best method of classifying these ceramics. A study of the whole glazed component of such an assemblage is perhaps a more valuable way of considering the relative contributions of the different types represented.

Table 6.12 is the result of such a consideration, based on the whole glazed assemblage from those sites from which glazed material was analysed. The chemical separation and subsequent grouping of the fine wares, as described in Chapter 5 and shown on Table 5.20, forms the basis for the information in the first four columns. These are not, however, purely calculations of the presence of these types in the fine ware portion of the assemblage. Instead these indications of the separation of those fine wares analysed from each site have been considered in terms of their significance within the total glazed ware portion of the relevant site assemblage as defined in Tables 2.7 to 2.26. The number of those sherds analysed that can be grouped into a particular column has been used as an indication of the portion of the fine wares at that site that may well derive from a particular source. This has then been compared to the total glazed portion of the site assemblage, and a rough classification into one of three groupings has then been made. These groupings are:

P = present; >0-25% of the glazed wares in the assemblage
C = common; 25-50% of the glazed wares in the assemblage
D = dominant; 50%+ of the glazed wares in the assemblage

These rough categories provide the basis of Table 6.12. They are broad enough to take account of all the uncertainties surrounding these data, whilst still providing useful information as to the importance of the various types within specific site assemblages.

If the first column of Table 6.12 is considered it is apparent that Laverstock products are present in most of the assemblages studied, their absence only being obvious at Holworth and Wareham. Furthermore, Laverstock products are dominant in the assemblages at Salisbury and West Grimstead. None of this is particularly surprising, as Salisbury and West Grimstead are very close to the kiln site (less than 10 km), whilst all the other sites are located between 25 and 70 km away from it. Holworth and Wareham are two of the most distant sites, and the absence of Laverstock products is probably explained by this distance, especially considering that the probable Poole Harbour ware F4 industry is geographically between these settlements and the kilns at Laverstock. The same is true of Corfe

Castle and it is reassuring to note that the evidence for Laverstock products here is only based on the similarity of one sherd, indicating that this was not a significant source for glazed wares used at Corfe. There is also a suggestion that a greater proportion of Laverstock products are found in assemblages in north Dorset, compared with those in the south east of the county. This derives from a comparison between those sherds classified in Table 5.20 as being 'Laverstock' in the collections from Shaftesbury and Sherborne, and those sherds classified similarly at Christchurch and Corfe Castle, and perhaps also Poole and Wimborne. This suggestion is not based on strong evidence, however, as only five ware F1 sherds, four ware F4 and three ware F3 sherds were chemically matched with Laverstock products from the latter four of these collections together. Overall the indications are for a wide distribution of Laverstock fine ware products across Dorset, but generally this material is only present as a small portion of the glazed ware, or fine ware, assemblages at any particular site. This information is almost totally derived from urban contexts and it is probable that the situation is somewhat different on rural sites.

As was described in section 6.1, rural assemblages from Dorset throughout the twelfth to fourteenth centuries possess smaller numbers of glazed vessels than their urban counterparts. Where Laverstock products are only present as occasional vessels on urban sites, it may be suggested that they probably were hardly present at all in similarly located rural contexts. This does not match the initial results derived from the Laverstock coarse wares, as shown in Figure 6.5, where examples are regularly present in rural assemblages in south central Dorset. It was indicated, however, in the coarse wares discussion, that there has probably been a partial failure to separate chemically Laverstock and Poole ware C1 products here, and thus the final assessment of the distribution of ware C1 sherds from Laverstock may indeed suggest that such material was only a minor component of assemblages in south Dorset. This does not contradict the evidence for the fine wares which indicates that they were only occasionally present as vessels in this same region.

The second column of Table 6.22, the material that was chemically matched with Southampton ware F1 wasters, has only two entries, those from Poole and

Southampton itself. In both cases the level of occurrence in the assemblage is defined as 'present', which is rather misleading as it groups together two very different situations. At Poole only one sherd can definitely be chemically matched with the Southampton wasters, whereas at Southampton these types form about 10% of the total glazed ware assemblage in the period 1250 to 1350 (about 500 out of approximately 5,000 sherds; Brown pers. comm.).

Thus, at Southampton the locally produced ware F1 material is very common, although it is only classified as 'present' under the scheme adopted in Table 6.12. At Poole the very slightest of evidence suggests that Southampton ware F1 products were present in the town. This is not surprising considering the potential for occasional coastal transportation of ceramics between the ports of Poole and Southampton, although it is unlikely that this was as part of a substantial marketing strategy. The lack of Southampton products at any other site studied (except possibly at Sherborne Old Castle-Table 5.19) supports the very local nature of this type's distribution as suggested by Brown (pers. comm.) and is generally not surprising in the context of the evidence from the coarse wares studied (Figure 6.5) and the likelihood of the New Forest presenting a significant barrier to the transportation and distribution of low-value items between central Hampshire and Dorset. This is supported by the evidence from the ware F3 material that was studied from Southampton and elsewhere. None of the four ware F3 sherds studied from the Sherborne Old Castle collection could be placed in Group Y which contains at least 40% and possibly 100% of the ware F3 sherds from Southampton. Furthermore, only one of the six ware F3 sherds from Poole could be placed in this group. The suggestion is again perhaps for some 'casual' contact between the ports of Poole and Southampton, but for no transportation of ceramics between Southampton and Sherborne.

Examples of Donyatt products studied by the author have generally been of a fabric comparable to ware F3. Although these sherds were of fourteenth-century date or later, it is probable that the earlier thirteenth-century Donyatt ceramics were also in this fabric. It is therefore quite likely that the ware F3 material from Sherborne did in fact originate from Donyatt, although until the author views sufficient of the products of this kiln, this cannot be confirmed. The ware F3 material studied at Southampton is locally known as Hampshire Red Ware and has been found at a number of sites in the Southampton/Winchester area (Brown pers. comm.). It has not however been identified further afield, and, apart from the possibility of one sherd of this material at Poole, the established view of the Hampshire Red Ware distribution is supported by the analytical results discussed here.

Ware F1 sherds that were analysed that did not chemically match the Laverstock or Southampton wasters are quite common and present in many collections. In all, out of the seventy ware F1 sherds studied that were not wasters, 29 sherds were not classified as either Laverstock or Southampton in Table 5.20. These derived from all the sites from which this material was studied except West Grimstead. It is probable that some of these sherds are in fact further Laverstock products, as many were matched with the Laverstock material in one or the other of the two discriminant analyses or principal components analysis (Tables 5.17 and 5.19). This was not enough evidence, however, to place them in the 'Like Laverstock' column in Table 5.20. Eight of these sherds were chemically matched with the Group Z material in Table 5.20. This in part illustrates the problems that arise when attempting the classification of ceramics into very broad ware groups when the basic criterion is colour. It is probable that most of these sherds are in fact of Group Z derivation but with rather atypical matrix colourations. Those that are not may of course be of some unidentified 'foreign' group that happens to possess rather similar values for the four elements used in the analyses. This is not deemed to be very likely, however, as the eight sherds mostly derive from assemblages where Group Z has a significant presence.

Sites where a number of ware F1 sherds of 'other' provenance have probably been identified include Christchurch, Sherborne Castle, Salisbury and possibly Poole and Southampton. All of these are either significant urban centres or ports and it would therefore perhaps be expected that occasional 'other English' or 'foreign' fine wares, visually similar to ware F1 material, would be found in these excavations. Brown (pers. comm.) reports that 14% of the total assemblage from Southampton in the period 1250 to 1350 is composed of imports, with other English wares totalling another 3%. Although this is an extreme case, deriving as it does from a major international port, it does illustrate the potential for long-distance movement of ceramics to and from other urban centres in the region.

On the whole, however, it is difficult to match any of these unprovenanced ware F1 sherds with another producer within the study region. Thus the only ware F1 producing industries that can be located within the area studied are those at Laverstock, Salisbury and West Grimstead. It is still possible, however, that the latter two are not actual production sites and represent the distribution of seconds or the dumping of wasters, from Laverstock.

The identifiable distribution of Group Z (Ware F4) material is of a more complex nature to that of the Group Y (Ware F3) sherds, resulting mostly from the fact that this material was undoubtedly produced within the central area of the study region, rather than on the periphery. On Table 6.12, Group Z material is evidently present in most of the assemblages studied, although in terms of its occurrence in proportion to the total glazed wares on each site it is only common at Sherborne Old Castle and dominant at Holworth. At first sight this does seem rather surprising , considering that this ware was probably made somewhere on the shores of Poole Harbour (discussed in Chapter 1; see also Jarvis 1983). It would perhaps have been more logical for the assemblages in this area, eg. Corfe, Poole and Wareham, to contain the largest proportion of Group Z pottery. This is not the case, not because only a small portion of the fine wares in these assemblages can be chemically identified as Group Z, but because these assemblages (and that from Shaftesbury) all additionally contain very large amounts of glazed ware C1 material as well. The reasons for this are not clear, but certainly at Shaftesbury some bias due to differential ware recovery or retention may be the cause. At the other sites this may well be due to their proximity to the Poole Harbour ware C1 industry which, as has already been suggested in section 6.1, was the only local producer of large amounts of glazed ware C1 items. At Wareham the presence of so much glazed ware C1 material may also be due to contamination with twelfth century material of the deposits used to calculate the assemblage make-up. This earlier assemblage is likely to contain larger amounts of glazed ware C1 as this was the dominant, and possibly only, glazed ware in this part of the region before about 1230. Furthermore, it is likely that this earlier material was also made in the Wareham area (Hinton and Hodges 1977, 60).

Group Z material forms the majority of the fine wares at Corfe Castle, Holworth and Wareham and is also common at Christchurch, Poole and Sherborne Old Castle. It therefore seems to have had more than a localised south-east Dorset distribution. It is probable that much of the ware F4 material found in Dorchester will also prove to be chemically matched with Group Z, and this may also hold true of the ware F4 sherds found at Shaftesbury.

There are of course other possible sources for ware F4 sherds in this region besides the Group Z 'Poole Harbour' industry. It is apparent that the ware F4 material studied from the Wimborne Leaze collection has a different provenance, perhaps relating to the Verwood and districts industry's origins around Damerham (le Patourel 1969) and Alderholt (Algar et al 1987). If this is so, it seems that this industry did not have a wide and prominent distribution in east Dorset, although it is possible that chemically similar material has been identified at Christchurch (Figure 5.101).

The ware F4 material analysed from excavations in Salisbury (Underwood unpub.) was identified in the site pottery report as 'Surrey White Ware' type. It was therefore expected that this material would not be chemically consistent with the Group Z sherds, and this certainly seemed to be the case when the results were considered in Chapter 5. However, about half of these sherds may have had some chemical similarity to the ware F4 sherds from Wimborne suggesting a possible alternative source for some of the so-called 'Surrey White Ware'. This cannot, however, be proved and therefore remains speculation for the time being.

A further white ware industry was also possibly operating on the periphery of the study region, around Ilchester in the late twelfth and thirteenth centuries. This possibility derives from the presence of glazed white ware material of this date that can be identified from the Ilchester excavations monograph (Pearson 1982). Unfortunately none of this material has been analysed and this producer must for the moment remain unknown. It might have been expected that the Sherborne Old Castle collections would show evidence of such an industry and the fact that it does not indicates that either it was located much further north or west than might be anticipated, and that Ilchester was on the edge of its market, or, that it was such a small-scale concern that products did not reach as far south as the most northerly towns of Dorset. Another possibility is that this industry ceased to function by the mid-thirteenth century, matching the demise of Ilchester as a significant trade centre. Thus its products would not feature in most of the contexts studied in the Sherborne collection.

Figure 6.6 is a representation of an 'ideal explanation' of the ware F4 provenance and distribution, based on the available archaeological data and the analytical results of this project. It is by no means certain that this represents the true situation, but it does serve as a clarification of the suggestions made in the preceeding paragraphs and provides an agenda for questions and answers concerning the study of Dorset medieval fine wares in the future.

Chapter 7

Wider implications and further work

7.1 The scale of ceramic production in the Dorset region in the medieval period

The scale of production at a particular kiln site is not liable to be archaeologically recoverable in a direct sense. Only with possession of records detailing ceramics made and/or sold, workers employed, duration of the process etc, could definitive statements on this subject be made. Such a situation is of course fanciful and information of this nature would not be expected of the most organised or prestige-laden English medieval craft, never mind of an activity such as potting, which was typically seasonal, being carried out in addition to normal agricultural duties (Le Patourel 1969).

McCarthy and Brooks state that in Peacock's stratified classification of pottery production of the form; household production - household industry - workshop industry - organised industry (Peacock 1982), most medieval ceramic manufacture is of a scale somewhere intermediate between household and workshop industry. Certainly ceramic manufacture in this period was not organised in the industrial sense. As Streeten has pointed out (Streeten 1981) an industry would require shared responsibility at each stage of production, and most documentary references to potters from the medieval period refer to individuals by name, rather than groups of workers. The rural earthenware potteries in the Verwood area which were active into the present century are likewise always the responsibility of named individuals (Algar et al 1987) and, although they show a level of job specialisation, they are undoubtedly still a form of Peacock's 'workshop industry'.

The excavated kilns in the region are of a scale that is in keeping with such a view of English medieval pottery production. At Hermitage the evidence is for one kiln in operation at any one time and, despite the large number of successive structures, the same has been postulated at Laverstock. This is perhaps surprising considering the latter site must have had some part in providing the "1,000 pitchers bought and carried from Muleford (Milford)"; to Clarendon (Le Patourel in Musty et al 1969). Any production site required to supply 1,000 decorated vessels to a royal palace might be expected to be more than a seasonal, one kiln, operation. Although it is likely that not all the kilns operating at Laverstock were located and excavated (Algar pers. comm.), there is as yet no actual evidence to confirm that the Laverstock 'industry' in reality warrants such a title. At Donyatt, which in the post-medieval period did seem to operate on a larger scale, in the thirteenth and fourteenth centuries the only excavated evidence is a group of wasters and a simle clamp kiln. Although such flimsy structures are undoubtedly difficult to locate archaeologically, and thus others may have been missed at Donyatt, the present indications are still for a very small-scale concern in this early period.

Streeten (1981) listed eight indicators of the larger centres of medieval ceramic manufacture, which could be gleaned from archaeological or documentary sources. These were:

i) More than two personal names of potters listed at a site at one time.

ii) Potter-prefix added to the settlement name in contemporary documents.

iii) Documentary references to specific orders sent the potter himself (rather than middlemen) for a larger number of vessels than could be produced by a single operator.

iv) Archaeological evidence for the existence of several contemporary kilns or workshops in close proximity to each other.

v) Standardised forms and fabrics associated with different kilns at the same place.

vi) Monopoly over local markets, reflected in the archaeological record by the ubiquitous distribution of a particular ware over a specified area. May be linked with the hinterland of a nearby town.

vii) Middlemen possibly involved in marketing. Archaeological evidence might include extended distributions and 'peaks' in the decreasing quantity of pottery sold at greater distances from the kiln.

> viii) Continuous pottery manufacture at a particular place lasting several generations or centuries.
>
> (Streeten 1981, 328)

This list can by no means be taken as the definitive criteria for any pre-determined level of production, be it 'industrial', 'workshop' or whatever. It is useful, however, for giving broad indications as to those centres that might have witnessed greater than 'average' ceramic production activity in the medieval period. What the 'average' production site actually was is again a contentious issue and it is almost certainly impossible to specify this accurately. For the purposes of this study, however, this will be identified as broadly Peacock's 'household industry' level of production, which, although the definition is angled towards the discussion of activities in the Roman period, remains fundamentally valid in medieval England as well.

In this classification of ceramic production some families meet the needs of their social group by seasonal specialisation in potting, with distribution through both markets and itinerant individuals be they members of the same family or outsiders. The second level of production roughly approximates to Peacock's 'workshop industry'. Here the activity is 'workshop-based' with several people being employed, labour is subdivided and manufacture is normally year-round. Selling tends to be at regular markets, although in this particular context both itinerant salesmen and specific-job production can also be incorporated into the set of methods of distribution.

It is probable that most of the medieval ceramic industries of the region were of a nature that would place them on a sliding scale somewhere slightly above the houshold production level. McCarthy and Brooks suggest that all English medieval ceramic production would lie between the two levels of Peacock's scheme that have been described (McCarthy and Brooks 1988). It is possible, however, that certain sites attained something approximating to 'workshop industry' status, which itself approximates to Streeten's 'large centres' for which the set of eight qualifying criteria were compiled.

Of the three excavated sites mentioned Laverstock qualifies as one of Streeten's large centres through points iii) and possibly iv), on the basis of the information available in the site report. From the chemical analyses described in Chapter 5 it is apparent that ware F1 Laverstock products were the dominant glazed ware at sites in Salisbury, and also perhaps at West Grimstead. This may suggest that Laverstock qualifies as a large centre under point vi) of Streeten's list of criteria, monopolising the market of the town of Salisbury and, perhaps, rural sites such as West Grimstead in the surrounding hinterland. The situation is by no means that simple, however, when the distribution of Laverstock products is studied in detail. First of all, the fine wares have a distribution that extends well beyond the primary market area of the city of Salisbury. This is evident from the probable Laverstock ware F1 material that has been found at sites as far afield as Sherborne Old Castle, Poole and Southampton. Thus it becomes apparent that the ware F1 products from Laverstock are exhibiting an extended distribution that would perhaps be termed that of a 'prestige item'. This therefore indicates that discussion of this type in terms of its dominance of a local market area is a consideration of only part of the product's true distribution. The ware C1 coarse wares from Laverstock would perhaps be expected to show a more localised distribution, although the dangers of making such dismissive statements concerning the transportation of coarse wares, as noted by Riley (1982), is observed by the author. The distribution of this type that is suggested by the results of the chemical analyses highlights such problems (Figure 6.5), with large quantities apparently being present in rural assemblages over sixty miles from the kiln site itself. Despite being aware that on occasion valid reasons for such peculiarities in coarse ware distributions do exist, in this case the author cannot identify such an explanation and therefore the assumption has been made that in this case the analytical data has proved unable to explain the archaeological problem.

Hermitage, on first study, does not qualify as a 'larger centre' under any of the eight criteria. If the sites where chemical analysis has identified ware S1 Hermitage products are studied, however (Table 5.12), it is apparent that such material is located in collections up to twenty-five kilometres from the kiln site (e.g. Poxwell). This could qualify Hermitage as a 'larger centre' under Streeten's criterion vii), but this must be regarded as only the flimsiest of evidence for such status. This particular point of Streeten's is worth discussing. He states that the involvement of middlemen in the marketing of ceramic products, archaeologically recoverable as "extended distributions and 'peaks" in the decreasing quantity of pottery sold at greater distances from the kiln" (Streeten 1981, 328) is an indicator of possible larger scale, more organised, production. The logic of this argument is hard to follow as the latter description could equally be applied to a situation where the potter hawked his own wares, necessitating only part-time manufacture itself. The scale of the problem becomes significant here. If a very wide distribution was identified, as, for example, has been described for the Laverstock fine wares, then a natural explanation for occasional groups of these ceramics found at centres many tens of kilometres from the kiln and outside the general fall-off of the type, would perhaps be that given by Streeten. In the situation of the Hermitage ware S1 material, where the pottery type is found occasionally at sites at varying distances up th 25km from the kiln, the explanation of this might again be that it is the result of the actions of itinerant salesmen, but this in no way supports any suggestion of increased status for the production site. With the example of Hermitage, with its products being found at sites across the south west of the chalklands, the natural distribution mode, regardless of the scale of production, would perhaps be through an itinerant hawker, whether related to the potter himself or not. This is because of the nature of the terrain, with many isolated valleys and small pockets of population offering many potential customers but in a variety of rather isolated localities. In retrospect then, it can be stated that the Hermitage kiln was undoubtedly not a 'larger centre', using Streetens definition and criteria, and that it was most likely to have been of a scale slightly above 'household industry', as defined by Peacock (1982).

Such descriptions of the Hermitage kiln site may be equally applied to any of the sandy ware producers whose existence has been suggested by this project. The greatest variation between these sites would perhaps be in the size of the areas into which the products were distributed, but the basic nature and scale of production would be fundamentally the same throughout. This is because the most important limiting factor in the distribution of products in an area without navigable rivers and at some distance from the sea is liable to be the the extent to which the topography inhibits road transport. This is assuming that, apart from the major national routeways, the quality of roads was uniformly poor across most of medieval England. Even if all of this is true, it would be very difficult to be certain that this was the case in a situation where the the only information available to suggest the existence of other kiln sites is the presence of chemically similar ceramics in a virtually random selection of settlements.

The ware S1 material identified as Group V in Table 6.12 represents the largest group of ware S1 material, of approximately similar chemical composition, that has been identified. It is probable that this does not truly represent just one kiln group as the ware S1 material cannot be separated completely, using the analytical results, from some ware S2 and ware S4/C2 sherds. This therefore suggests that the ware S1 sherds in this group may not be all from the same kiln site, despite being grouped together in the multivariate analyses. The indications may well be for two centres of production of this type, as described in section 6.2. the more northerly centre would be located north of Hermitage and supply ceramics to Sherborne Old Castle in the medieval and post-medieval periods. The other centre would perhaps supply ceramics to sites south of Dorchester. The size of these distributions is comparable with that suggested for Hermitage if viewed separately in this way (approximately 30km X 30 km). If the whole group of material is viewed as one distribution, however, the resultant distribution is much larger. This can be contrasted with the evidence for the ware S1 material found at Yondover. The suggestion here may well be for a distribution that is only a few kilometres across, bearing in mind that examples of this chemically-defined group have only been found at Yondover and Woolcombe. A westward extension of this distribution is likely, although no excavated material is known from this area to test the assumption. The results so far, however, indicate that this production site may well have had a much smaller distribution zone than those identified or suggested for other ware S1 producers.

A similar situation may well be evident with the ware S2 material from Lodge Farm, Milton Abbas and Sherborne Old Castle, with each site group representing a chemically separate type, with a quite local distribution. This may well be rather interesting considering at least the first and last of these three sites possess much late-medieval ware S2 material. It has been suggested that the late-medieval period (the late fourteenth and fifteenth centuries) saw a great drop in pottery production which echoed general economic trends in society at the time (Bettey 1986, McCarthy and Brooks 1988). The presence of what seems to be very localised distribution networks for ceramics of this period in the study region is certainly of note, especially as the previous century saw distribution over such wider areas.

No information relating directly to the distribution of Southampton-type ware C2/S4 ceramics outside the medieval town was collected. As the Southampton sherds themselves are the only evidence available for the existence of such a production centre, the study of this 'industry' can be taken no further. With regards to the ware S4/C2 products known from Laverstock, although it is apparent that large numbers of ware C2 vessels were present in excavations at Old Sarum (Musty and Rahtz 1964), this type has not been positively identified in other excavation reports from the area. Thus it is again difficult to assess the true distribution of this type, although its probable absence from the sequence at Gomeldon (Musty and Algar 1986) suggests it was not transported very far.

In Dorset ware S4/C2 has been identified as being divided into two types. The more northerly, darker-coloured material is probably made near Ilchester (Pearson 1982) and its distribution extends eastwards at least as far as Shaftesbury, and southwards to Winterborne Houghton. The lighter-hued, southerly type has been chemically separated from the other group and has been found at Compton Valence and Woolcombe, and probably at Dorchester and other sites further south. The size of the former type's distribution is quite large, considering that the material is expected to have been distributed north and west into Somerset as well as into Dorset. The latter group has a distribution that is probably in keeping with that for the ware S1 types, with the type being common in an area about thirty kilometres across.

The marketing of the northern sub-type of ware S4/C2 was probably not subject to the problems posed by a well undulating terrain that affected the distribution of the southern version, and also the ware S1 pottery in the same area. The latter wares would probably be transported in small batches into the small valleys and hamlets of the south west chalklands, carried either by an independent hawker or the potter or a member of his family. This last possibility has been documentarily attested for post-medieval pottery distribution in the Verwood industry (Copland-Griffiths pers. comm.). The more northerly, Ilchester-type, ware S4/C2 was distributed into a region that includes the Blackmore Vale, the Yeo Valley and the fringe of the Central Somerset Plain. The topography in these areas is more uniform over greater distances, and this, coupled with the presence of larger numbers of more closely-packed towns (see Figure 2.1), would have probably have resulted in larger amounts of ceramics being transported further, in comparison with the situation to the south. Thus a wider distribution for the more northerly ware S4/C2 type, as suggested by the results of the analyses, is perhaps not surprising.

Central Dorset witnesses the edge of two traditions of ceramic manufacture as shown in Figure 6.3. To the west of the ware C2/S4 and ware C1 contours, the sandy wares are the dominant tradition, whilst east of these contours is the coarse quartz-gritted tradition exemplified by the Poole and Laverstock coarse wares.

The sandy wares, except ware S4/C2 are often found in jug and pitcher forms, over the whole of their region of occurrence. Ware S4 pitchers have been found at Ilchester and Sherborne Old Castle, but these tend to be quite rare and are absent by the thirteenth century. At Hermitage ware S1 jugs were common and this is repeated in assemblages at Dorchester, Holworth and Sherborne Old Castle, but not at Compton Valence and Woolcombe. The reason for this difference is unclear but it may be as a result of differing agricultural practices in the case of Holworth, when compared to Compton Valence and Woolcombe. For example; jugs and bowls are liable to be used in dairy farming, but as this area of study has not been investigated further here, it would be unwise to make any further statements on this matter. It is probable that the presence of larger numbers of jugs and pitchers at Dorchester and Sherborne Old Castle is due to additional activities taking place at these castle sites, in comparison with the rural hamlets represented by the other collections described. Despite these differences, the majority of sandy ware material at all the sites studied is in the form of cooking pots.

This latter is also true of the ware C1 material across its whole region from Dorchester eastwards. There are differences in the general assemblage of this type in certain cases, in particular where products of the supposed kilns from the Poole Hrbour area are involved. The Poole harbour ware C1 'industry' regularly produced jugs in contrast to the Laverstock and Southampton kilns which did not. At both of these latter locations, however, locally-made jugs in finer fabrics are known. As has been discussed in Chapter 6 ware F4 fine ware jugs (Group Z) do seem to have been made in the Poole Harbour area, but why similar forms were made in approximately the same period and area in ware C1, is a mystery. This material is often well- decorated with glaze, applied strips in different coloured clays, and the characteristic red painted ware designs. Material of this type has been found in quantity on excavations immediately adjacent to the harbour and it is also present in collections from Dorchester, Wimborne, Sherborne and Shaftesbury.

The area encompassed by the Poole products is at its greatest extent, including occasional examples of painted sherds in urban collections, very large indeed. This is comparable with the distribution for the Laverstock ware F1 material and these glazed jugs from Poole, despite their coarse fabric, must be viewed as prestige items, in terms of their value and distribution. In contrast the more mundane forms, mostly cooking pots, are difficult to study because in many respects they seem to be visually similar to cooking pots from other ware C1 producers. Despite the reservations that have been voiced concerning the chemical classification of ware C1 material in Chapters 5 and 6, the data from the analyses as shown in Figure 6.5 does indicate a rapid fall-off of the percentage of assemblages represented by Poole ware C1 material, as the distance from Poole itself increases. The only site collection that appears as a definite anomaly is Shaftesbury, and it is fairly certain that this collection was incomplete anyway. Thus the indications are perhaps that the primary distribution area for Poole ware C1 products in cooking pot forms was Poole itself, with Wimborne and perhaps

Christchurch, Corfe and Wareham as secondary markets. Outside this area there was probably still some transport of this material but, due to the way some of the original data was compiled, this becomes confused with the more gradual fall-off of the ware C1 jugs. It is quite probable that there were other ware C1 kilns in the area, besides those that supplied the sherds used when characterising the Poole material. This is suggested by the large amounts of 'unknown' ware C1 material from Christchurch and Wareham. Whether this represents other kilns around Poole Harbour or elsewhere (e.g. the Verwood industry) or, perhaps both, it is impossible to say. The indications are definitely that the cooking pot products of such kilns do not seem to have had distribution zones that were any greater than those attributed to the sandy ware producers. This is not the case with the more valuable decorated material, however, which had a distribution more in keeping with its vessel type and degree of decoration.

The scale of production of the fine ware types identified in the region is even more difficult to determine than that of the coarse wares and sandy wares. The glazed material from Laverstock and Poole has already been discussed in the context of the more mundane ware C1 products of these industries. It was noted that both these types exhibited distributions that covered much greater areas than those suggested for the coarser, or undecorated, material. The indications are therefore that these particular glazed wares would give distribution fall-off curves of the long-tailed, prestige item type, as described by Renfrew (1977, 77).

Because of the smaller number of these better quality sherds that are usually identified in archaeological assemblages, it has already proved difficult to attach numerical values to aid in the interpretation of glazed ware production and distribution. Thus in Chapter 6 the situation has arisen where pie charts can be constructed to illustrate the contribution of sandy wares and coarse wares to the assemblages studied (Figures 6.1 and 6.2), but only presence and absence data are available in an overall study of the fine wares (Figure 6.4). It is therefore very difficult to construct models for, or gain an understanding of, the scale of production and distribution of the fine wares, and some other glazed wares manufactured in medieval Wessex.

Figures 6.4 and 6.6 present the data for, in the former case, the presence of visually identifiable fine ware types in the collections studied and, in the latter case, the presence of chemically identified ware F4 products of specific' 'industries'. Although only some of the sites represented on the former figure were studied for the latter, it is apparent that some valuable information concerning the size of the various distributions of ware F4 products can be made.

Firstly, ware F4 material is known from nearly all the collections studied, regardless of location. Nearly all the ware F4 material studied seems to derive from the Poole Harbour industry (Group Z), but this is by no means true of the material from all the assemblages. In the north and west of Dorset, although in many cases where ware F4 material was identified, it was not also studied chemically, the presence of this type at both Shaftesbury and Sherborne Old Castle suggests that it is likely that Group Z material would also have been located in collections in the centre of the county, (e.g. at Dorchester and Milton Abbey). The evidence here is perhaps for the typical gradual fall-off of a prestige item, with increasing distance from its production source, with little inhibition of this pattern due to the lack of competing fine ware producers in central and north Dorset in the thirteenth and fourteenth centuries. In the east, however, the situation is more complicated, with the presence of other fine ware-producing kilns inhibiting a repeat of the simple fall-off identified elsewhere. The suggested Alderholt industry, producing ware F4 vessels, may well be a major contributory factor here, but the large quantities of fine wares produced at Laverstock and, perhaps, elsewhere around Salisbury. as well as the locally-produced material found at Southampton would also have acted as competitors, limiting the spread of ware F4 material from the Poole Harbour fringe. The presence of the New Forest in the east would also undoubtedly have acted as some sort of barrier to the distribution methods that could be expected the hawkers of medieval ceramics, bearing in mind difficulties that might be encountered when transporting bulky, fragile items long distances on poor roads.

In contrast to this rather wide distribution for the Group Z products, the so-called Alderholt industry (although this is only a guesss as to its actual origins), supplier of ware F4 ceramics to Wimborne and perhaps the sites in Christchurch as well, does not seem to have had a distribution zone that was much larger than twenty to thirty kilometres across. This is of a size that matches that suggested for many of the coarse and sandy ware producers, and it can perhaps be seen as indicating that the production at this site in the late thirteenth and early fourteenth centuries was geared towards local consumption, rather than long-distance distribution. This could have been a deliberate move, with awareness of the several other ceramic production centres that seem to have supplied east Dorset, but it is perhaps more likely that it came about as a result of this 'industry' being set up at a later date than its competitors. The first reference to ceramic production in the Alderholt area is at Damerham in 1275 (Le Patourel 1969), which is later than the date of 1230 suggested by Musty et al (1969) as the start of the known production at Laverstock, and later than the earliest ware C1 vessels that seem to originate from around Poole Harbour (they appear at least by the early twelfth century at Wareham (Hinton and Hodges 1977)). In such a situation, with well-established producers at no great distance from the new kiln site, the new producer may not have been able to secure a large market area until other factors produced a decline in one of its senior competitors.

The general social hiatus of the mid-fourteenth century (Bettey 1986) probably disrupted economic systems to such an extent that a previously small concern, such as that proposed for Alderholt, could have had an equal chance of developing into a larger tradition as a previously much bigger producer such as that at Laverstock, or those proposed around Poole Harbour (ware C1 and ware F4 manufacturers). Whether this occurred immediately is, however, uncertain. The later incarnation of the Alderholt industry, as the post-medieval Verwood and District pottery industry (Young 1979, Algar et al 1987), is representative of such an expansion, but there is as yet no evidence for kilns that were active between the mid-fourteenth and early-sixteenth centuries. There are some indications to suggest that low-status occupations that were a necessary addition to agriculture for many before the social traumas of circa 1315 to 1360, were abandoned once wages and available land increased as a result of the population decline. Dyer (1982) suggests that this may be a cause of the decrease in identified pottery and documentary evidence for pottery manufacture in the late fourteenth and fifteenth centuries. The delay in the expansion, or re-emergence, of the Verwood industry until the early-sixteenth century may well be a result of this phenomenon and it could also be seen as the exploitation of a previously unavailable market by a small industry, but with a time lag between this initiative and the demise of the original competitors.

The thirteenth century Laverstock ware F1 industry seems to have had a wide distribution that was of a similar order to that identified for the Poole Harbour, Group Z material. This is suggested by the presence of Laverstock fine ware products in collections as far apart as Sherborne Old Castle and Southampton. The local fine ware producers at Southampton seem, on the other hand, to have had a much more localised distribution, with few examples of this type being identified in assemblages outside of the medieval port and town. The reasons for this are unclear, but, considering Southampton's place at the confluence of many complex national and international trading networks, it may be very difficult indeed to find a simple answer to this question. The lack of identified examples of this material from excavations in Winchester is indeed rather puzzling (Brown pers. comm.), as Southampton has regularly been described as gaining its early status from its position as the international port for this royal centre. Certainly, the 'market' for ceramics represented by the town and port of Southampton would be very substantial and it may not have been necessary for the producers of this material to look elsewhere for their custom. Winchester has its own pottery traditions for most of the period under study (Hurst 1964 and Brown pers. comm.) and this city and its hinterland may well have also been a distinct market for locally produced material. If this is so, then the question arises, why were the Laverstock potters involved in long-range trade, when a similar large local market existed close-by this production site, represented by Salisbury and its hinterland (and Clarendon Palace)? It is probable that this was indeed the primary market for these wares, and any other distribution of them was of a secondary nature, not directly involving the potters. The highly decorated nature of the Laverstock ware F1 products might have increased its wider appeal, but this should not be stressed too strongly as most of the glazed material found in Wessex in the late-thirteenth and early-fourteenth centuries exhibits examples of a wide variety of decorational techniques, although the execution of these ideas is not always to a high standard.

It is therefore apparent that, on the whole, the glazed wares and fine wares that were manufactured in the Dorset region in the medieval period were distributed beyond the hinterland of the closest town, whilst this does not seem to be the case for similar material produced in thirteenth and fourteenth-century Southampton and Winchester. In the former region an average size of distribution for less-decorated, or coarser, ceramics was an area about thirty kilometres across, which suggests transport up to about 15km from the kiln. This size of distribution area was common to utilitarian wares of a variety of fabric types, and it only seems to apply to regularly decorated or glazed material when intense competition prevents the producer from exploiting anything other than local requirements. Fine and glazed wares could become marketed more widely. Whether this was through a deliberate policy on the behalf of the potters, or through rather casual secondary distribution by hawkers or individual purchasers, it is difficult to ascertain. Once this had occurred, however, there seems to be no limit, on a regional scale, to the distances that such 'prestige' items could travel. It is likely that the producers of the fine and glazed wares had little awareness of the final resting place of their more travelled products, this long-range distribution being perhaps handed over to hawkers, or carried out alongside more local trade, through a stall in the nearest large town. If the occasional production of batches of material for the royal household at Clarendon is ignored, the Laverstock potters would have probably concentrated on selling their wares in the markets of Salisbury. Once the vessel was sold, this might have been as far as the producers interest in it extended. With such a large centre as Salisbury, located so close to the kiln site, there may have been little incentive to attempt to directly exploit markets further afield. The fact that the same 'industry' also produced coarse ware cooking pots in abundance, suggests that its sights were not necessarily set particularly high up the social scale, with, apart from royal orders, a normal concentration on the needs of the local populace. These people, regardless of whether they lived in the town or its hinterland, could all be reached through the former's market place in a form of central-place market exchange (Renfrew 1975).

This may well have also been the case with the Group Z industry around Poole Harbour, although the lack of a firmly identified production site makes it hard to be very specific here. However, the presence of five market towns within fifteen kilometres of Poole Harbour, suggests that a 'local' market of a similar physical size to that exploited by producers of more utilitarian vessels would have here included a much greater population, and this may have adequately supported a producer of better quality products. The distribution of some of this pottery further afield, particularly in towns further west and northwards into Dorset, may again have been seen as almost a bonus, but the presence of further examples of these products at rural sites such as Holworth perhaps suggests that a more concerted effort to reach consumers of quality ceramics in the countryside in Dorset was being made. Certainly, with no known producer of fine wares westwards into Devon, or northwards as far as Donyatt in Somerset, the potential for an extended distribution of this material is self-evident. The method by which these ceramics were distributed is likely to be in a similar fashion to that suggested for the coarse wares and sandy wares of central and west Dorset. Owing to the large rural population and the rather isolating nature of the 'incised' valleys in the western downlands, the most likely method of distribution of ceramics here, in the medieval period, was suggested earlier as being through itinerant hawkers. These individuals could supply such a fragmentary population directly, as well as through the small markets and fairs at places such as Bridport, Beaminster, Cerne, Milton and others.

In conclusion the suggestions are perhaps that the marketing of ceramics in medieval Dorset and its region was carried out in a fashion whereby the quality of the product and, particularly, local conditions dictated the method adopted. The prospective potter would undoubtedly consider the likely markets available locally, and the location of a large town, or a number of smaller towns, close to the kiln would be a fairly vital criterion for the success of a glazed ware or fine ware producer. In all areas, except the heathlands and the New Forset, the local populace would have been a large enough basis to support the existence of a manufacturer of utilitarian wares, providing the raw materials were available. This is exemplified by the kiln at Hermitage, but in all cases a method for reaching the customers was still needed. This is likely to have been a combination of sale at small or medim-sized, local market towns (Hermitage was located near the Dorchester to Sherborne road), and through hawking by itinerant individuals. It was undoubtedly not an easy life for a potter in medieval Dorset, but in most areas the means for a living was present.

7.2 The value and use of analytical provenance study; a question of methodology

The author feels that notable successes have been achieved through this project, in terms of increasing our understanding of the nature and scale of ceramic manufacture and distribution in medieval Wessex. By no means all of the chemical data proved valuable in answering questions of an archaeological nature, but through careful structuring of the analytical programme to answer specific questions concerning particular ceramic producers and their markets, much useful information has been created. This illustrates the problem-specific approach necessary if scientific techniques are to be of use in 'mainstream' archaeology. Badly structured, or unstructured or open-ended studies will never produce as good a results-to-effort ratio, as that derived from carefully constructed research designs. This is because, until the problem to be tackled is properly defined, it is impossible to create a sampling strategy that will solve that problem satisfactorily. This may occur eventually, but the quantity of data collected may have become large and unwieldy, and the time taken rather excessive, by the time such a stage is reached.

Such statements apply equally to the collection and use of both archaeological and analytical data. Both are complex phenomena, deriving from both natural and man-made processes, neither of which can be over-simplified or over-generalised without inhibiting understanding. In the case of analytical provenance studies of ceramics, both the natural formation processes that produced the raw material, and the culturally-defined activities of the potter, produce the actual ceramic. Whether the true variation inherent in this material at any culturally significant level is represented in those examples studied, however, depends upon the discard of the vessel, the post-depositional processes acting upon it, its excavation, the method of selection for analysis, the sampling and analytical method and the statistical procedures employed. Vitali and Franklin's statements concerning archaeologists perceptions of analytical provenance studies illustrate well the problem of conception and understanding.

> "Both phases of provenance studies, the data gathering and the data analysis, must be carried out with due regard to the complexity of the processes on which the diagnostic phenomena are based. Only when this is the case can archaeologists expect usable and verifiable information from the technical analyses. As data analyses begin to define the necessary and sufficient input of information for particular provenance problems, experimental requirements can be modified and simplified accordingly."
> (Vitali and Franklin 1986, 162)

The most significant part of this quote is, perhaps, the last statement. If it was generally understood by archaeologists wishing to utilise scientific analyses that a well-constructed, more complex, research design regularly leads to simpler and quicker results, then scientific archaeology could proceed on a much more straightforward path than it has up until now. It should, however, be borne in mind that technical operators and scientists should pay equal attention to their archaeological colleagues statements concerning their database, if a scientific studies are to prove truly valuable in helping to understand the past.

In the initial stages of this project the aims were defined in the following manner:-

1) To characterise the chemical composition of ceramic fabrics from some medieval pottery kilns in Dorset and adjacent counties.

2) To assign fabrics from excavated sites in this region to kiln groups.

3) To describe and explain the distribution of the kiln products.

Initial guidance notes then earmarked the Hermitage and Laverstock kiln groups as the basis for study under point 1), with the characterisation and mutual separation of these types being the aim of the greater part of the first year's study. It was also suggested that some ceramics from excavated 'settlement' sites be compared with the kiln material studied, but the brief for this stage was naturally fairly broad to allow for all possible avenues of project development.

After about eight months it became apparent that the Hermitage and Laverstock material could be easily separated by chemical means, and this could also be achieved with a much-reduced suite of elements. Thus the next stage of the study could be initiated, but before more than two or three groups of pottery from 'settlement' sites had been studied, it became apparent that a proper overview of the medieval ceramics available in the region was necessary, if anything more than a very patchy understanding of the producers and their product distributions was to be achieved. The very small number of excavated medieval kiln groups in the region was in part to blame for this situation, but also significant was the sheer number of collections of ceramics known to have been found in the region, as well as the rather slow and laborious nature of analyses using AAS.

This latter problem was effectively bypassed through the restriction of the analyses to four elemental determinations on each sample, a decision that was made once it was apparent that, using such a small data set, the Hermitage and Laverstock products could still be easily separated, and other material from sites such as Sherborne Old Castle and Woolcombe could be matched with both of the kiln groups. This allowed a much quicker analytical stage than would have been necessary if a larger suite of elements was needed, and thus enabled a much larger number of samples to be processed. As the project had been specifically initiated as one based on the tecnique of AAS, the shortcomings of this analytical method, particularly in terms of its capacity to only measure one element at a time, had to be accepted and the project designed accordingly.

The small number of excavated kiln groups available from the region and the very large number of other collections of medieval ceramics, created a number of problems specific to this project which would not be encountered in medieval ceramic provenance studies in many other regions. With so much excavated material available, the temptation was to study sherds from as many sites as possible, spread across all parts of the region. The problem with this was that, with only two excavated thirteenth century kilns, and wasters from, at most, four other sites of thirteenth or early fourteenth century date, much of the material studied from 'settlement site' excavations was liable to derive from unknown producers. This material could not be ignored as, to do so would result in only a small part of the archaeological evidence for medieval ceramic manufacture in the region, being used. This body of information is itself a far from complete record, and thus disregarding the greater part of it would not be a sensible step in a broad analytical study. Thus the material that was not Hermitage or Laverstock products had to be considered, and attempts had to be made to identify the likely location and nature of the previously unknown production sites. To do this a carefully structured analytical study was necessary, based on an interpretation of all the information available concerning medieval ceramics found in the study region. Such a study formed the basis of Chapters 1 and 2, which in reality was carried out after the pilot study on the Hermitage and Laverstock products (Chapter 4). The result was that a list of those collections most likely to provide the required information was drawn up, and indications of the existence of other production sites were collated.

It is difficult to perceive how the project could have proceeded without being carefully structured in this manner. Certainly, without a full understanding of the archaeological 'background' over which the analytical problem-solving was constructed, few of the conclusions drawn in this and the proceeding chapter could have been made. The simple lesson to be learnt from this is that the scientific study of archaeological material should not be conceived and/or executed in relative ignorance of the basic archaeological and historical background to the study. Thankfully the best archaeological science projects that are initiated nowadays seem to be well conceived and generally prove supportive of, and of benefit to, the more traditional archaeological data base. However, by no means all projects in the past could be described in this manner, a fact that may well have 'tarnished' the view afforded to valuable scientific techniques by many traditional archaeologists.

It is perhaps unwise to consider what the likely outcome of a research project, of the type described here, might be if proper consideration to all the relevant databases was not given at an early stage.

7.3 The implications for future work

Any large research project provides lessons for future research design and future researchers. In this sense the research described here has not been atypical. The general 'gut feeling', perhaps familiar to all who undertake protracted individual study is that, if the project were done a second time, many changes to the outline would be considered before any work was carried out. Reflections with hindsight can be more than just sterile operations, however, especially if used to suggest how best to approach similar studies in the future.

This research project was initiated as a study of medieval ceramics in "Dorset and its region". The notion was therefore of a 'regional study' even if this region was spatially smaller than those considered in other recent PhD projects concerning English medieval ceramics (Streeten unpub., Vince unpub.). The notion that the region is a valuable unit for archaeological ceramic studies to consider was first suggested in the early 1960s (Rice 1982). Since then the idea of the 'regional study' has become a common basis for archaeological research of a variety of forms. The actual size of such regions varies enormously, to the point where any project of more than site home-range size, and less than national scale, could be termed a 'regional study'. The concept of the region is almost impossible to define in a way that is relevant to more than a handful of disciplines, data types or perspectives. The region as a unit in archaeological ceramic studies is no exception.

The study region for this project was ultimately dictated by the number of site collections and ware types that could be studied, both visually and analytically in the time available, bearing in mind the necessity to consider a representative portion of the available data base. Once the archaeological background work had been carried out it became apparent that no more than thirty site collections could be studied analytically, if a meaningful portion of the sherds and ware types available in each site assemblage were to be considered. This resulted in the selection of a specific set of site collections, representative of the common settlement types and geographic zones present in the study region, as described in Chapter 2.

In retrospect little of the above selection procedures would actually be changed if a second attempt at the project was possible. The analytical technique specified produced a significant limiting factor relating to the number of analytical operations that could be executed in the time available. Each of these analytical operations represents the measurement of one elemental concentration in a manageable batch of pottery samples (between 60 and 80 samples). Thus the number of samples analysed could increase if the number of different elements determined was decreased. The result of this situation was that a significant effort was made to determine whether as many elements as possible could be 'dropped'. This resulted in the production of a suite of the four 'best' elements, which was used as the basis for analysis across the whole study. The use of only four elemental determinations for each of these samples did have its drawbacks. Particularly the increased possibility, when compared to a situation with many elemental determinations, of different ceramic types being inseperable using the data set thus provided. It may well have been possible to gain much better insights into the distribution of ware C1 material, and possibly also ware S1 groups as well, if more elemental concentrations had been determined for each sample. The increased time taken on fewer samples would, however, have resulted in less samples from less sites being studied, with the possibility of a decrease in the overall understanding of these distributions.

It is therefore apparent that there is probably no one solution to the question of how a particular research project is executed, unless the research design is extremely specific. In the case of this project, because the research design was geared towards the interpretation of the production and distribution of medieval ceramics across a region, the decision to study more samples from more sites, but with less different elemental determinations, was taken once it was apparent that some good separation of the kiln site material was possible with the data from only four elements. The best solution to this particular problem would, however, have been the adoption of an alternative method of elemental analysis, if the only consideration was the production of as much good data as possible. This was not possible with a research project designed with the intention of using one analytical method, in this case AAS.

There is no doubt that the AAS data were of good enough quality to produce a valuable study, but for future long-term, individual, provenance research projects, this could perhaps be regarded as 'not the best tool for the job'. AAS is, for the most part, more accurate and more sensitive over more elements than most alternative analytical techniques, furthermore it is very much cheaper to purchase the hardware for AAS, than it is with, for example, ICPS, NAA and XRF. In a broad regional provenance study, however, once the archaeological questions have been defined and once a pilot study has indicated the potential for success, the benefits of producing analytical information relating to twenty or more elements, quickly, are obvious. This is possible with , for example ICPS, and the benefits as described may well outweigh the prohibitive factors of lower sensitivity with some elements and higher cost. This latter is not as significant as it was only a few years ago, with a number of educational laboratories now offering ICPS determinations in consultancy programmes. Even if an ICPS system is purchased, the running costs are not significantly different to those of an AAS laboratory, bearing in mind the operator cost of repeated single element AAS determinations. The indications are therefore that large-scale analytical provenance studies may be better served in the future by techniques such as ICPS, than they are by AAS. This must not, however, be seen to be detrimental to studies that have utilised AAS, such as this one. Furthermore, any provenance study of the type described here can only succed through the sort of rigorous research design and background data accumulations that have been described. Thus the utilisation of a new analytical technique is no substitute for a properly conceived, problem-specific, research design. Added to this is the necessity for a pilot study stage in any prolonged project, whereby initial suggestions and possibilities can be tested before the main body of work is attempted.. Finally, it must be stressed that AAS is still undoubtedly a valid analytical method, although the author feels its role is perhaps now more as a tool for small-scale problem solving, rather than in grandiose regionally-based schemes.

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Abbreviations used:

Am. Chem. Soc.	American Chemists Society.
CRAAGS	Committee for Rescue Archaeology in Avon, Gloucester and Somerset.
DNHAS	Dorset Natural History and Archaeology Society.
Med. Arch.	Medieval Archaeology.
MVRG	Medieval Village Research Group
PDNHAS	Proceedings of Dorset Natural History and Archaeology Society.
PSANHS	Proceedings of Somerset Archaeological and Natural History Society.
WANHM	Wiltshire Archaeological and Natural History Magazine.

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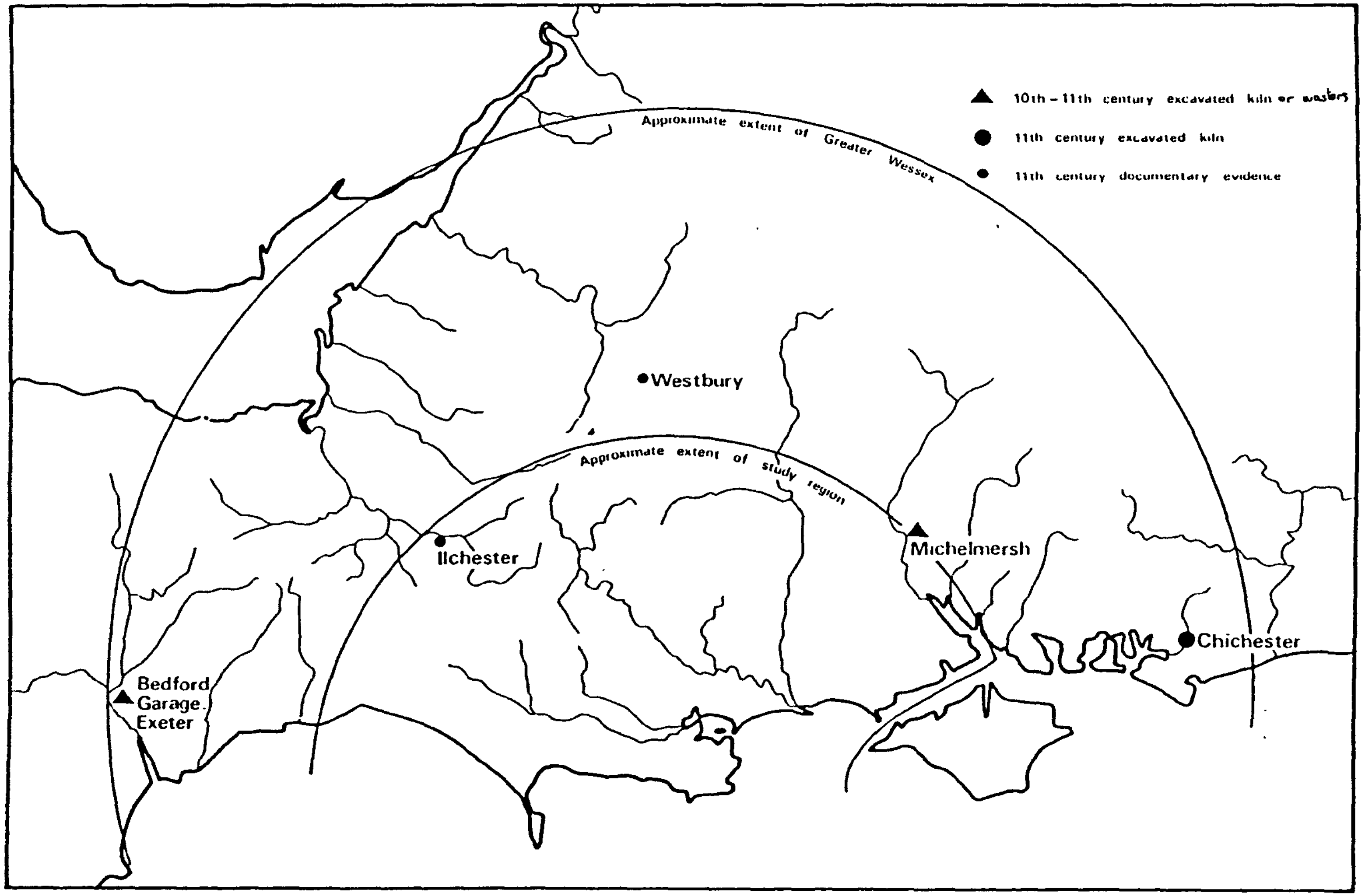
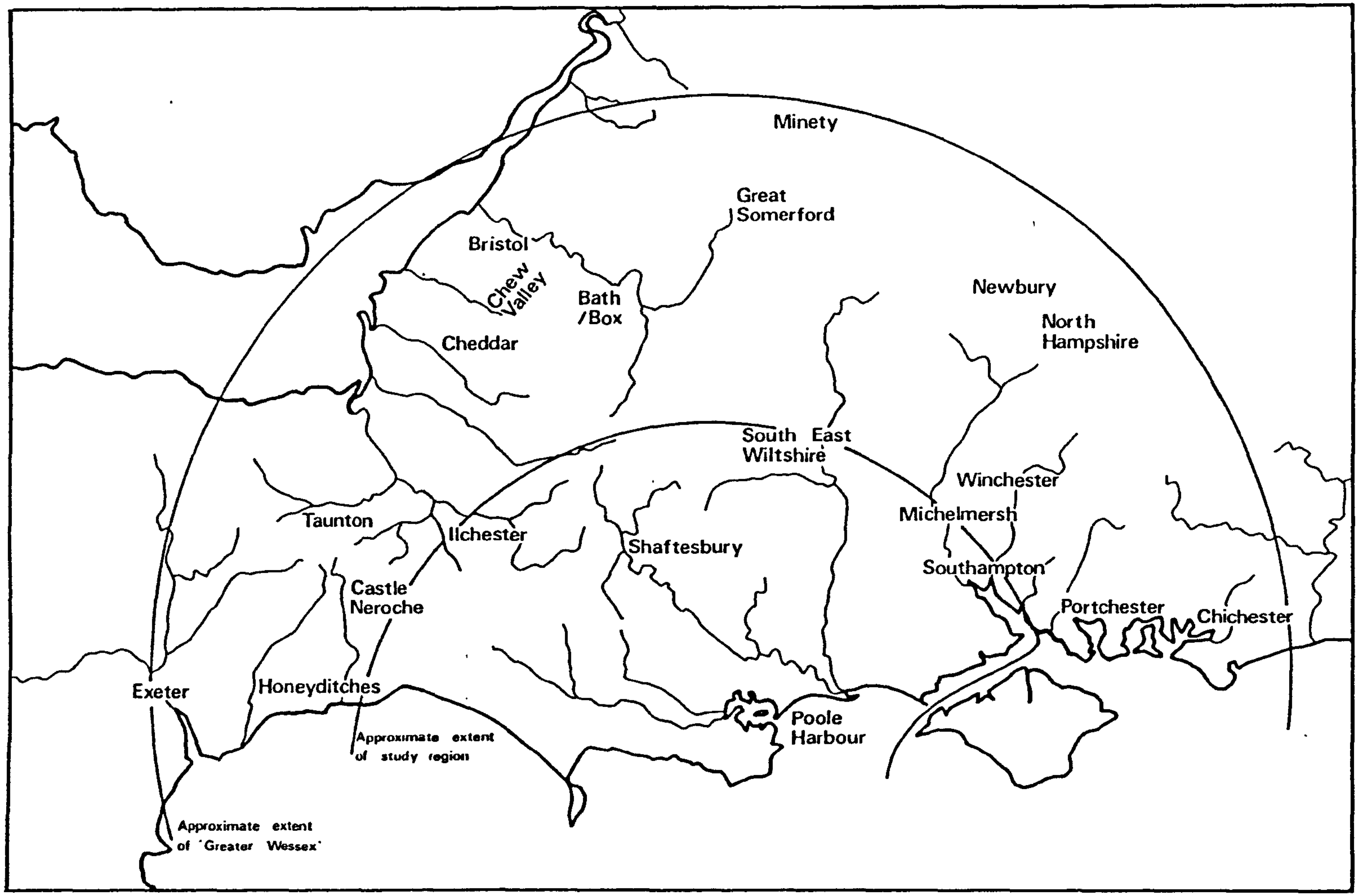
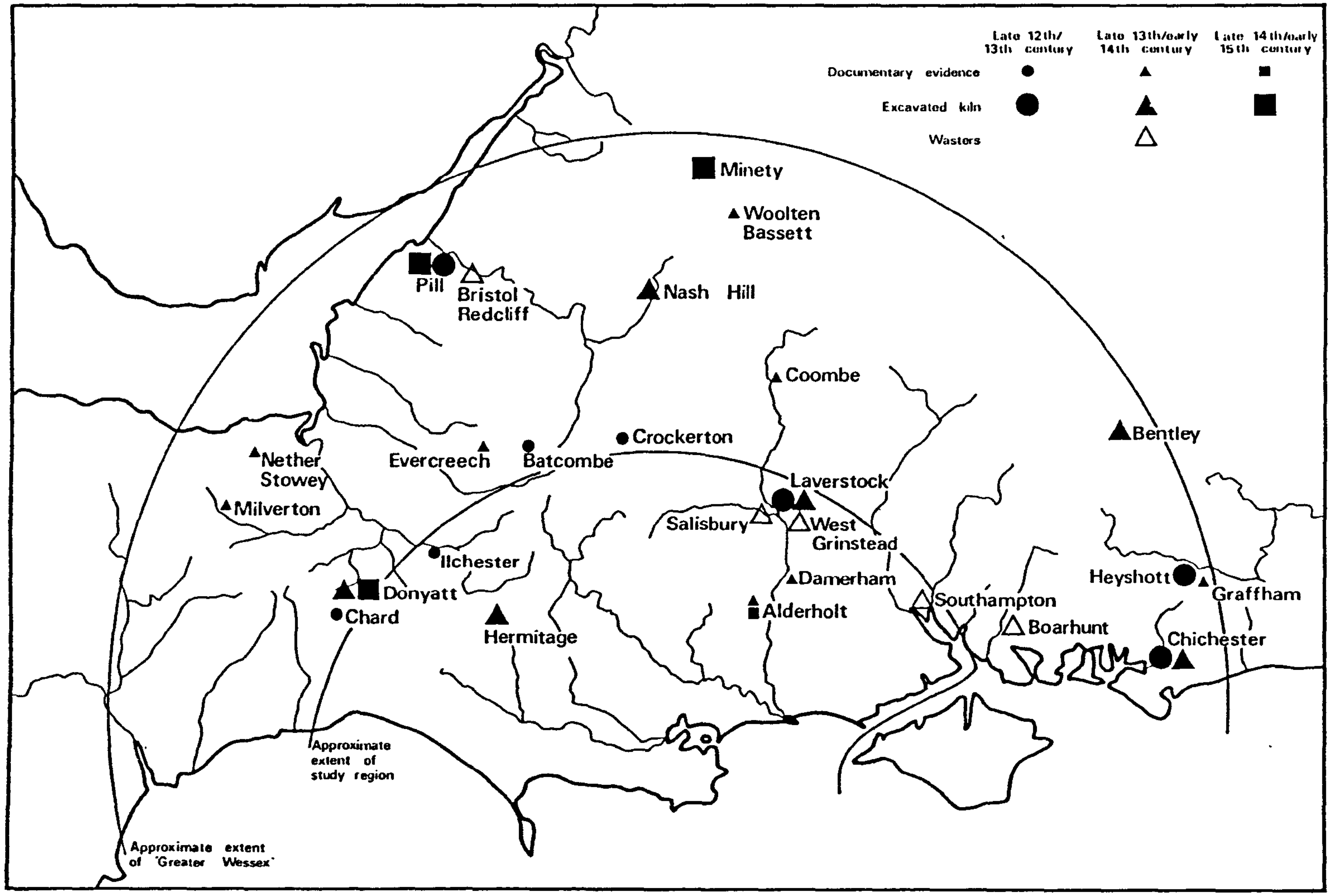


Ceramic Producers in 'Greater Wessex'

FIGURE 1 1

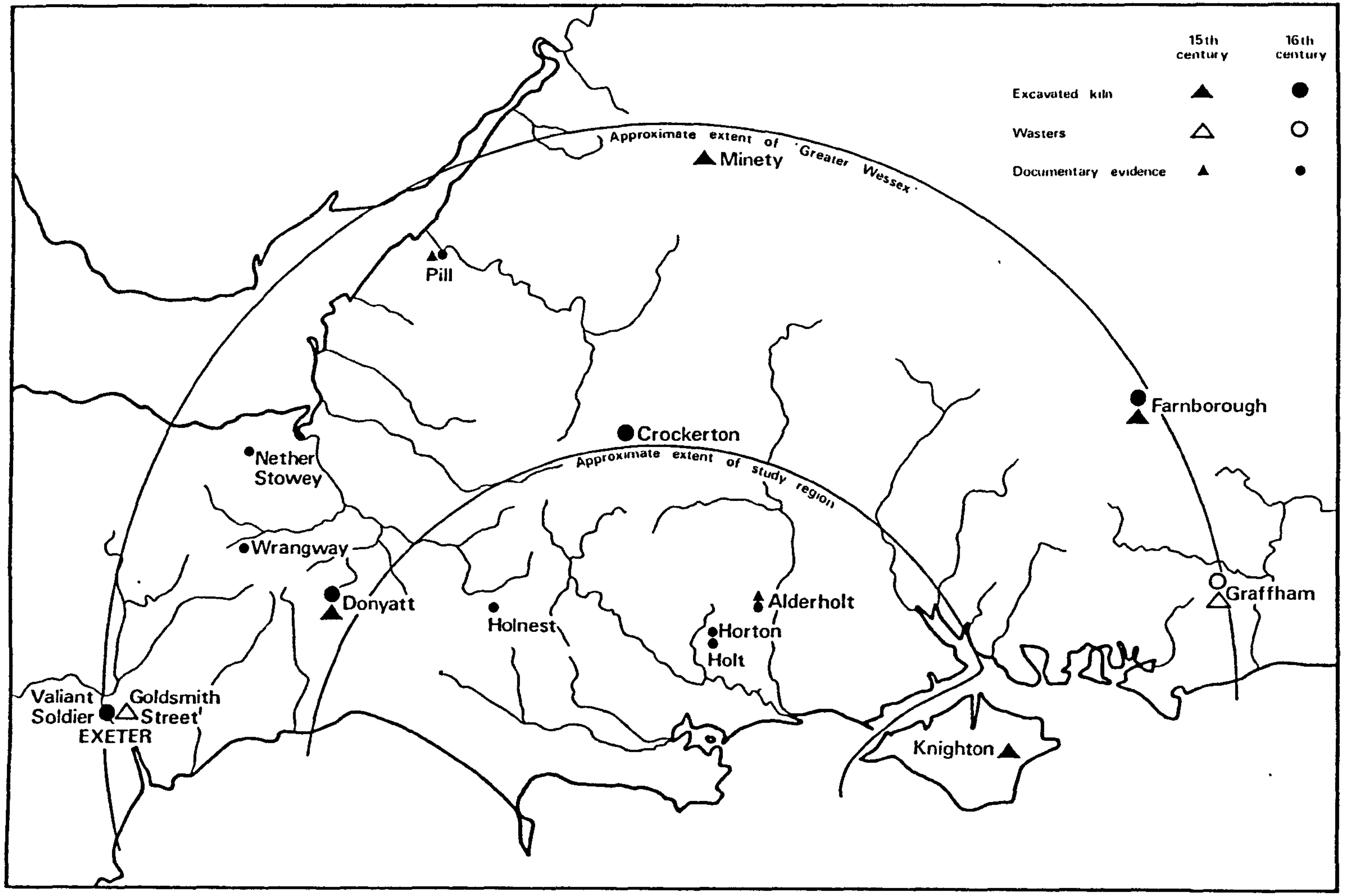


Identifiably Local Wares in Wessex (mid 11th to mid 12th centuries)
Figure 1·2



Ceramic Producers in 'Greater Wessex'

FIGURE 1·3

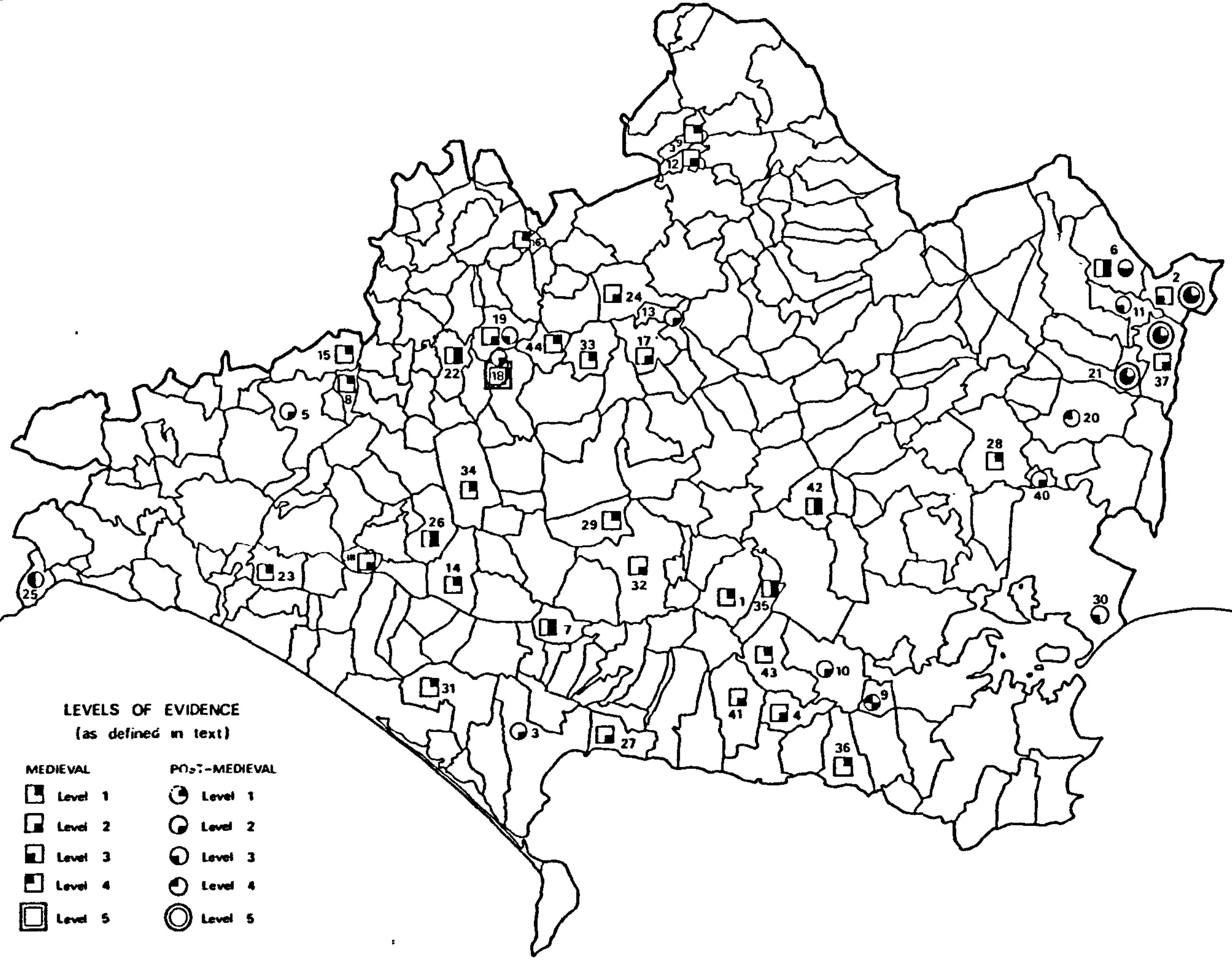


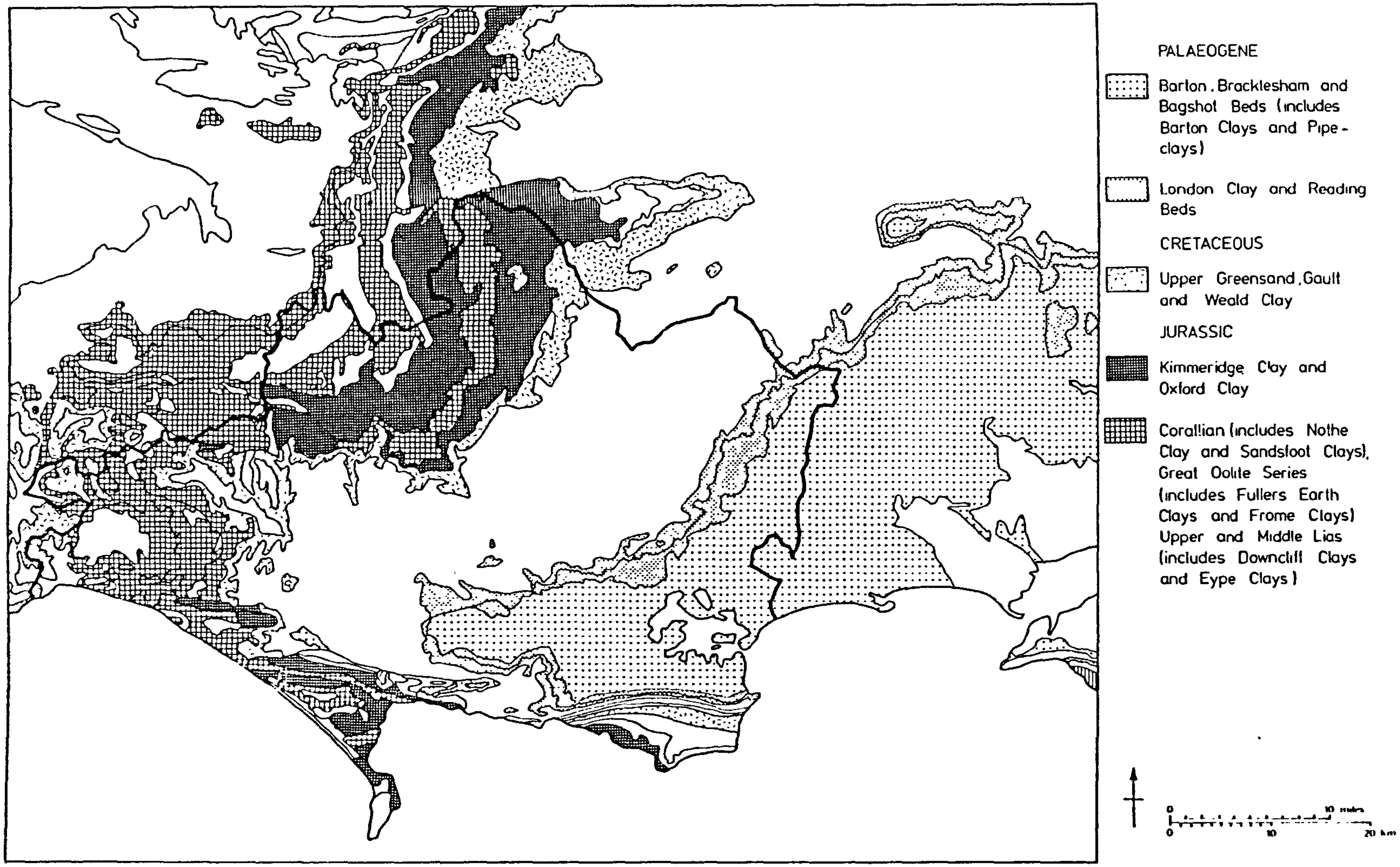
Ceramic Producers in 'Greater Wessex'

FIGURE 1·4

Documentary and Archaeological evidence for medieval and post-medieval production of pottery in Dorset

FIGURE 1 5





Major Clay-bearing strata of Wessex

FIGURE 1·6

FIGURE 2 1

Medieval Urban Centres in Southern Wessex

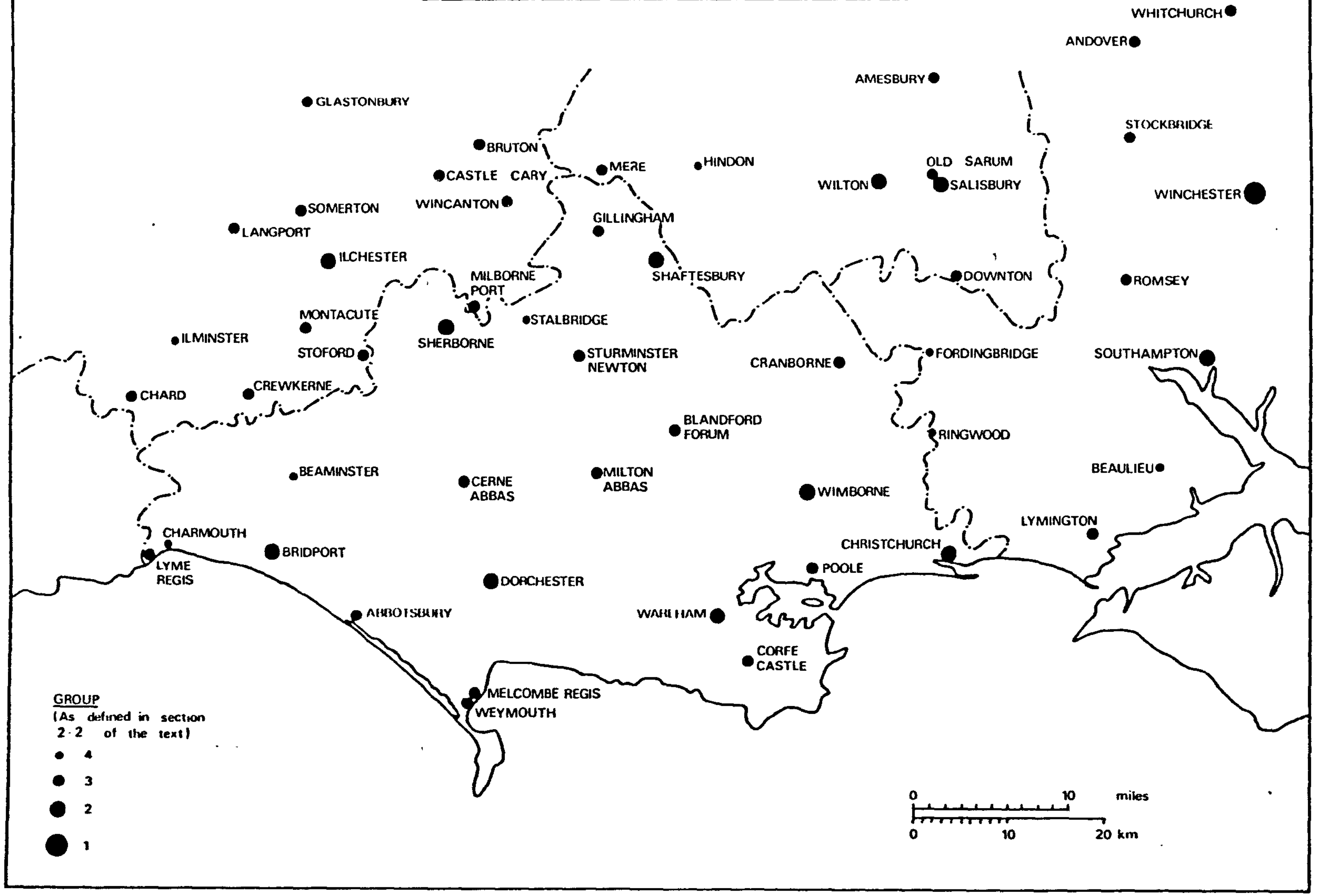
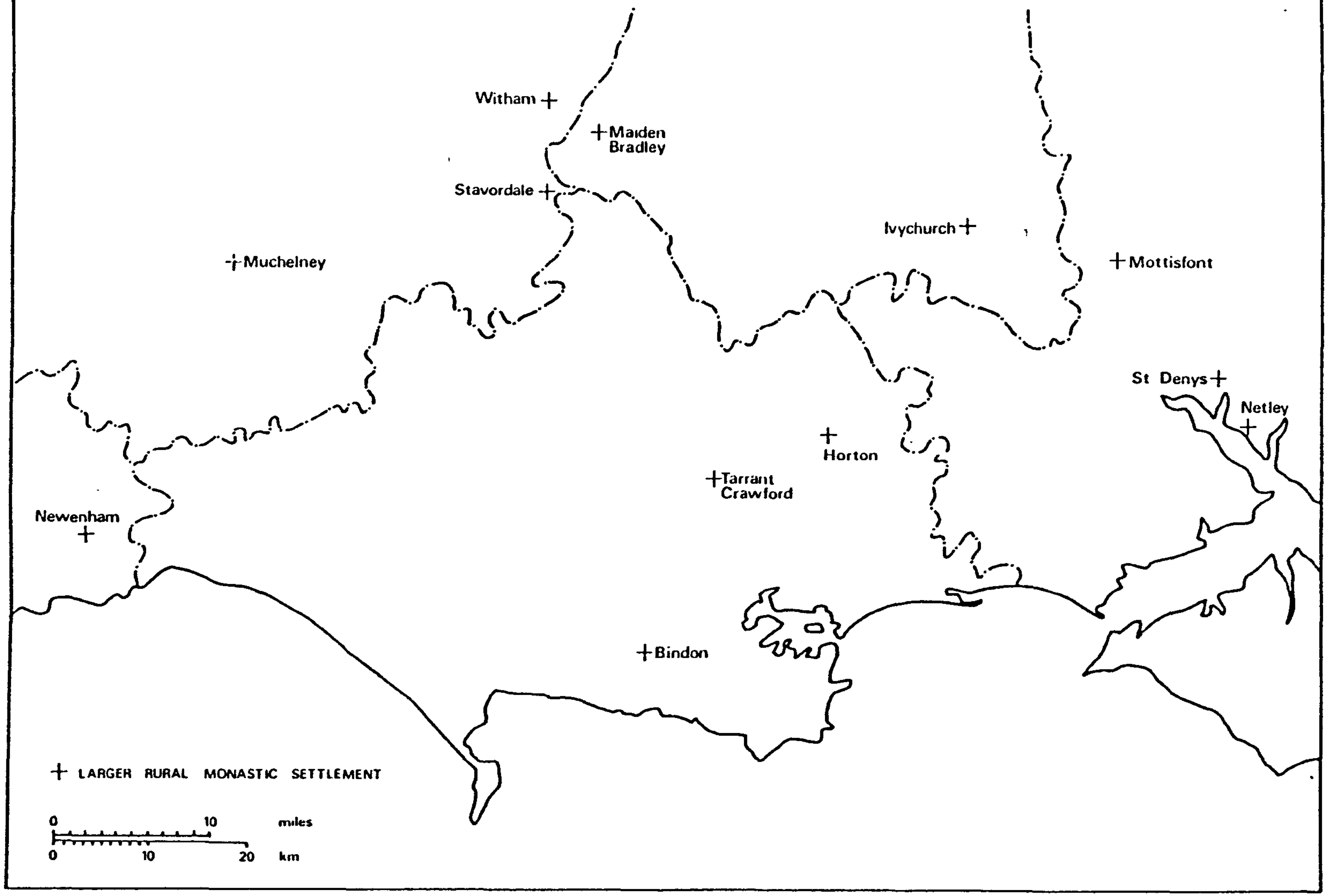


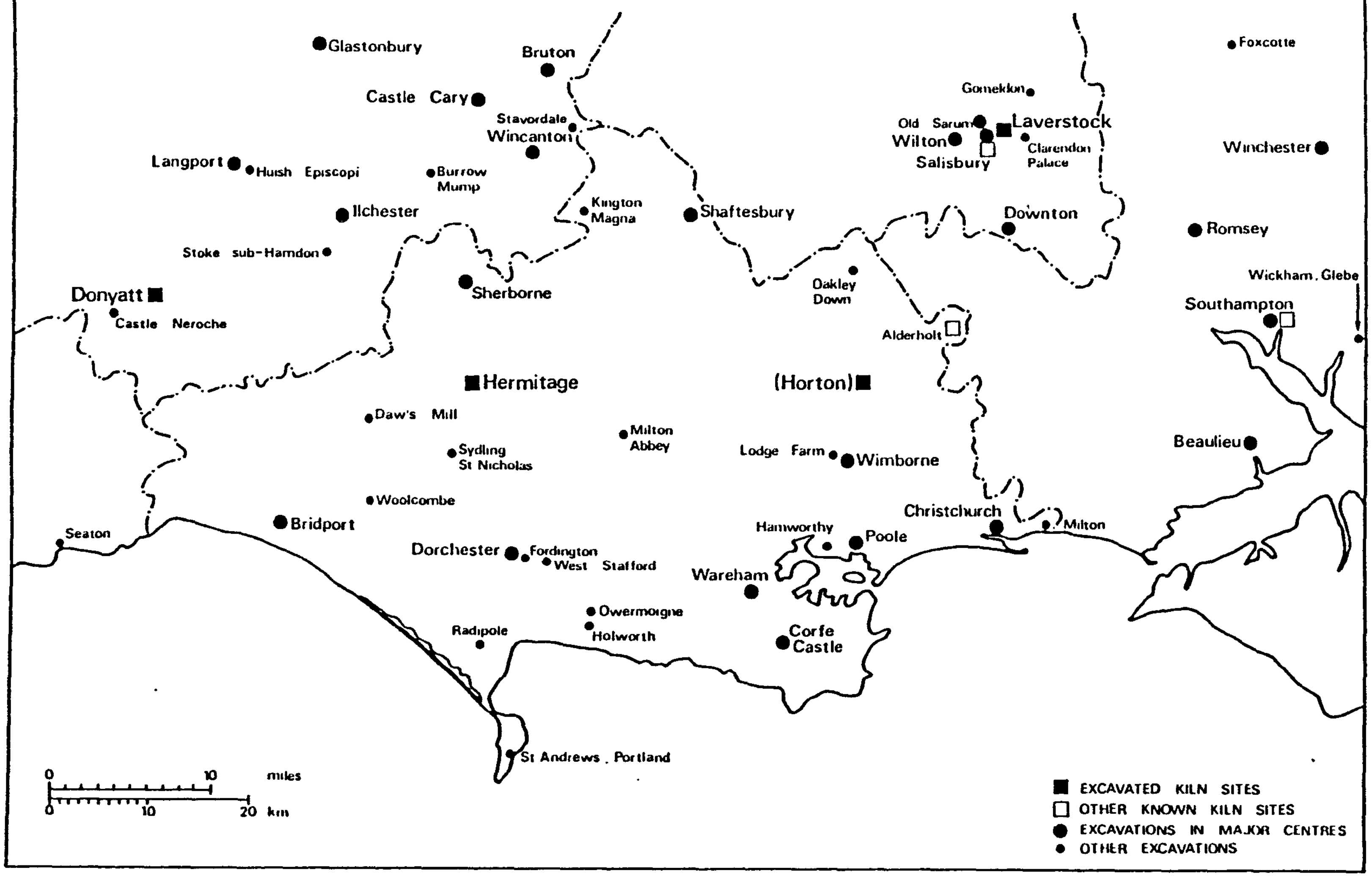
FIGURE 2 2

Major Monastic Settlements and Castles in rural contexts



Location of excavations producing medieval pottery in Dorset and selected sites from the surrounding area

FIGURE 2·3



Location of small medieval pottery collections (fieldwalking, watching brief etc) in Dorset

FIGURE 2 4

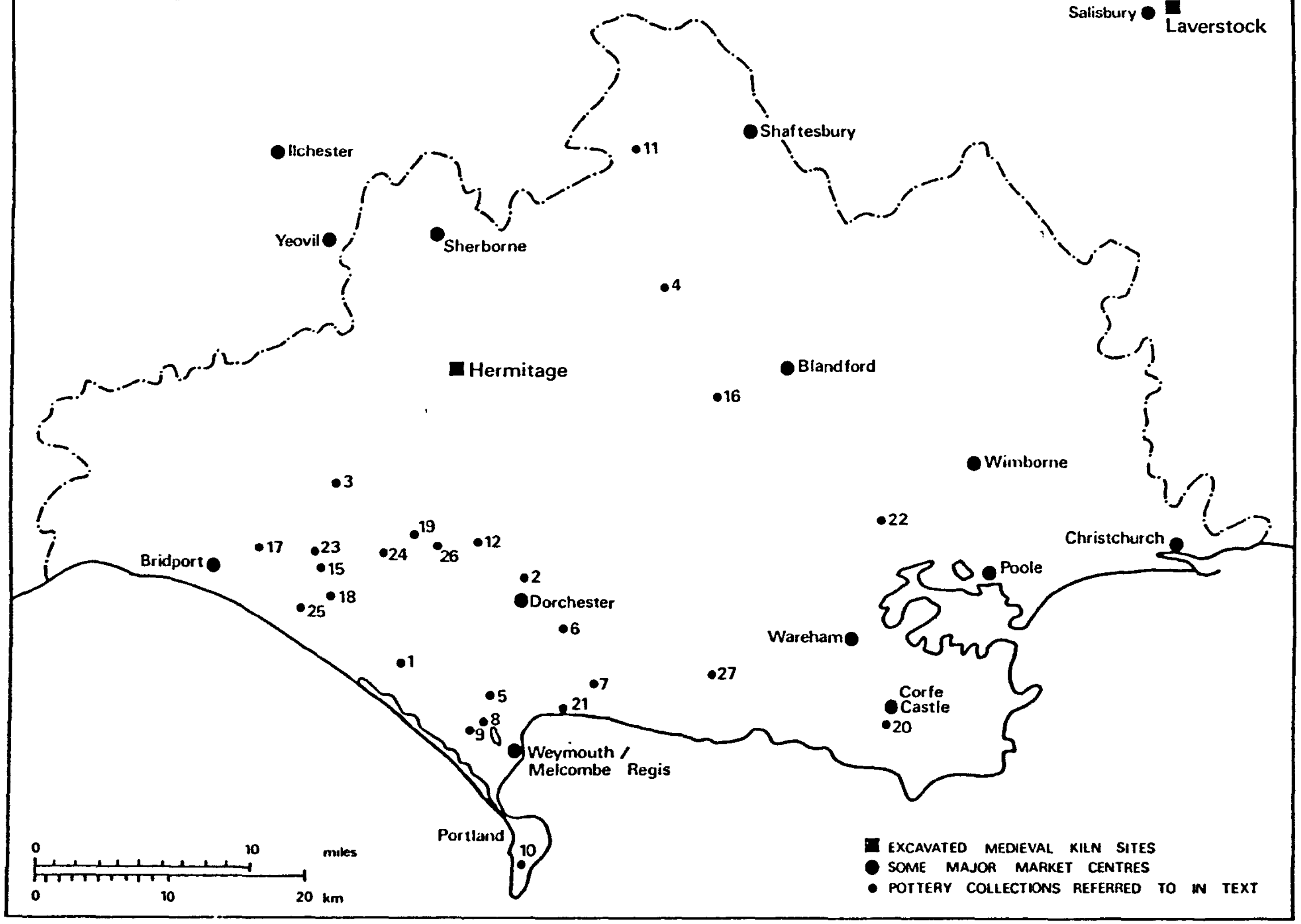
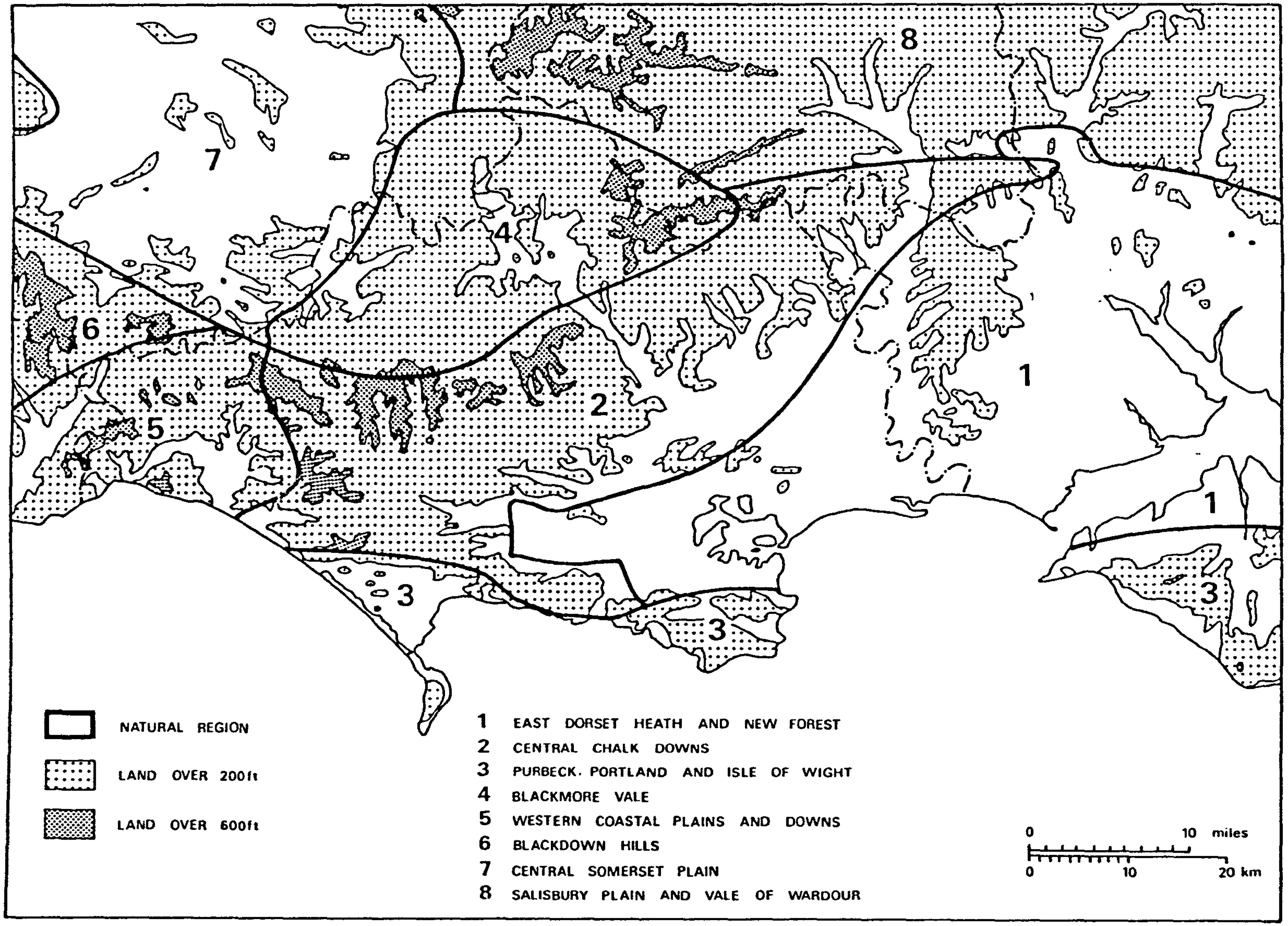


FIGURE 2·5 Natural regions in the study area



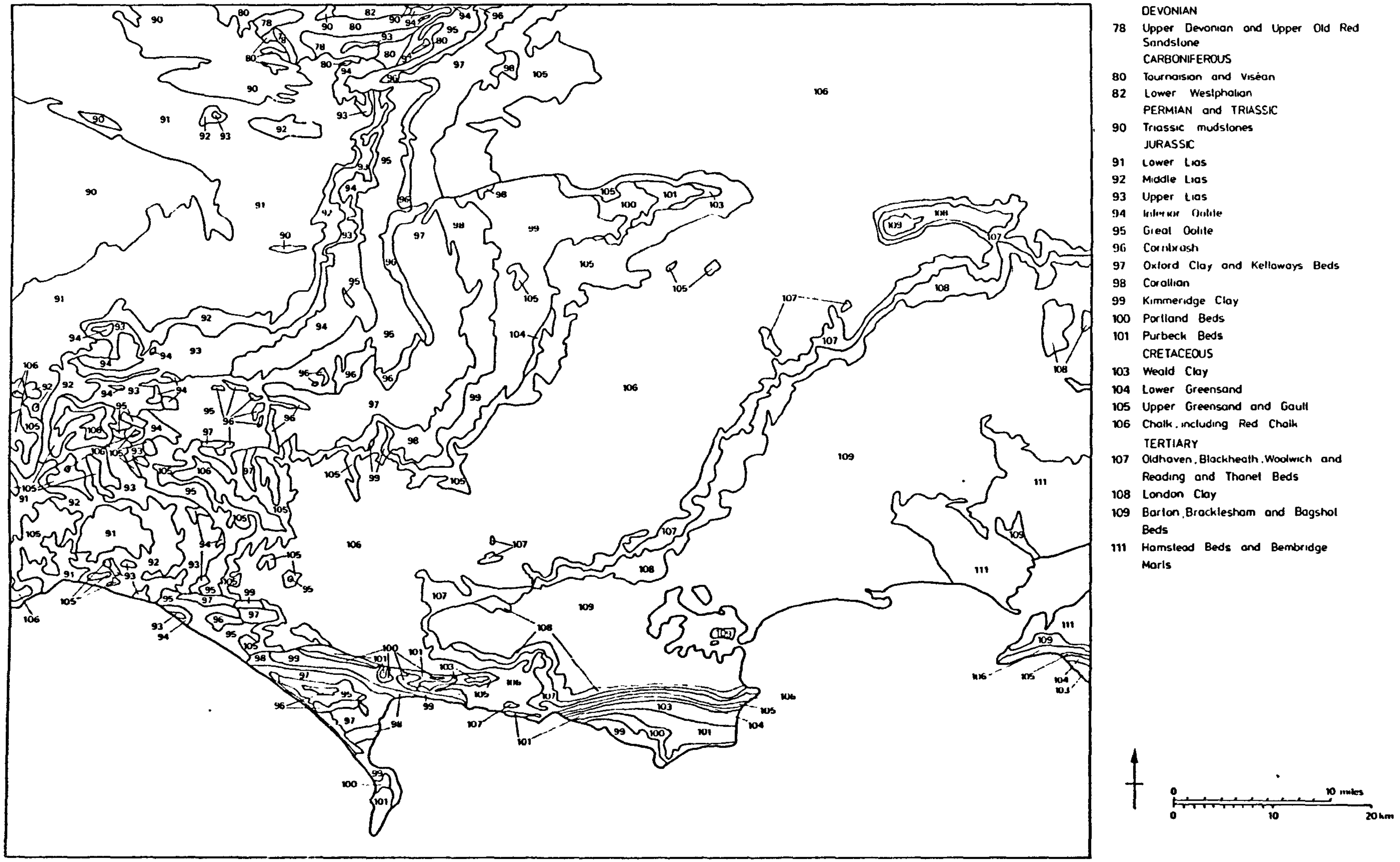
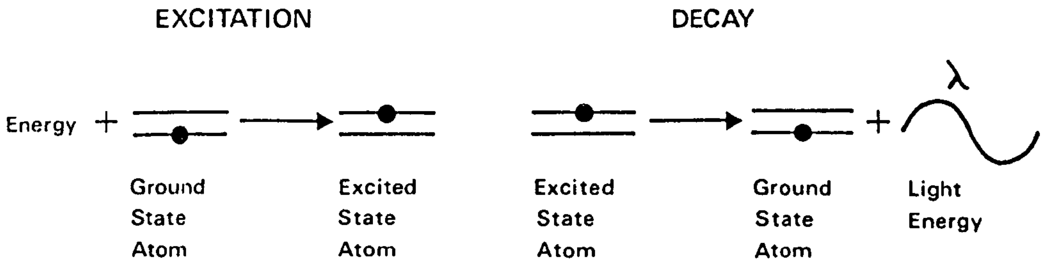


FIGURE 26 Geological map of Wessex (solid).

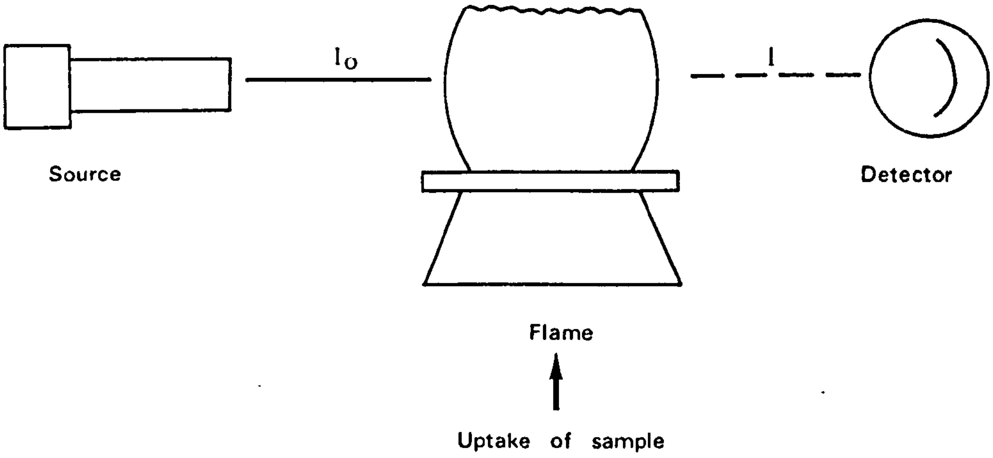
FIGURE 2·7

Collections of medieval pottery selected for study



Excitation and Decay of Free Atoms (after Beaty 1978)

FIGURE 3·1



$T = I/I_0$

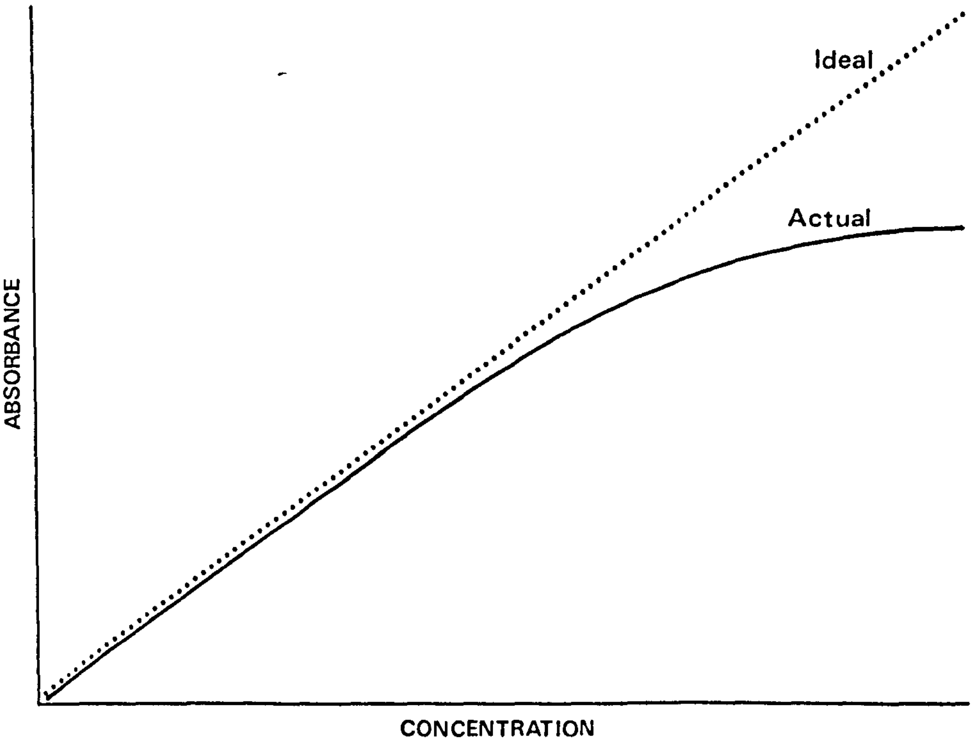
$\%T = 100 \times (I/I_0)$

$\%A = 100 - \%T$

$\text{Absorbance} = \log(I_0/I)$

Diagrammatical Representation of Atomic Absorption (after Beaty 1978)

FIGURE 3 2



Depression of Absorbance away from ideal

FIGURE 3·3

Fig 4.1 Fe vs. Mn concentrations

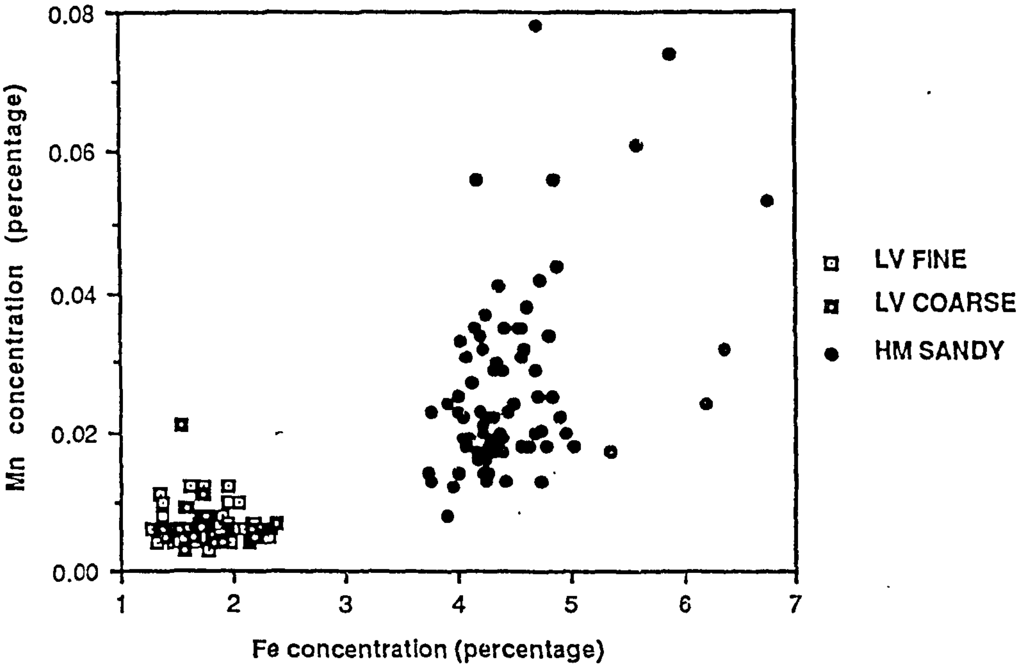


Fig 4.2 Ni vs. Mg concentrations

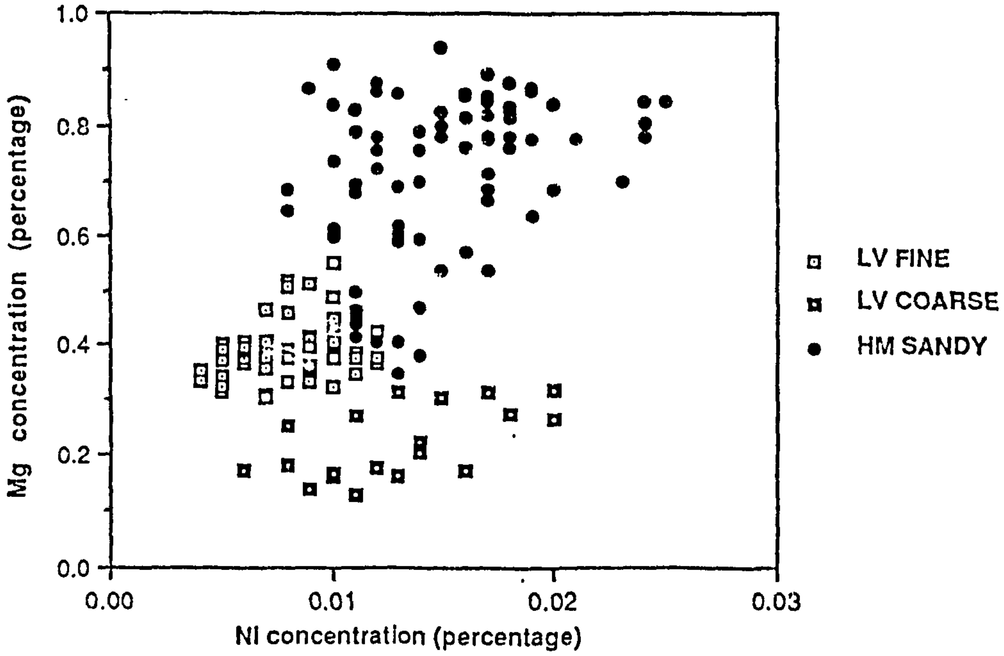


Fig 4.3 Mg vs. Al concentrations

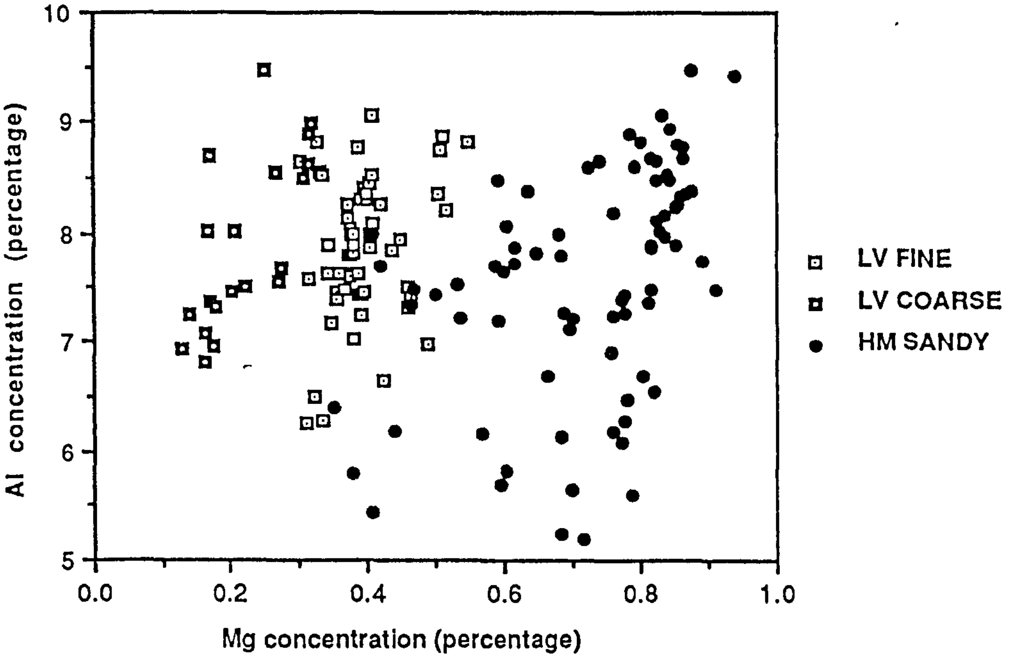


Fig 4.4 Fe vs. Mg concentration

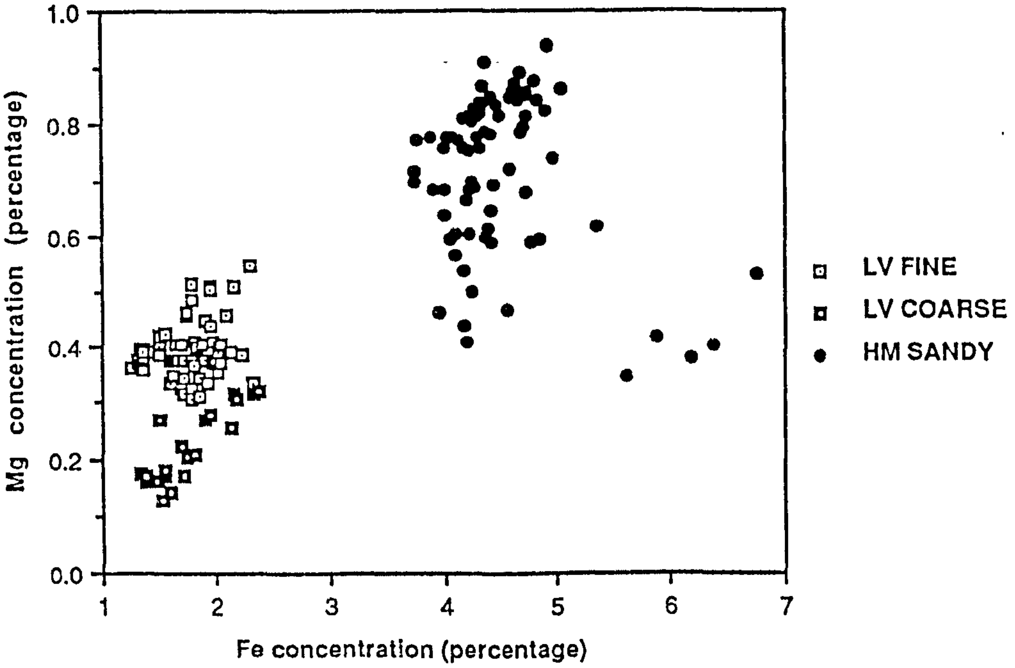


Fig 4.5 Illustrates how cluster analysis, neglecting correlations, overestimates the volume occupied by a group of points

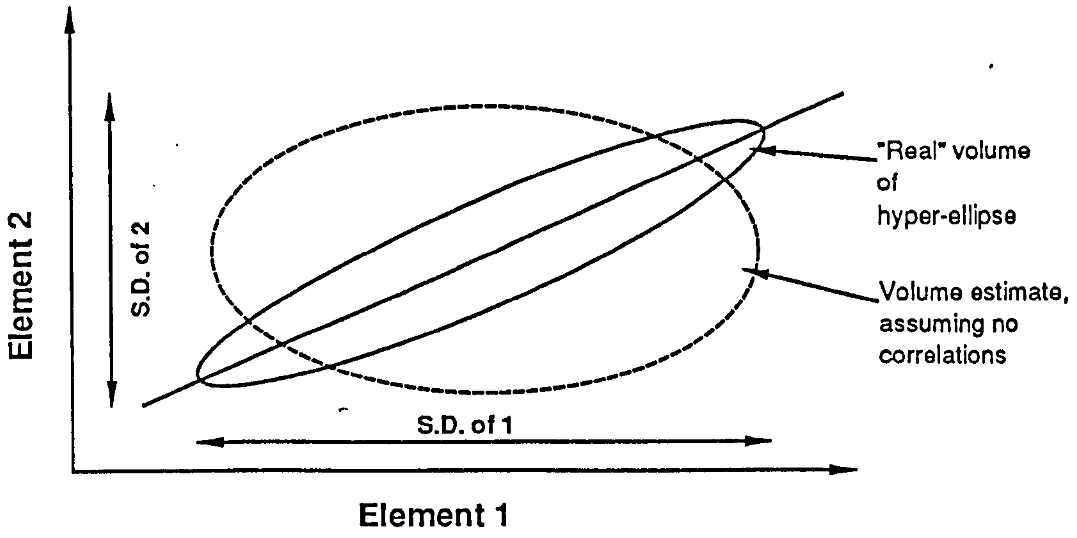
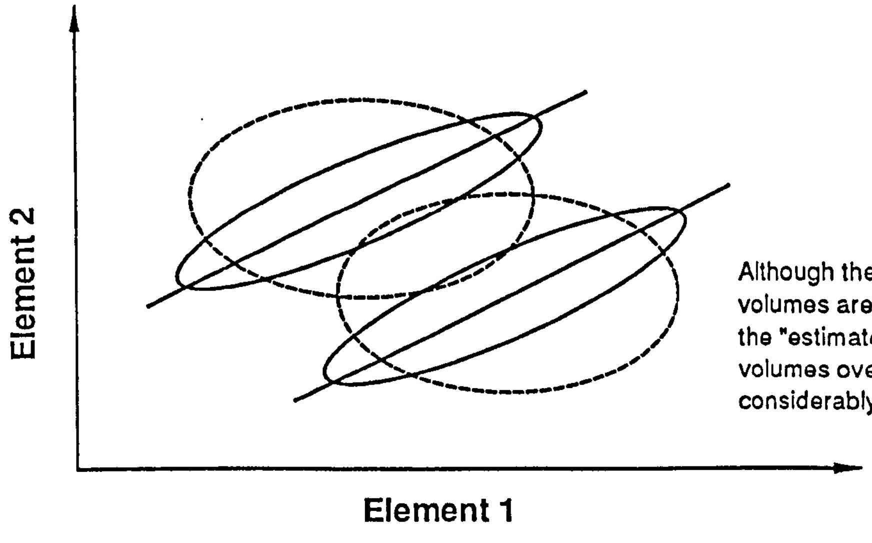


Fig 4.6 Because of neglecting correlations it becomes impossible to separate groups which are close together



Although the "real" volumes are separate, the "estimated" volumes overlap considerably

Figs 4.5 and 4.6 are taken from an unpublished paper by Vince Robinson

Fig 4.7 Graphical explanation of the derivation of principal components from bivariate data.

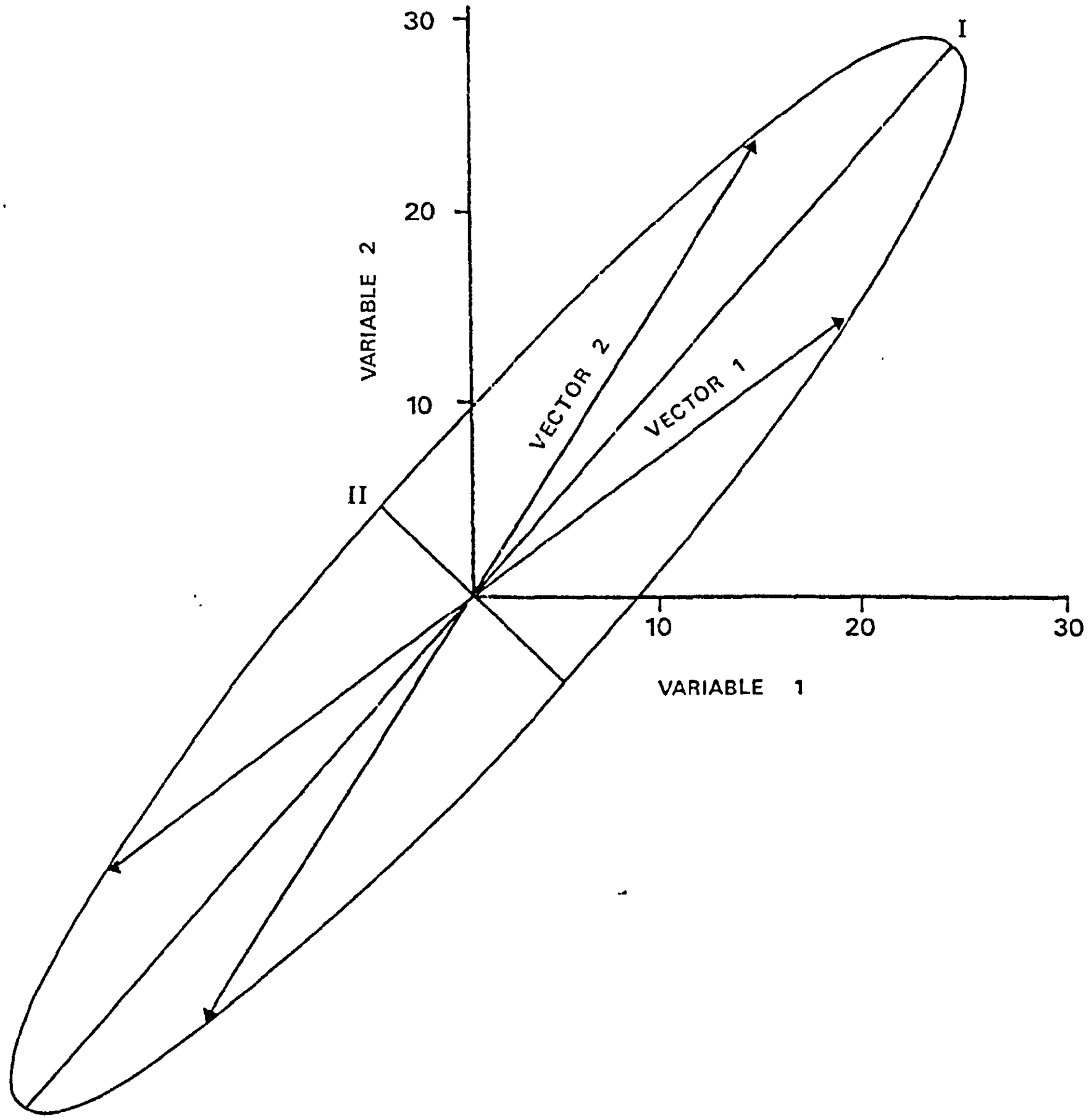


Fig 4.8 Discriminant Analysis using ten elements. One DF defined and plotted as a histogram

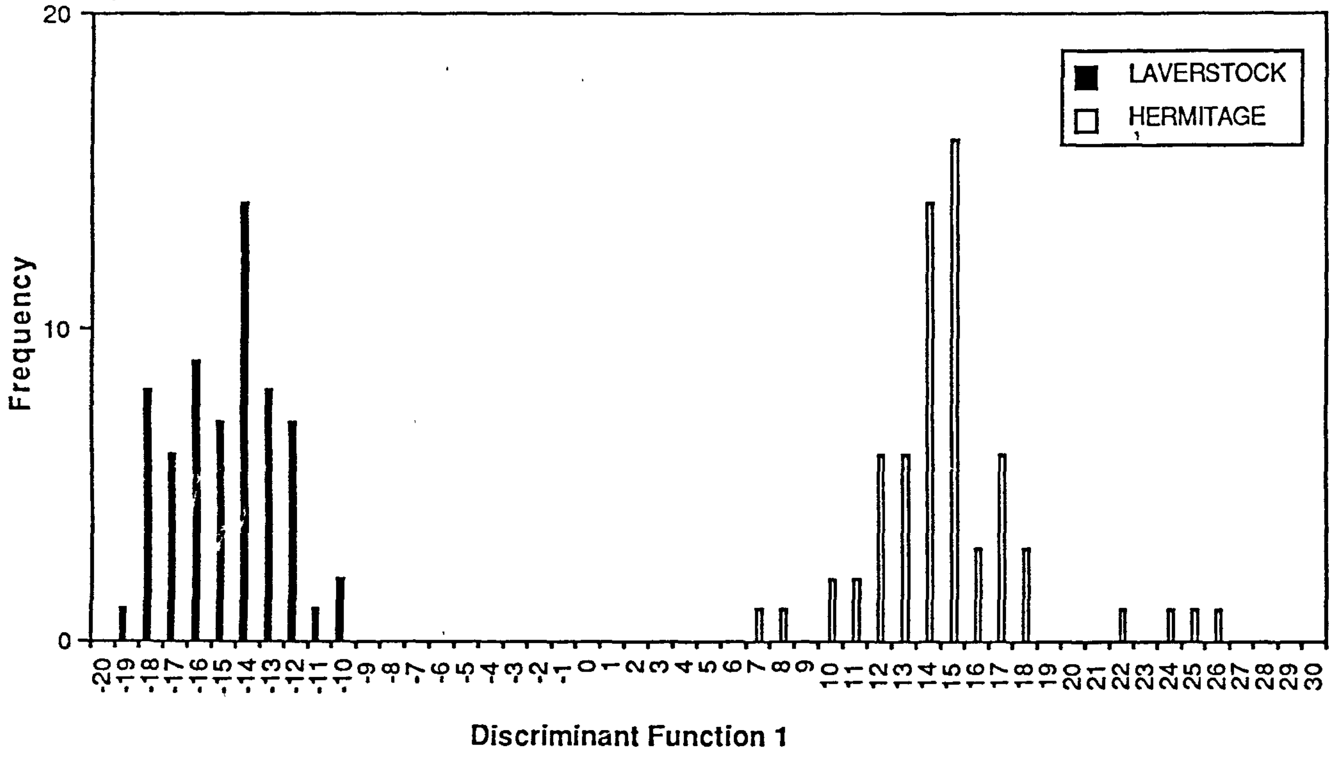


Fig 4.9 Principal components analysis using ten elements. PC1 vs. PC2

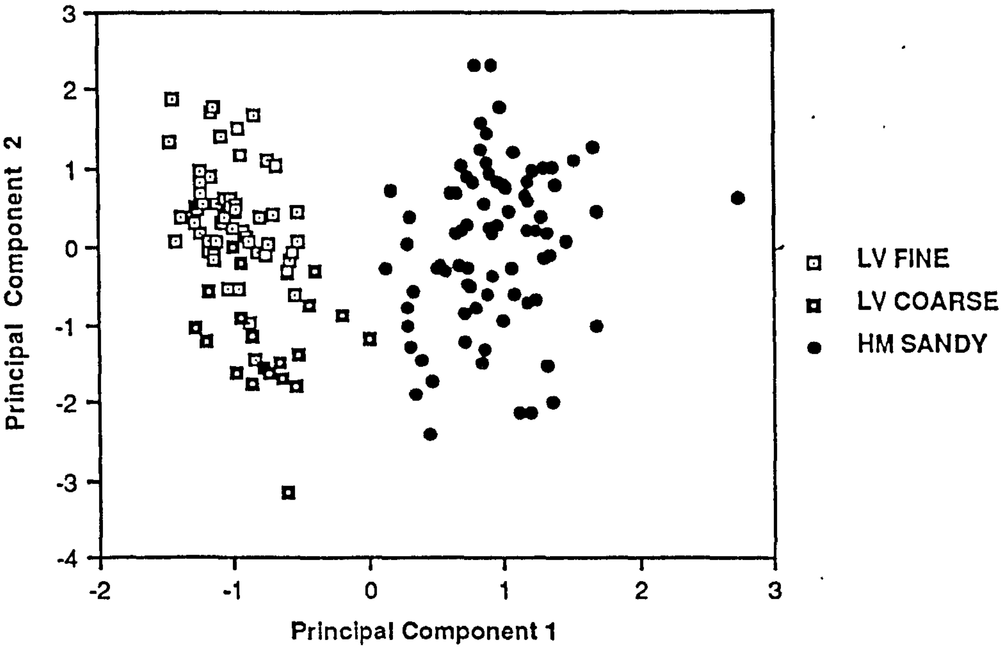


Fig 4.10 Discriminant analysis of kiln 'wares' using ten elements. DF1 vs. DF2

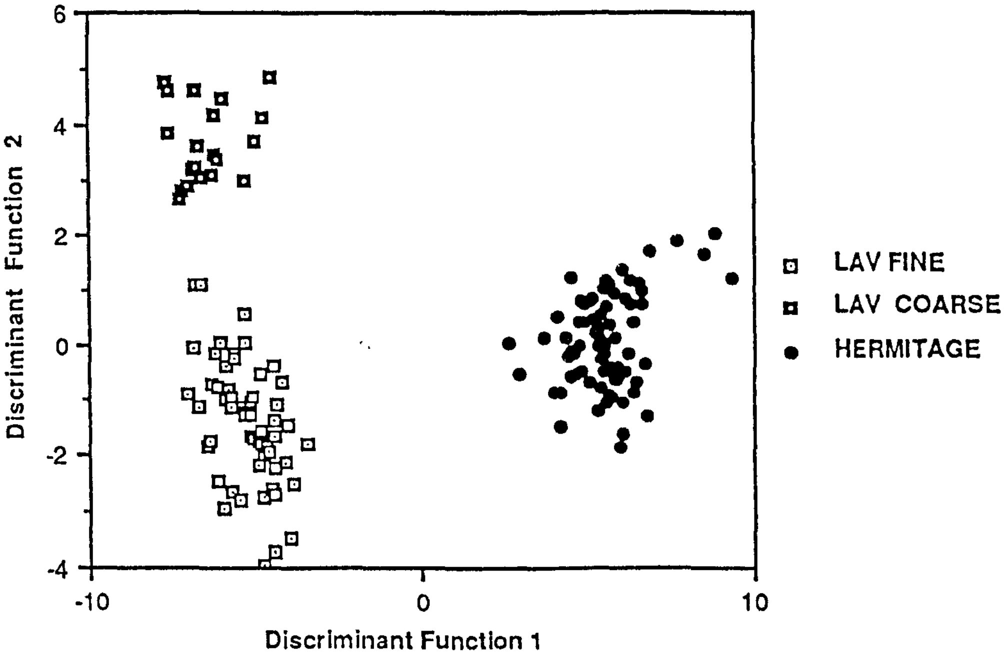


Fig 4.11 Discriminant analysis of 'kilns' using ten elements. DF1 vs. DF2

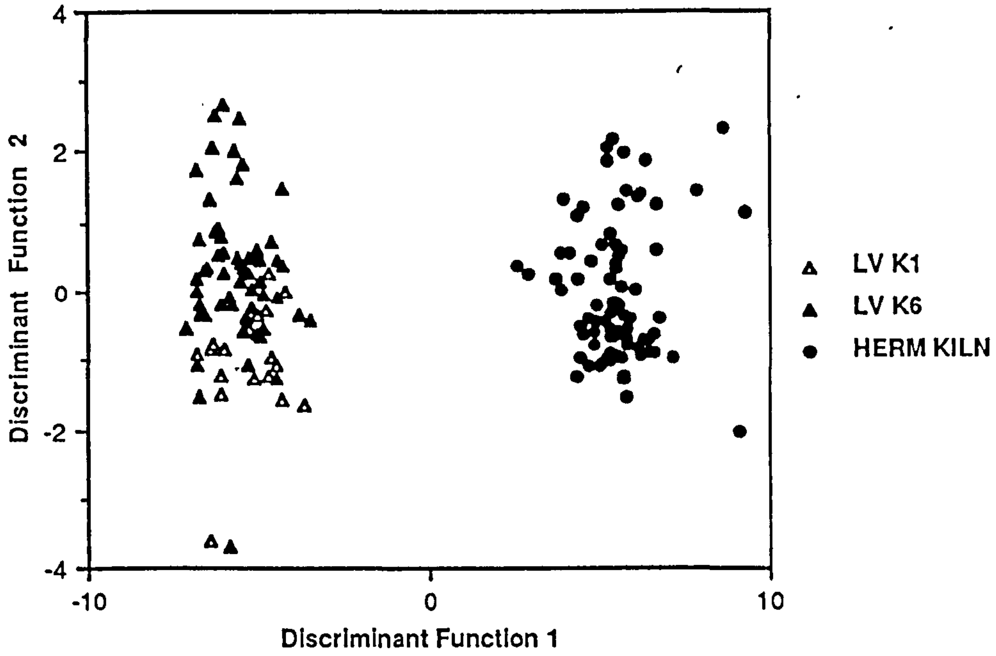


Fig 4.12 Scree plot of eigenvalues for 10 element PCA

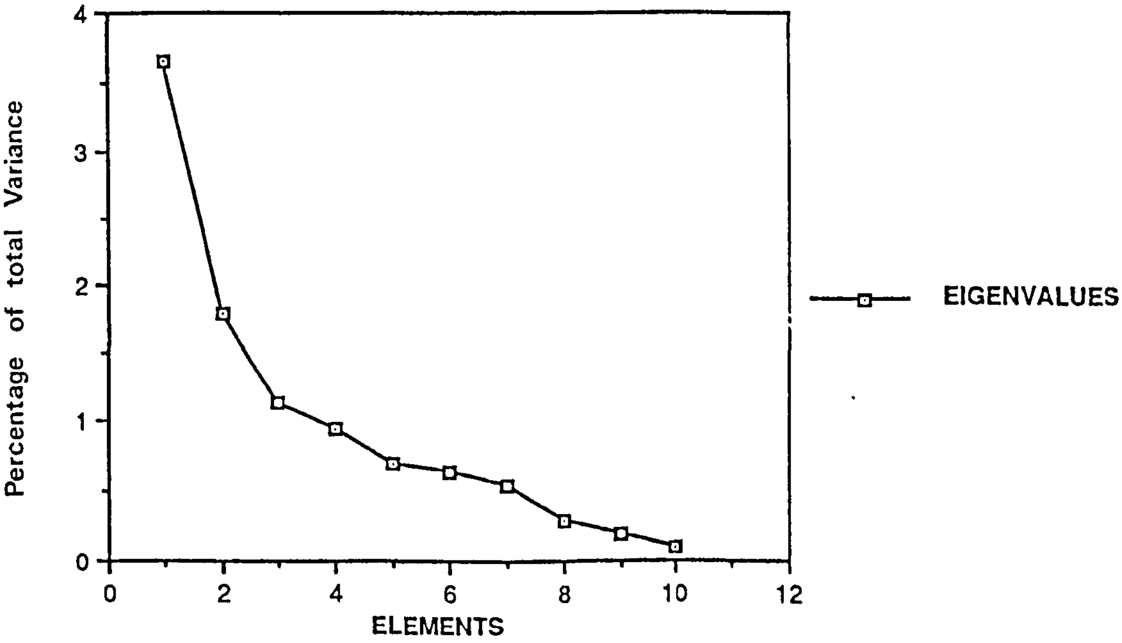


Fig 4.13 Discriminant analysis of 'wares' using four elements. DF1 vs. DF2

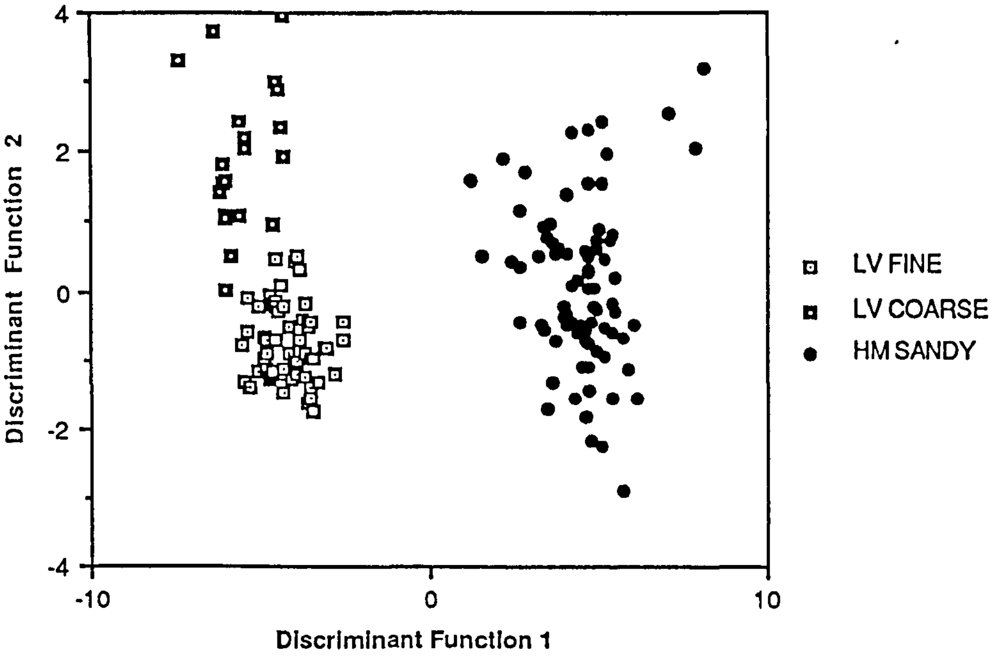


Fig 4.14 Principal components analysis using four elements. PC1 vs. PC3

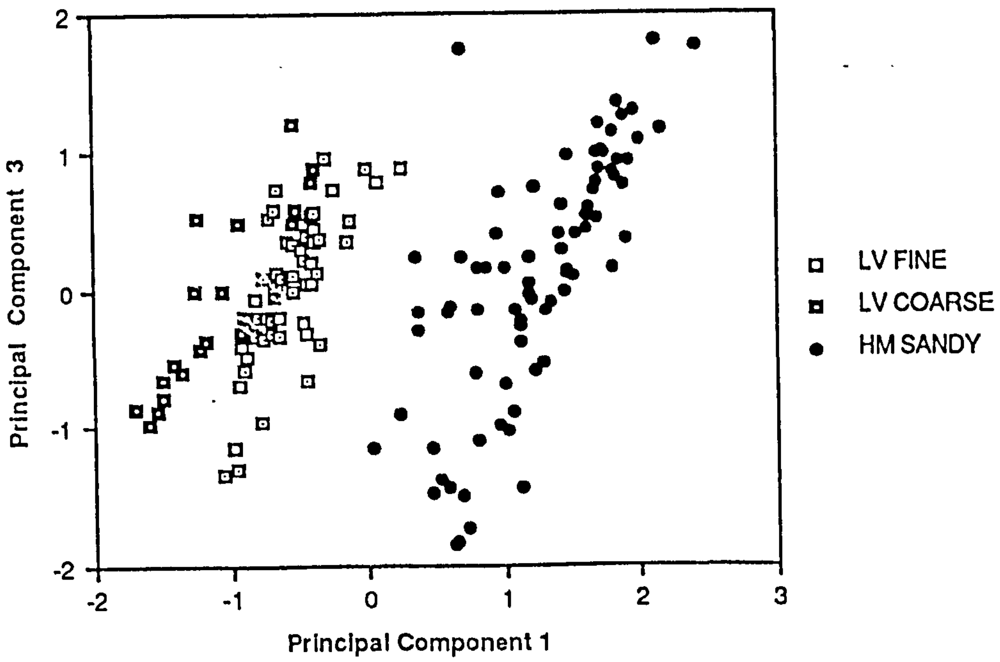
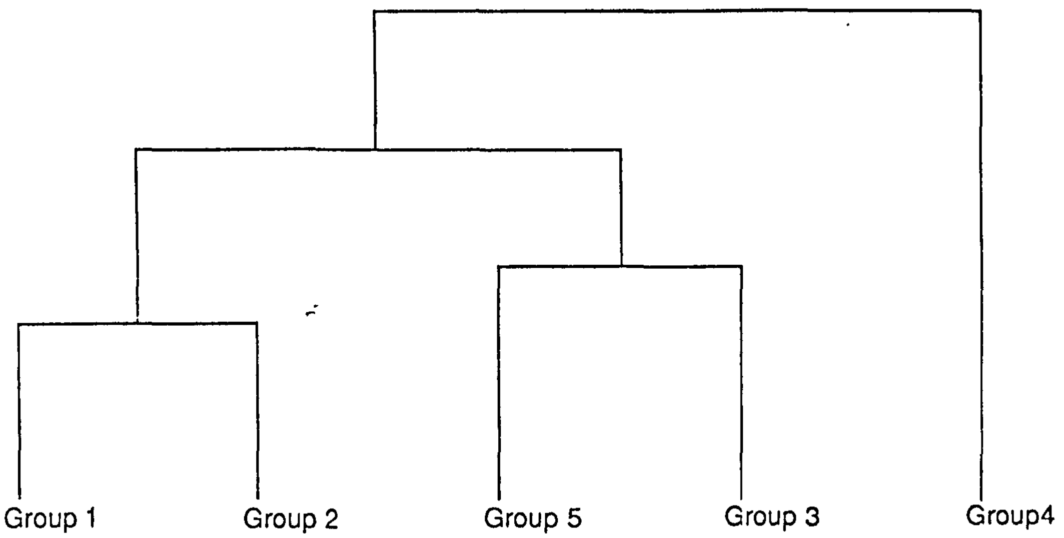


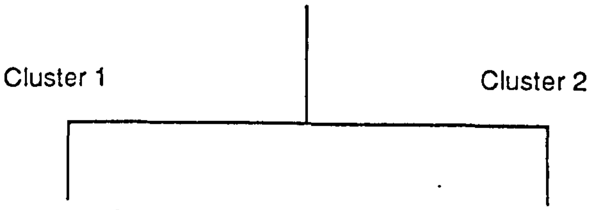
Figure 5.1
Membership of groups at five clusters level using 'Between Groups Average ' method. Data from all sherds analysed.



Group 1	Group 2	Group 5	Group 3	Group4
212 X ware C1	6 X ware C1	2 X ware S1	1 X ware S1	1 X ware
14 X ware C2	40 X ware C2			2 X ware
168 X ware F1	5 X ware F1			1 X ware
1 X ware F2	0 X ware F2			
15 X ware F3	15 X ware F3			
81 X ware F4	2 X ware F4			
5 X ware S1	255 X ware S1			
3 X ware S2	54 X ware S2			
0 X ware S3	10 X ware S3			
10 X ware S4	35 X ware S4			

Figure 5.2

Membership of groups at two clusters level using Ward's method. Data from all sherds analysed.



Cluster 1	Cluster 2
205 X ware C1	14 X ware C1
1 X ware C2	53 X ware C2
137 X ware F1	38 X ware F1
0 X ware F2	1 X ware F2
20 X ware F3	10 X ware F3
91 X ware F4	1 X ware F4
5 X ware S1	258 X ware S1
3 X ware S2	54 X ware S2
0 X ware S3	10 X ware S3
13 X ware S4	32 X ware S4

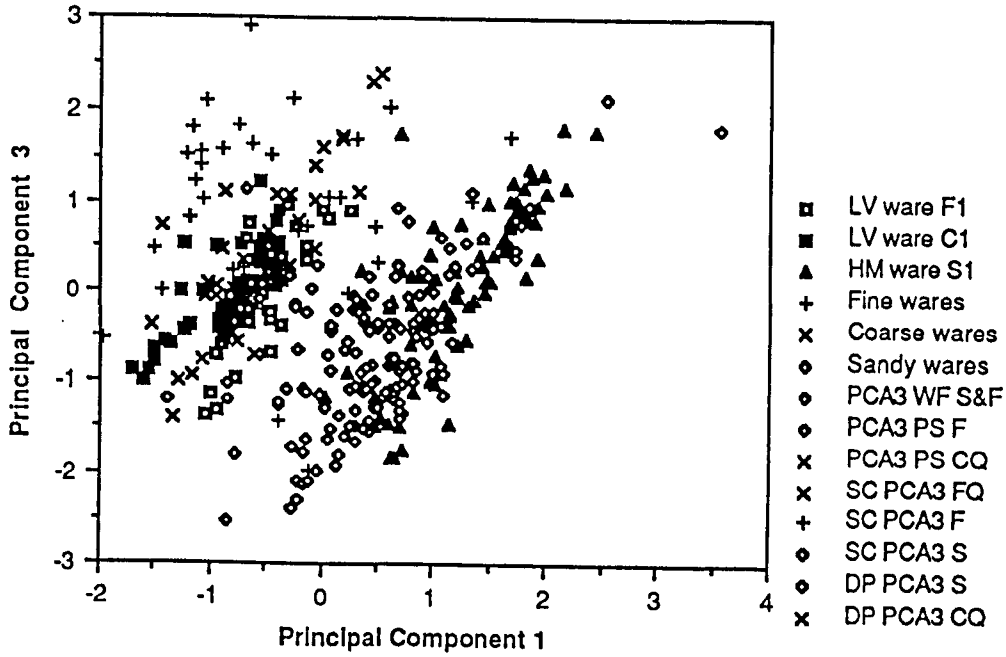

Scatterplot of Laverstock and Hermitage wasters and sherds from five sites. Principal components derived from all sites data

Figure 5.3

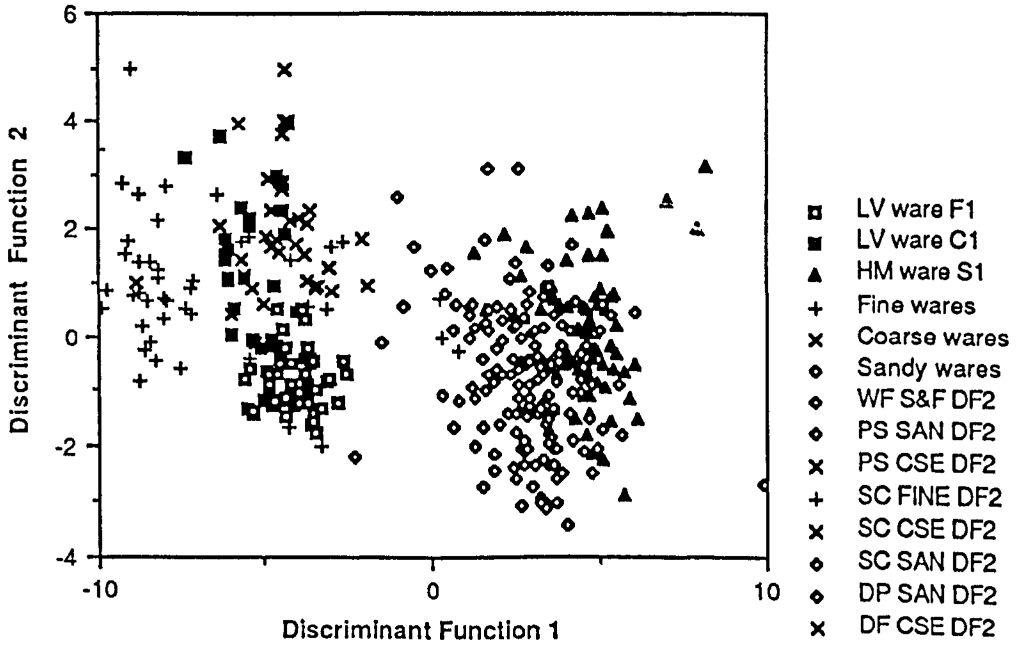
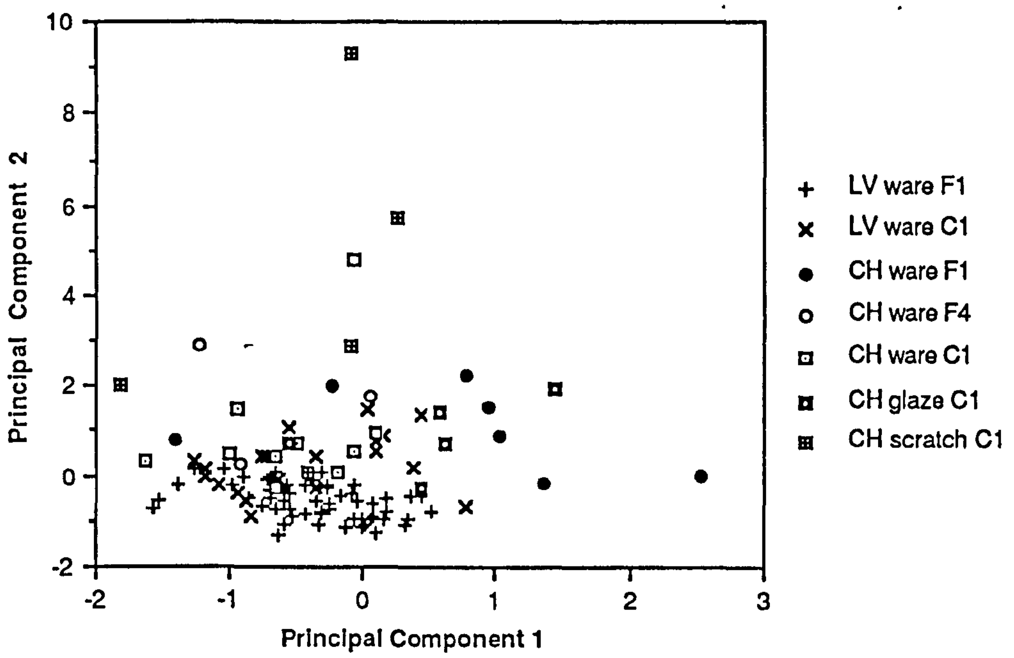
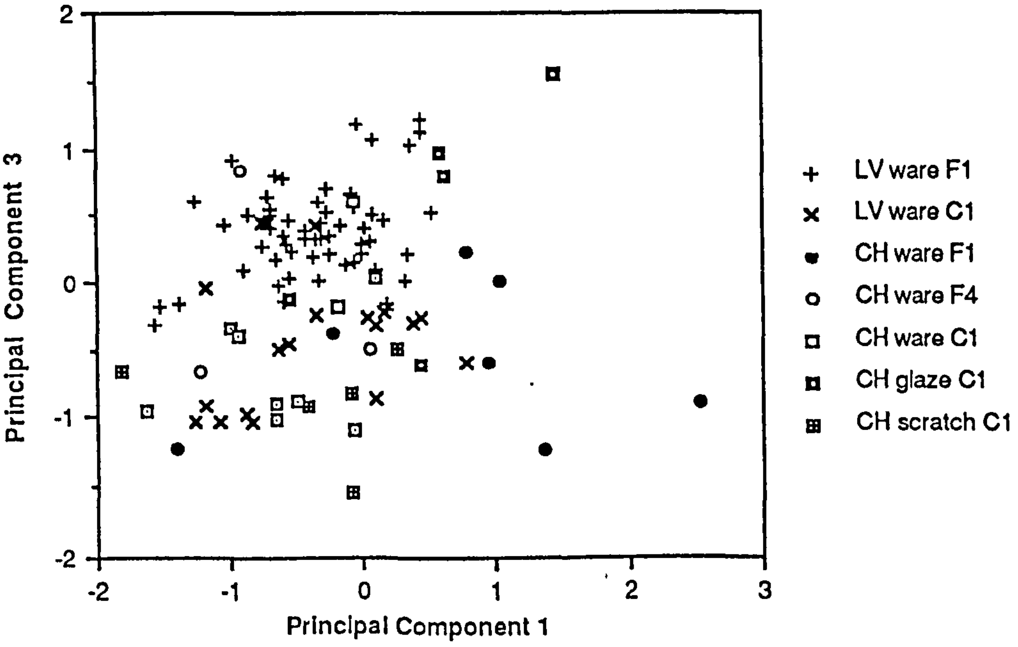

Discriminant functions derived to separate Laverstock and Hermitage wasters. Sherds of three ware groupings from five sites added as 'unknowns'.

Figure 5.4



Scatterplot of Laverstock and Christchurch coarse and fine wares.
Principal components derived from fine & coarse wares data.

Figure 5.5



Scatterplot of Laverstock and Christchurch coarse & fine wares.
Principal components derived from coarse & fine wares data.

Figure 5.6

Discriminant functions derived to separate Laverstock products and Southampton sherds. CH sherds added as 'unknowns'.

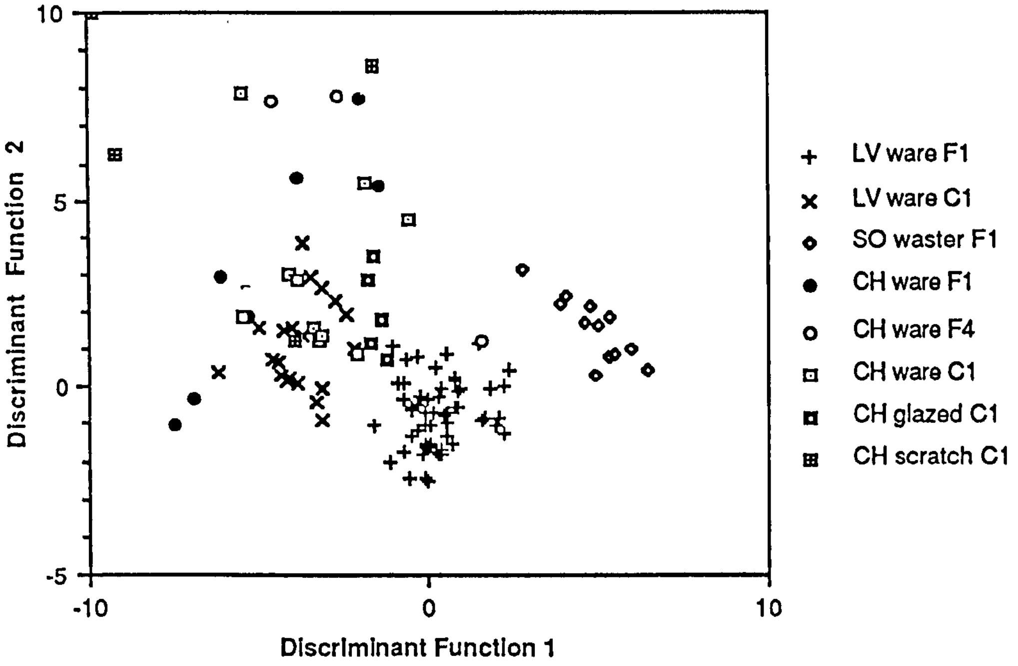


Figure 5.7

Scatterplot of Hermitage, Yondover and Compton Valence sherds. Principal components derived from sandy wares data.

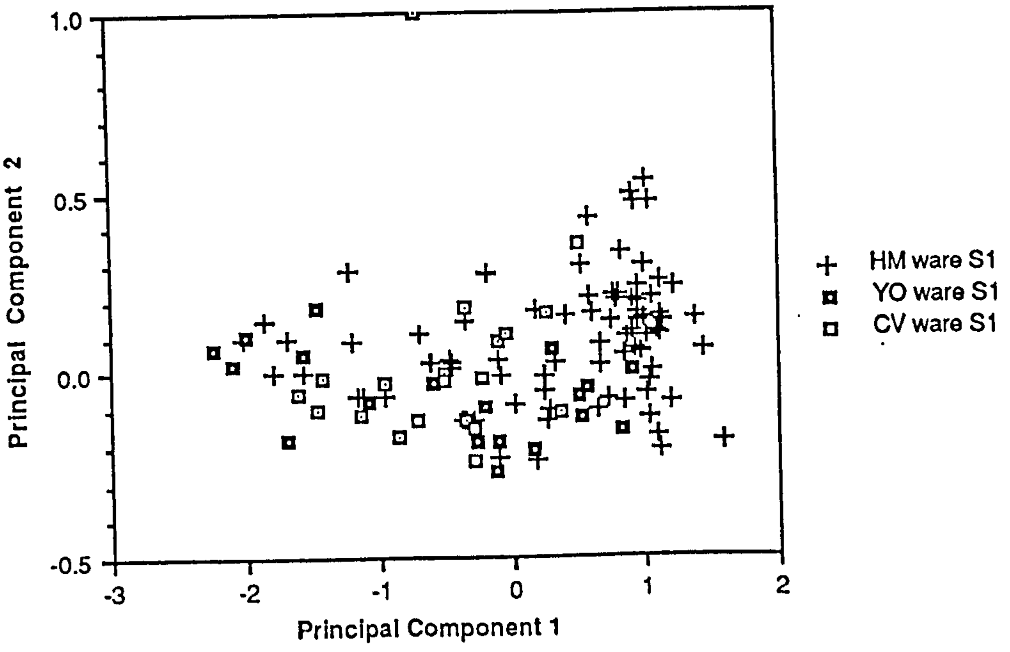


Figure 5.8

Scatterplot of Hermitage, Yondover and Compton Valence sherds. Principal components derived from sandy wares data.

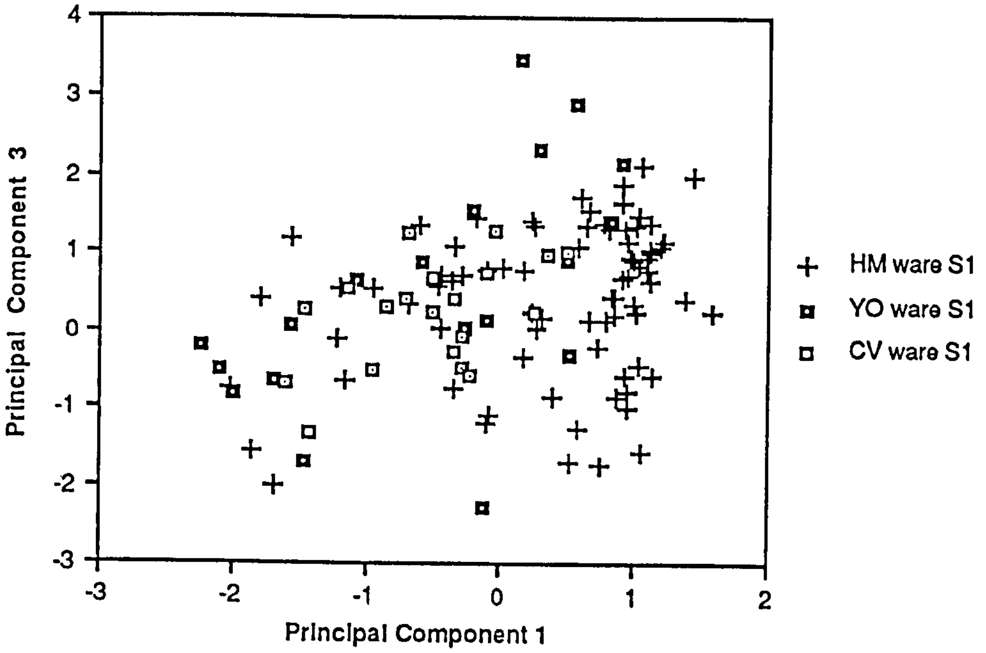


Figure 5.9

Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. YO and CV sherds added as 'unknowns'.

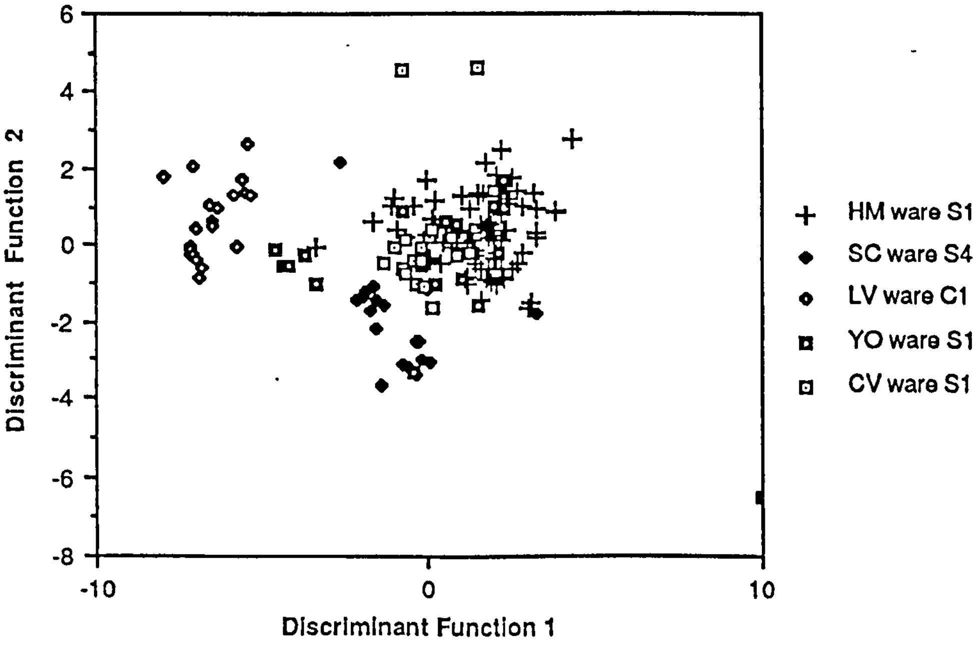


Figure 5.10

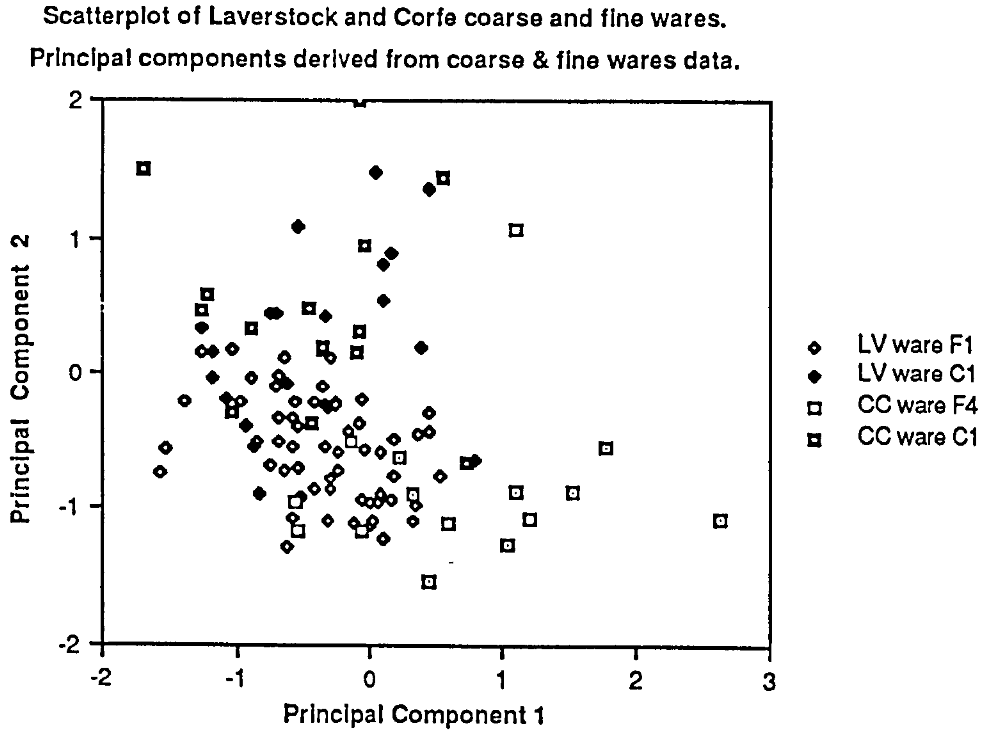


Figure 5.11

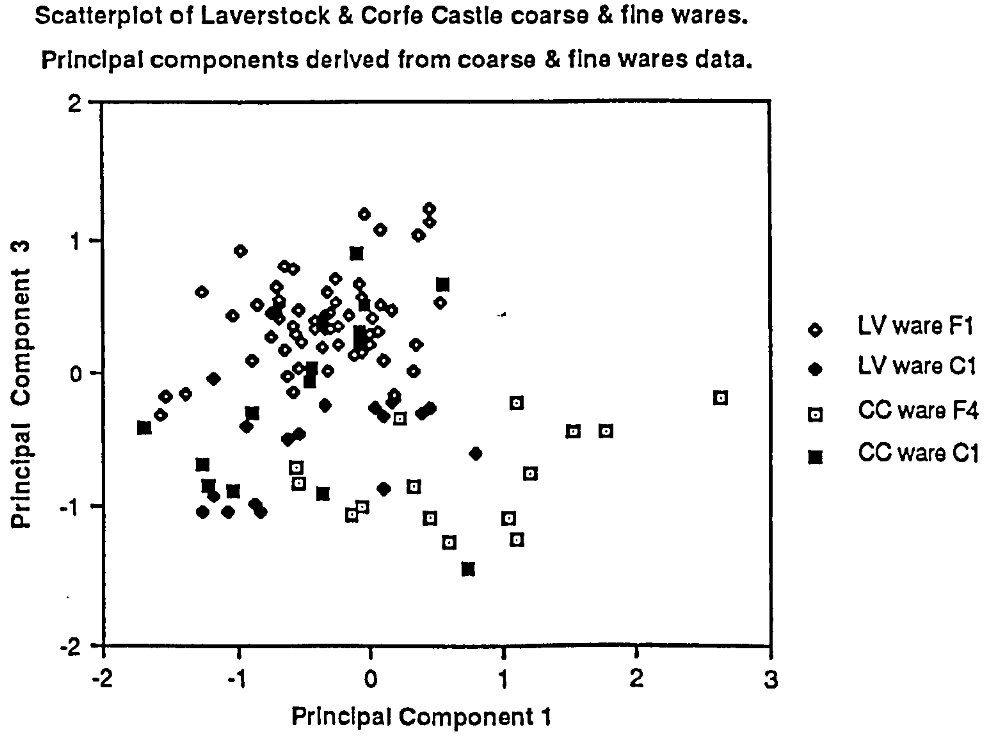


Figure 5.12

Discriminant functions derived to separate Laverstock products and Southampton wasters. CC sherds added as 'unknowns'.

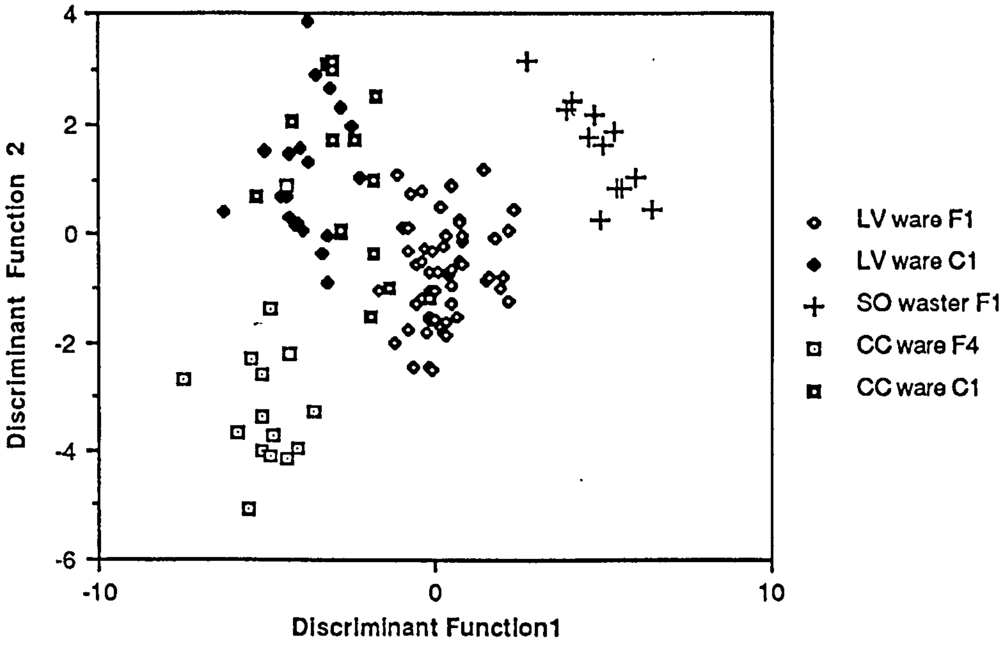


Figure 5.13

Scatterplot of Laverstock, Dorchester and Portland coarse wares. Principal components derived from fine and coarse wares data.

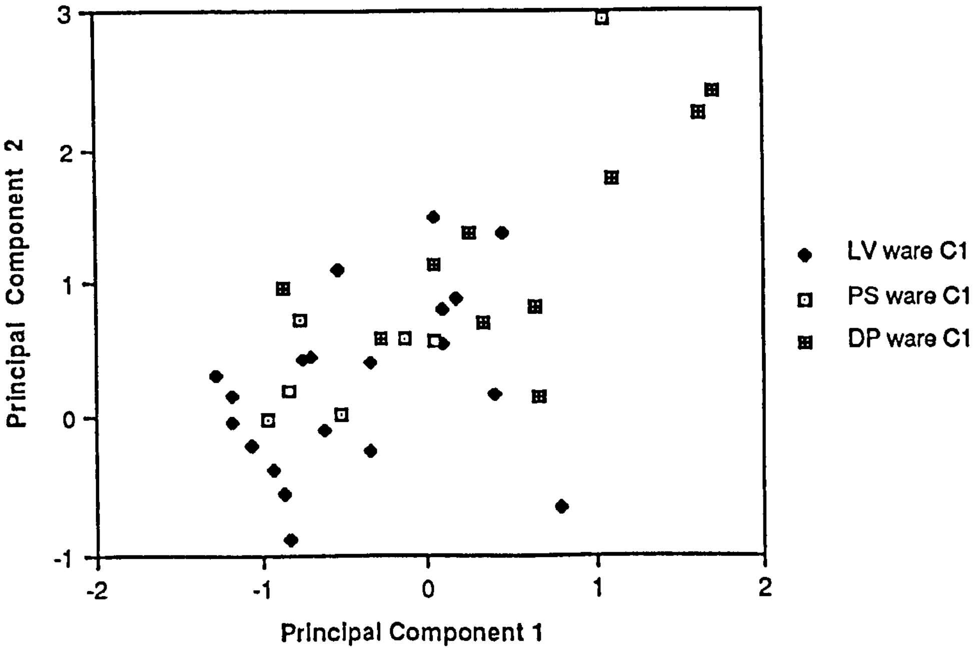


Figure 5.14

Scatterplot of Laverstock, Dorchester and Portland coarse wares. Principal components derived from coarse & fine wares data.

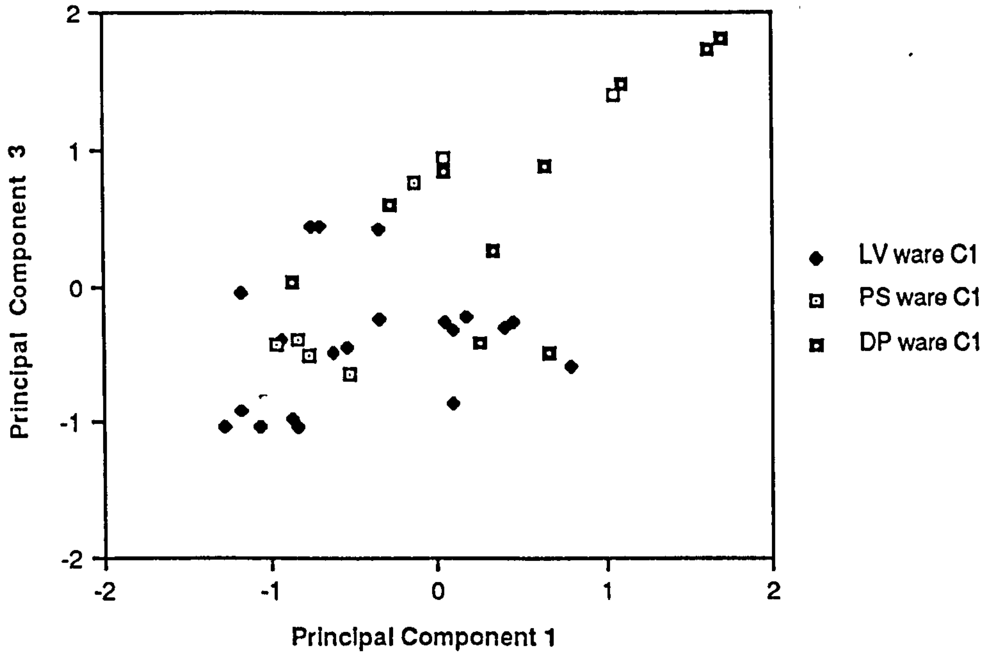


Figure 5.15

Discriminant functions derived to separate Laverstock products and Southampton wasters. PS & DP sherds added as 'unknowns'.

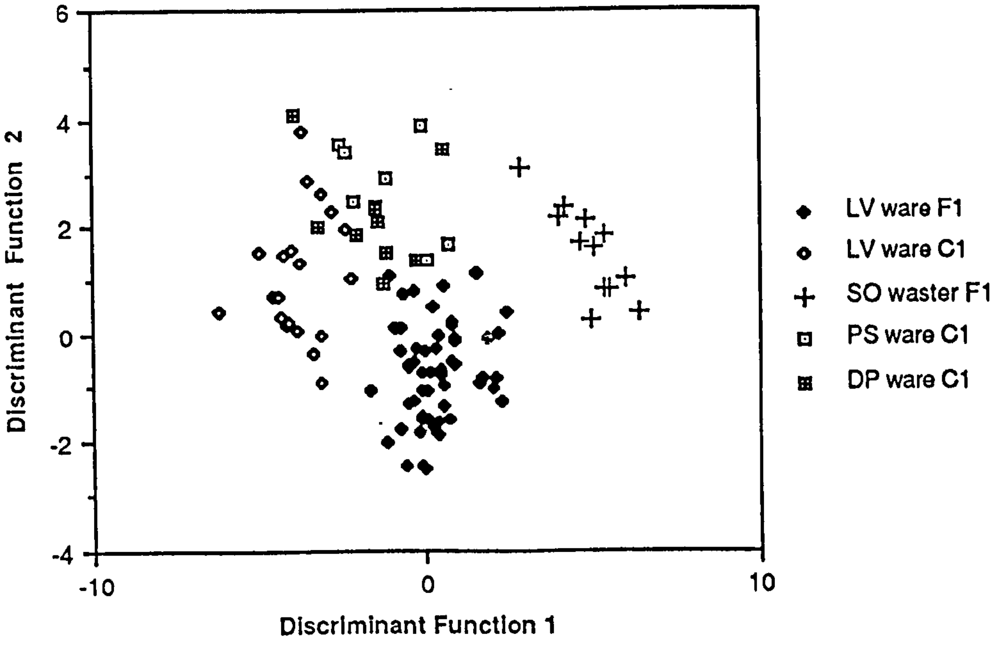


Figure 5.16

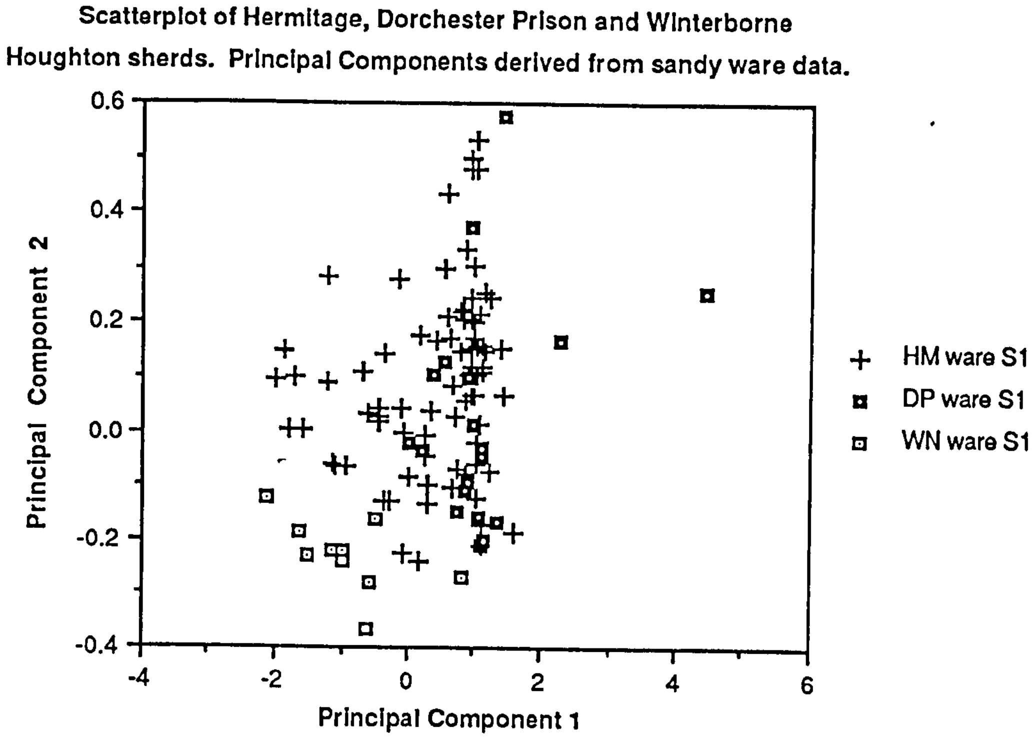


Figure 5.17

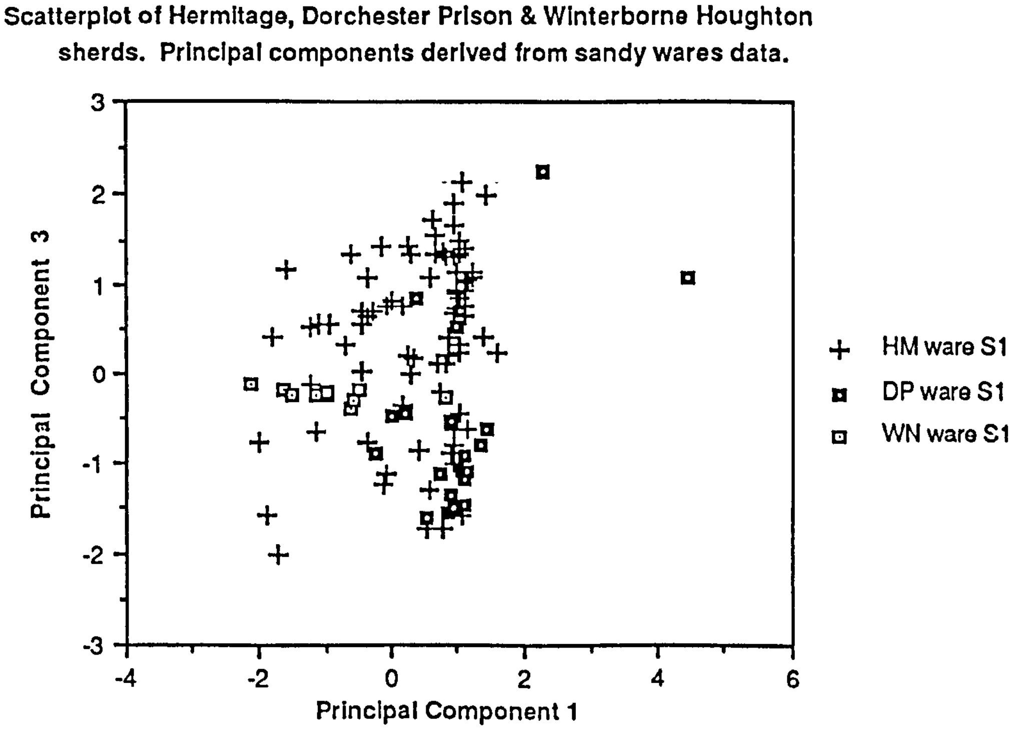
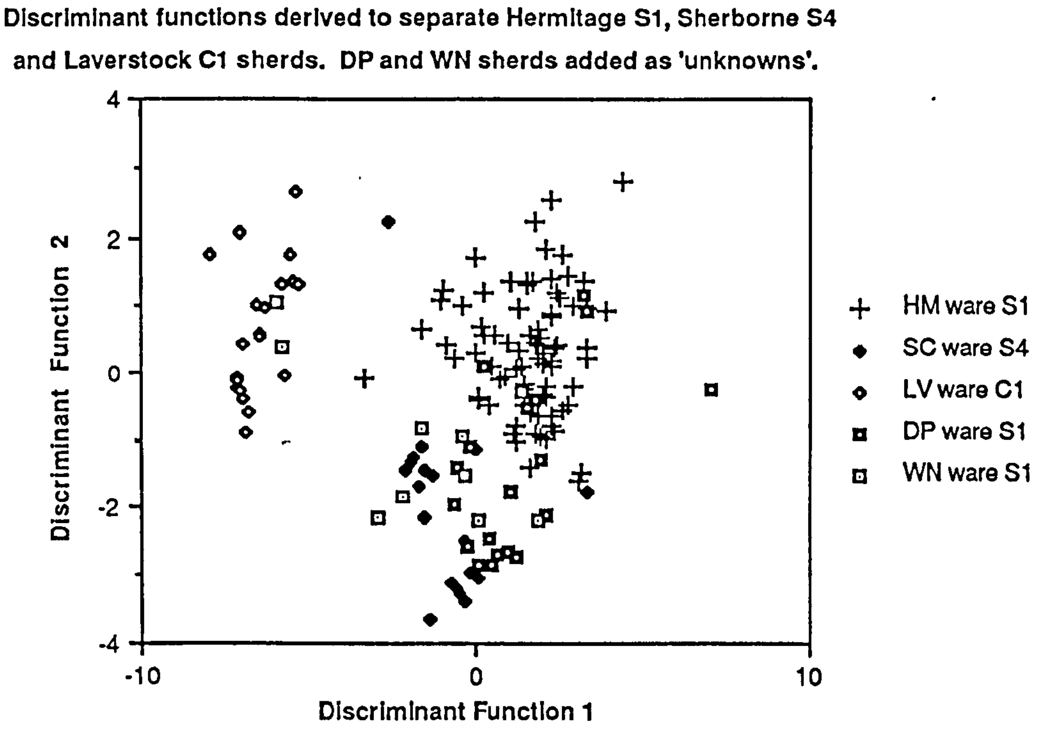
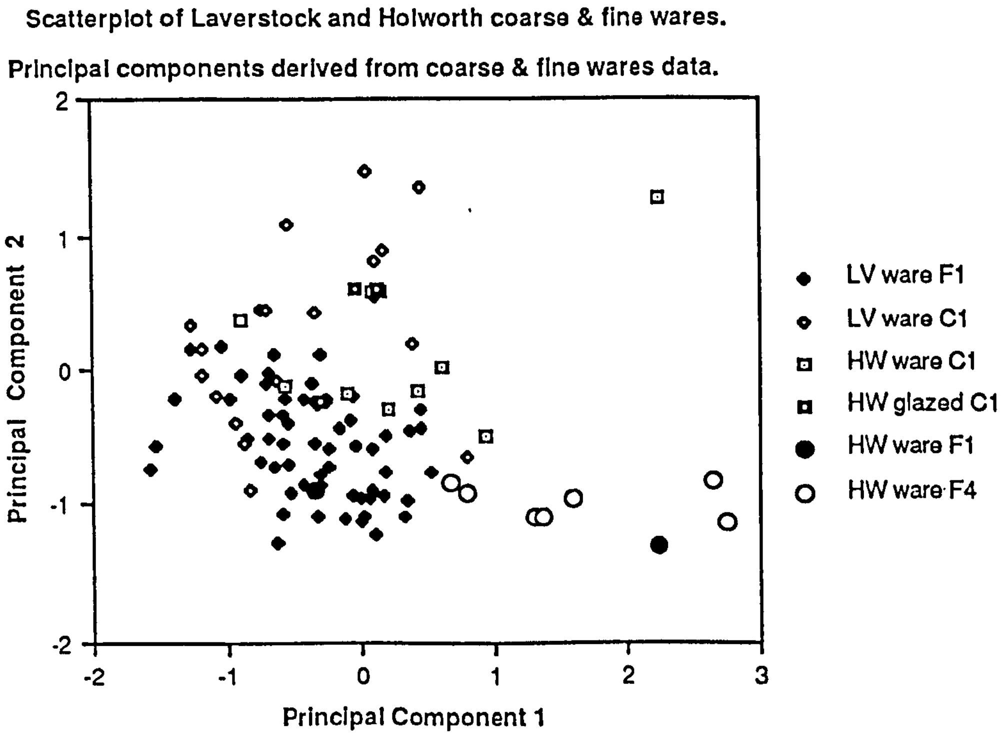


Figure 5.18



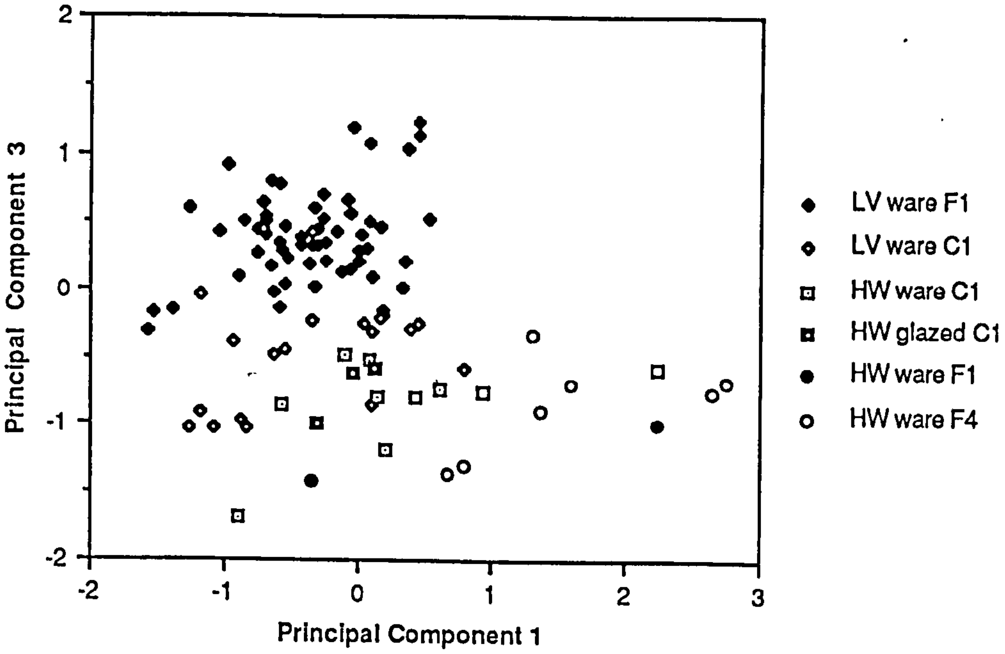
Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. DP and WN sherds added as 'unknowns'.

Figure 5.19



Scatterplot of Laverstock and Holworth coarse & fine wares. Principal components derived from coarse & fine wares data.

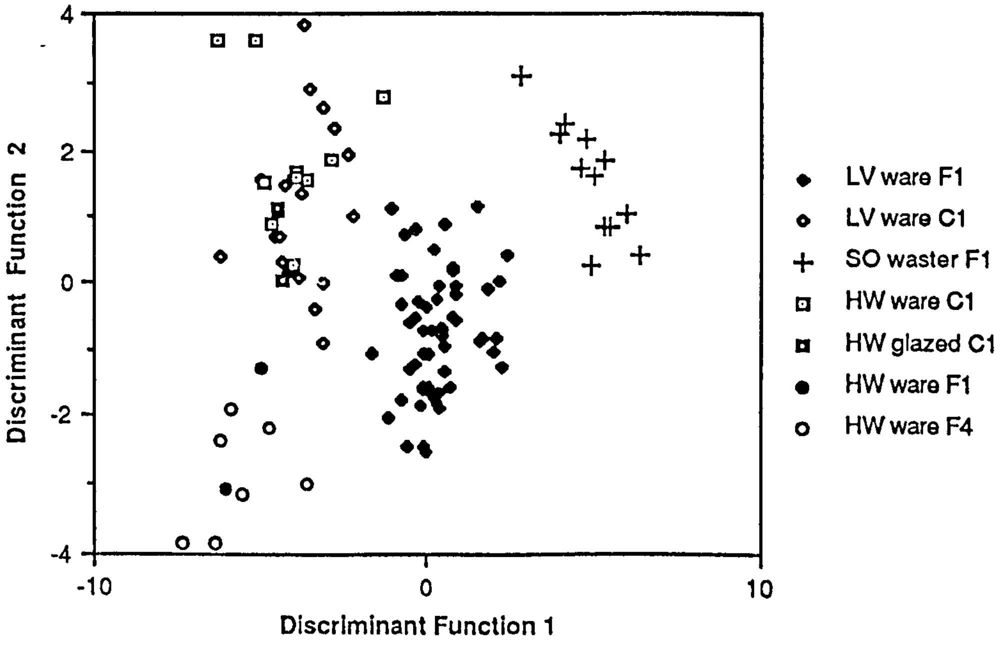
Figure 5.20



Scatterplot of Laverstock and Holworth coarse & fine wares.

Principal components derived from coarse & fine wares data.

Figure 5.21



Discriminant functions derived to separate Laverstock products and Southampton wasters. HW sherds added as 'unknowns'.

Figure 5.22

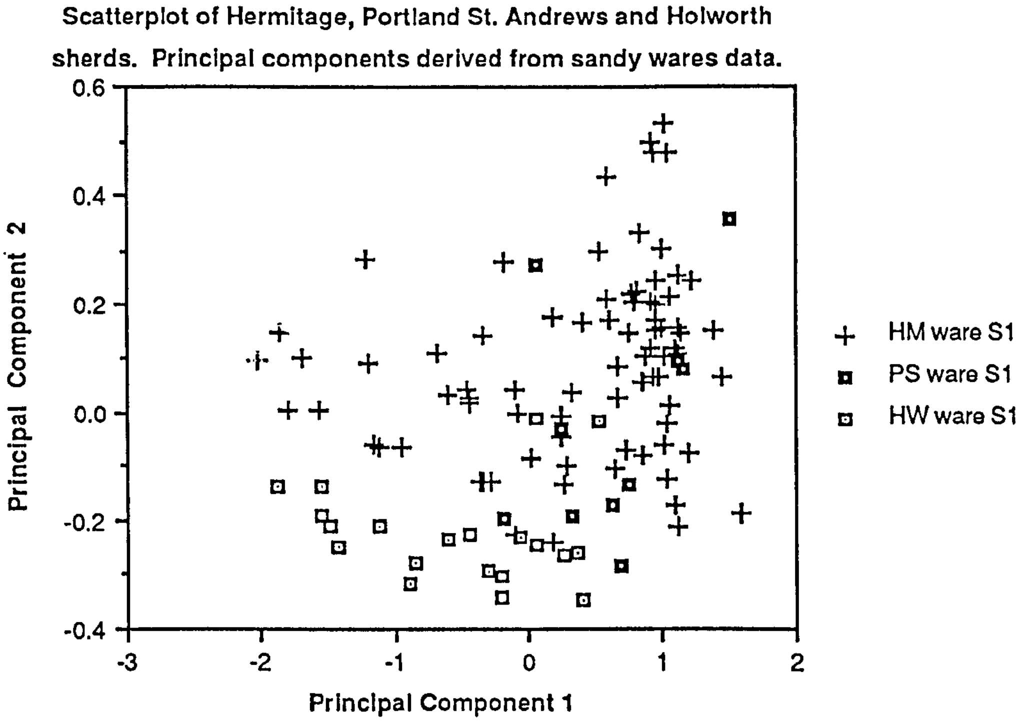


Figure 5.23

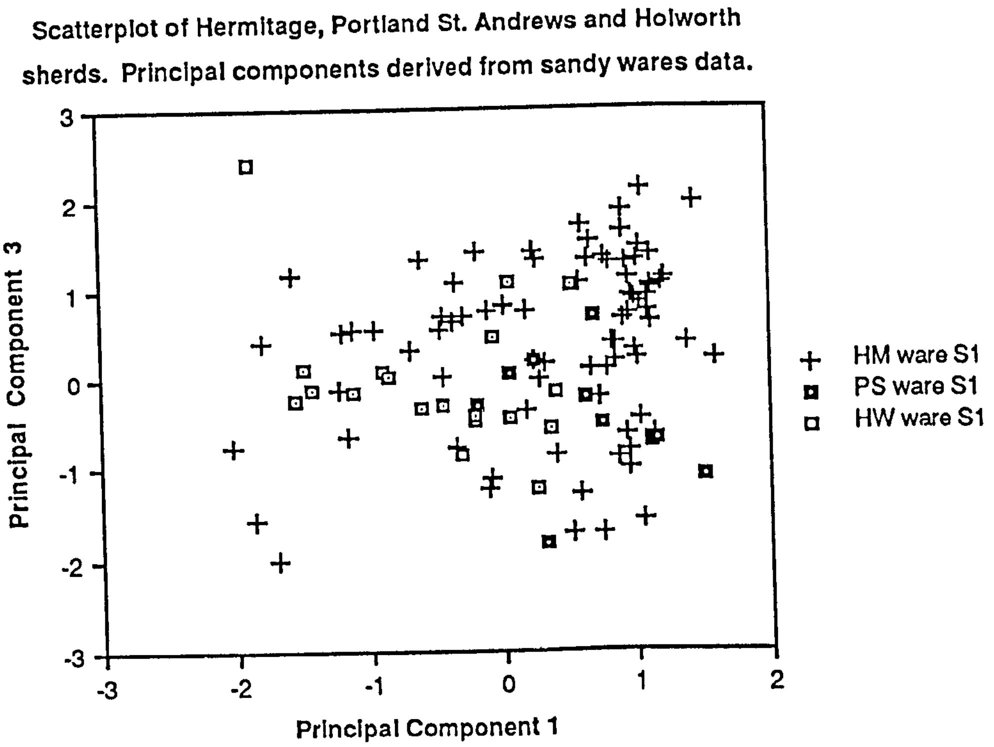


Figure 5.24

Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. PS & HW sherds added as 'unknowns'.

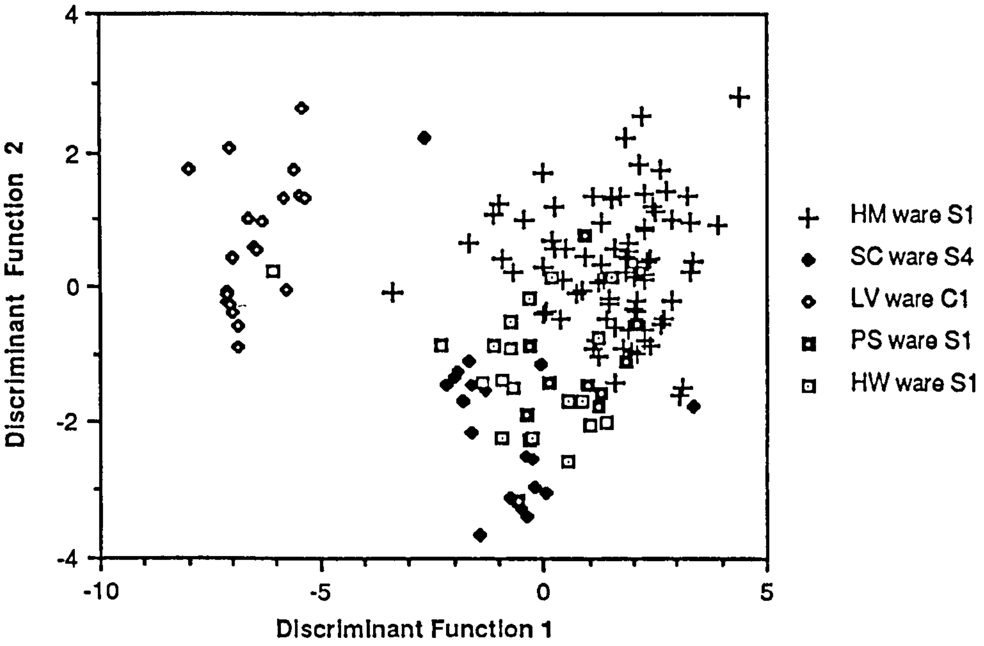


Figure 5.25

Scatterplot of Laverstock, Kington Magna and Winterborne Houghton coarse wares. Principal components derived fron coarse & fine wares data.

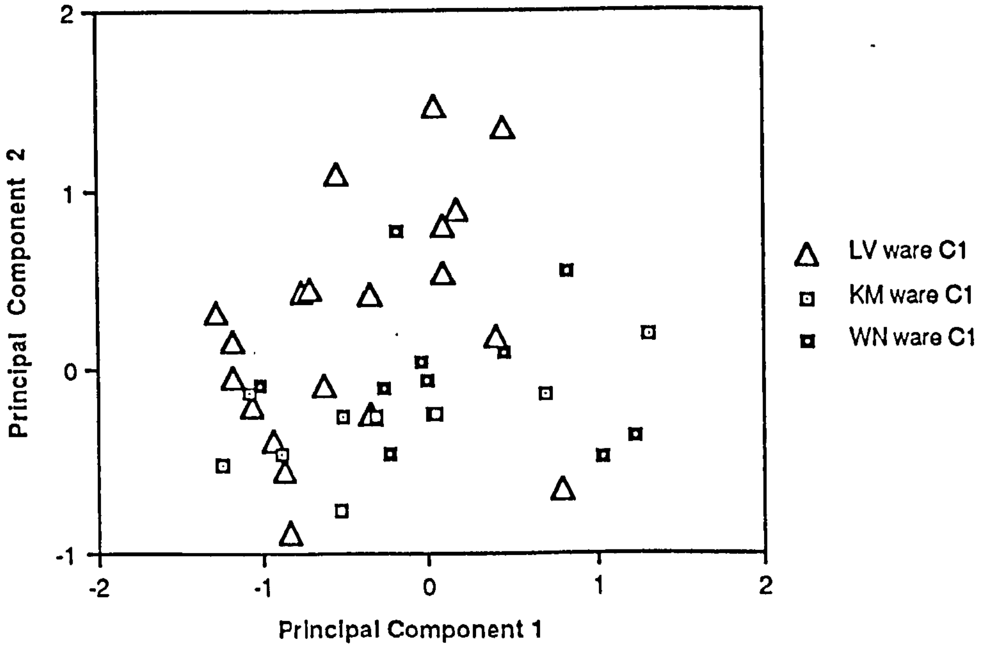


Figure 5.26

Scatterplot of Laverstock, Kington Magna and Whitcombe coarse wares.

Principal components derived from coarse & fine wares data.

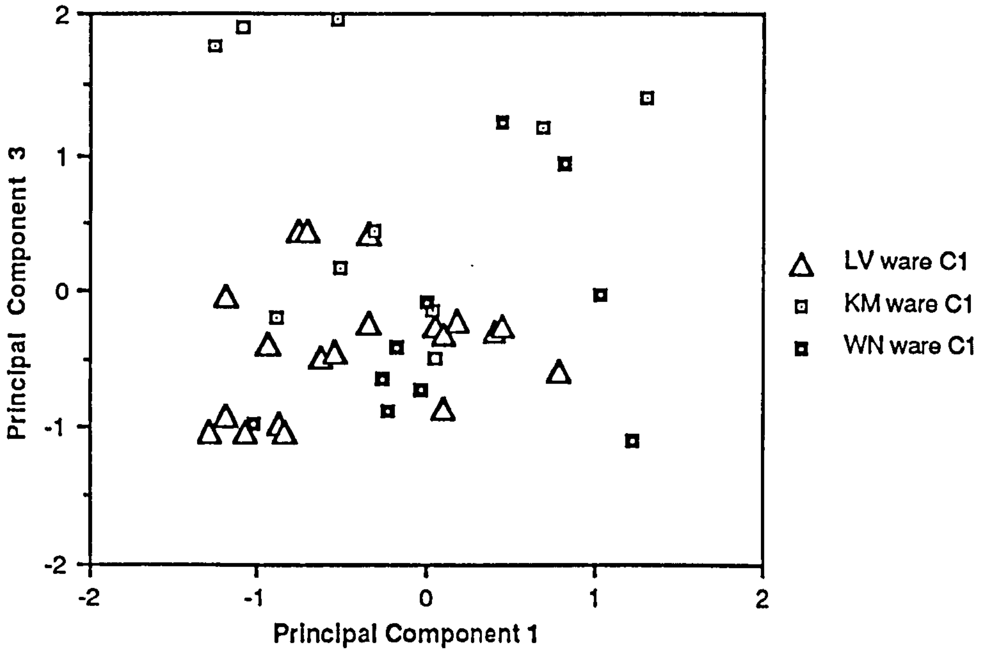


Figure 5.27

Discriminant functions derived to separate Laverstock products and Southampton wasters. KM & WN sherds added as 'unknowns'.

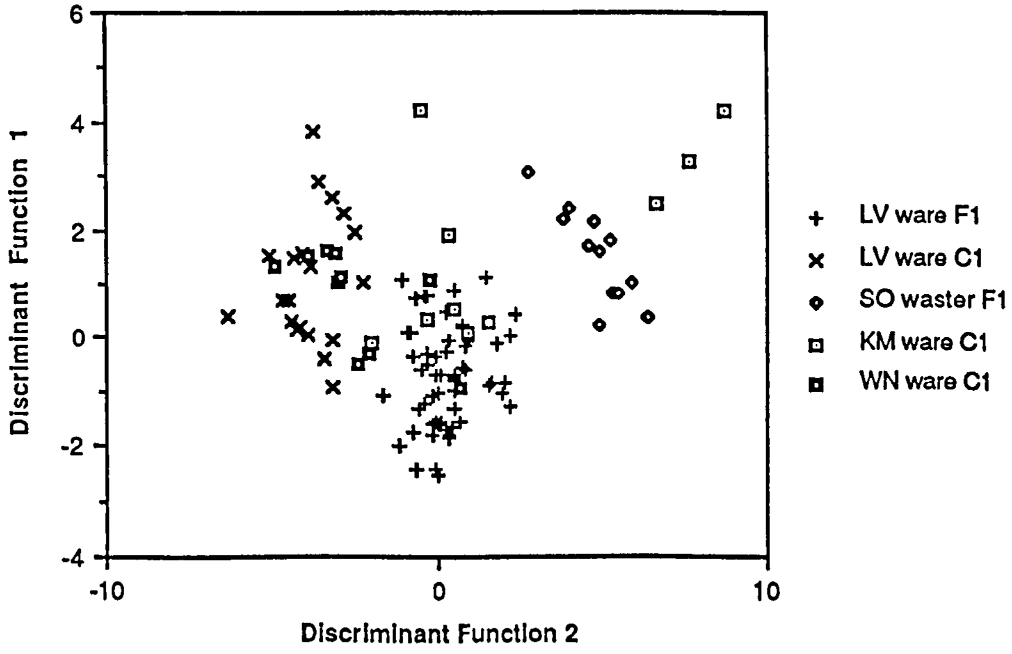
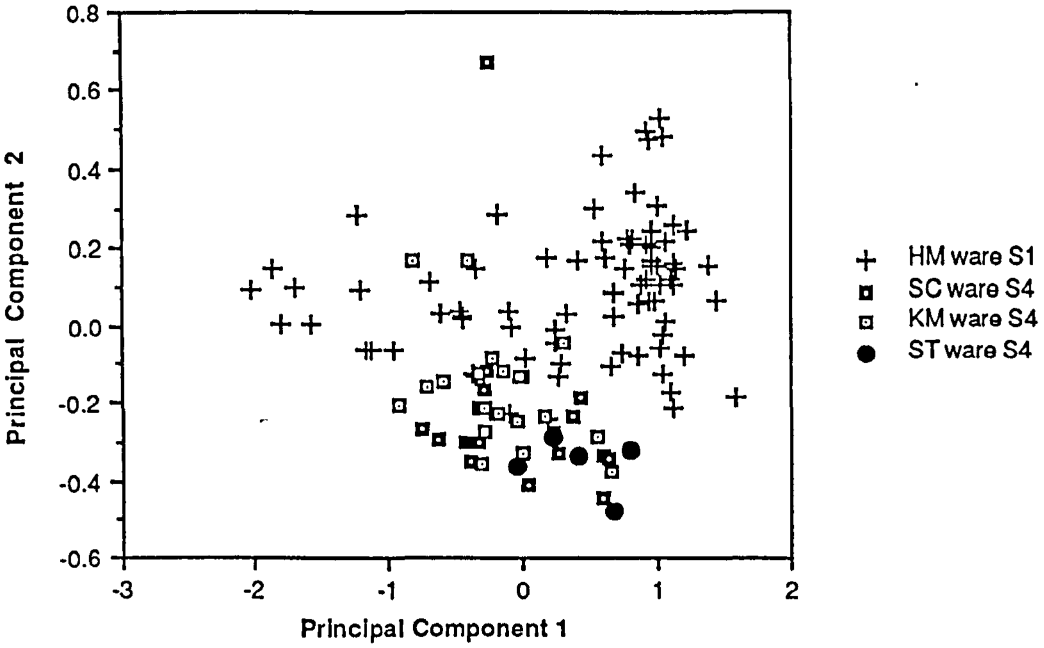
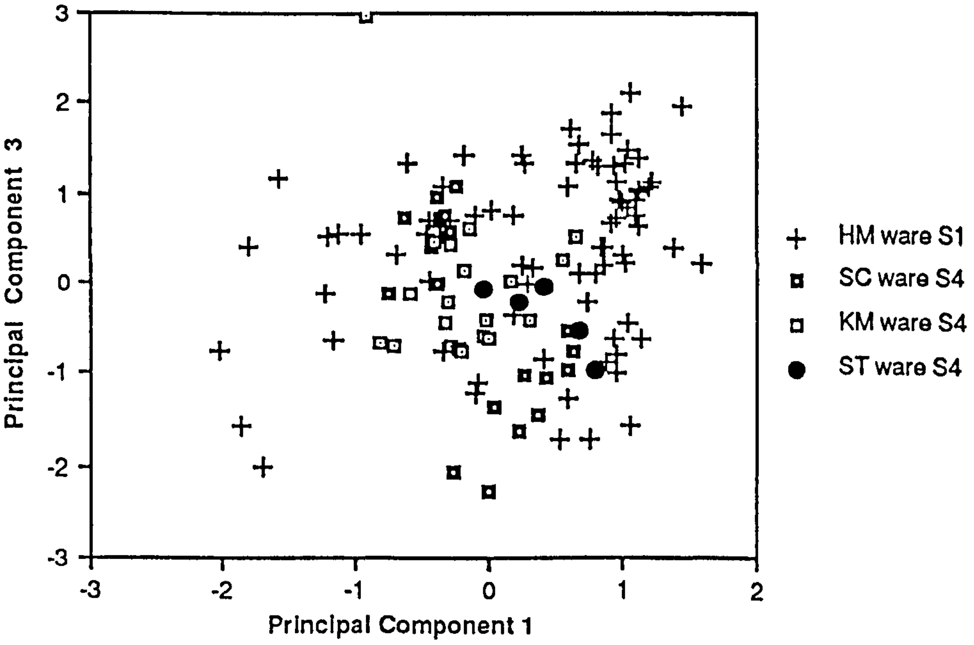


Figure 5.28



Scatterplot of Hermitage sherds and sherds of ware S4.
Principal Components derived from sandy wares data.

Figure 5.29



Scatterplot of Hermitage ware S1 sherds and ware S4 sherds from SC, KM & ST.
Principal components derived from sandy wares data.

Figure 5.30

Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. KM and ST ware S4 sherds added as 'unknowns'.

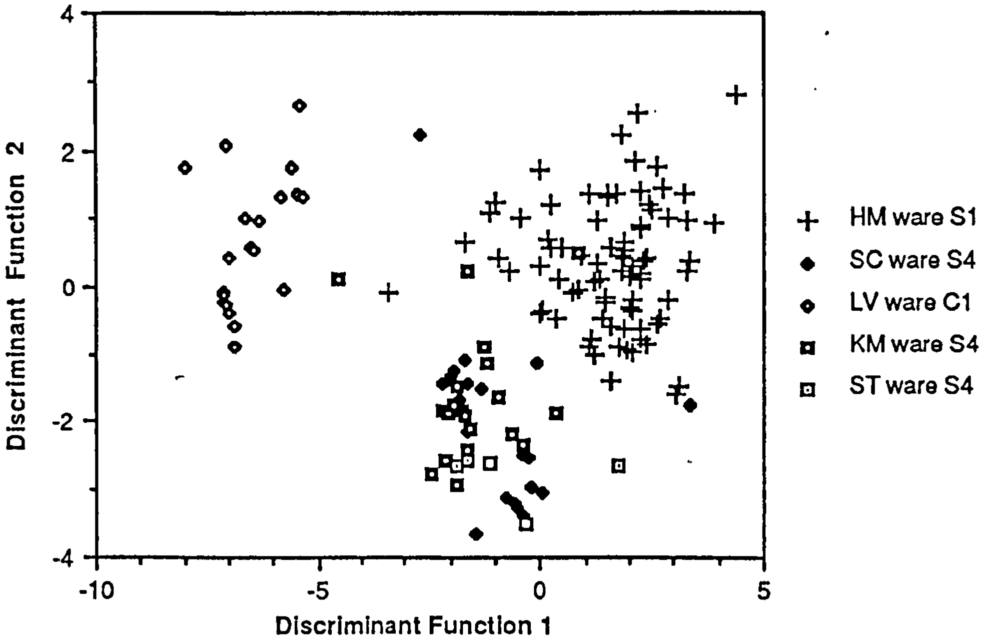


Figure 5.31

Scatterplot of Hermitage, Milton Abbas and Lodge Farm sherds. Principal components derived from sandy wares data.

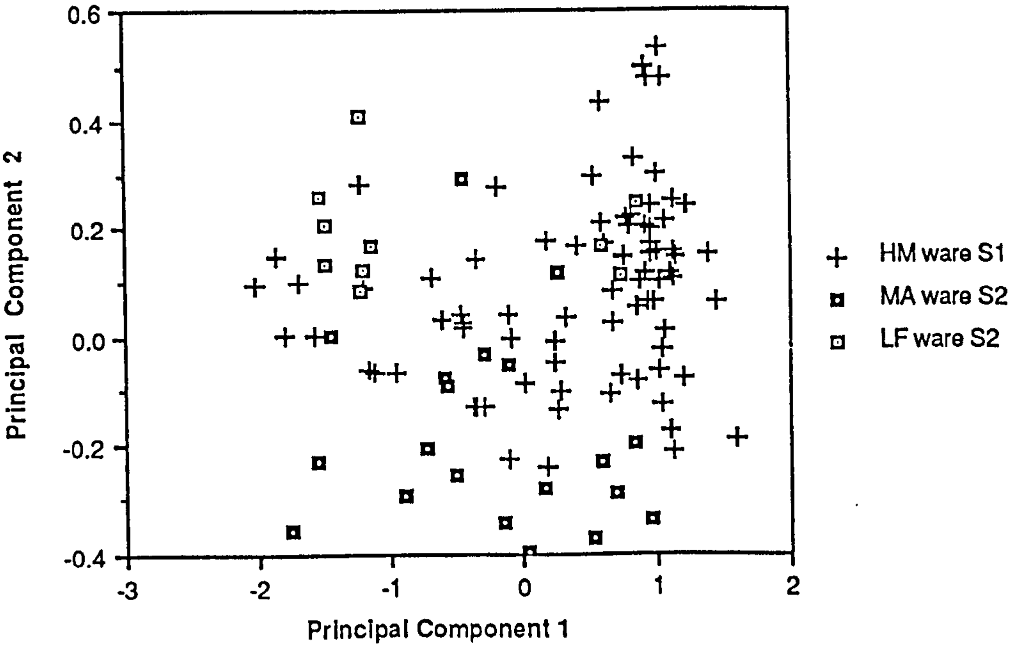
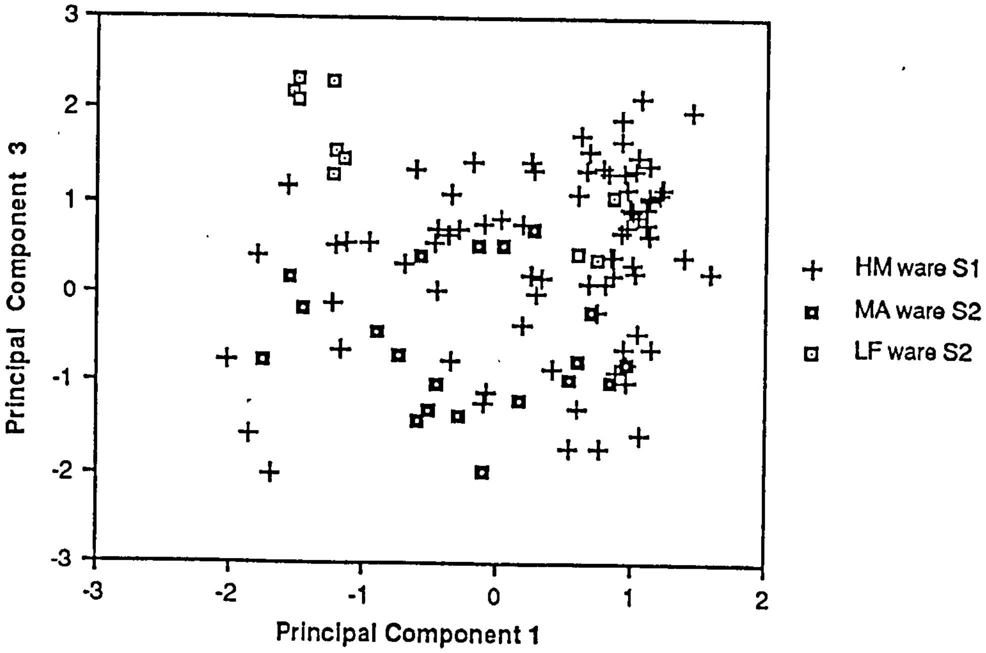
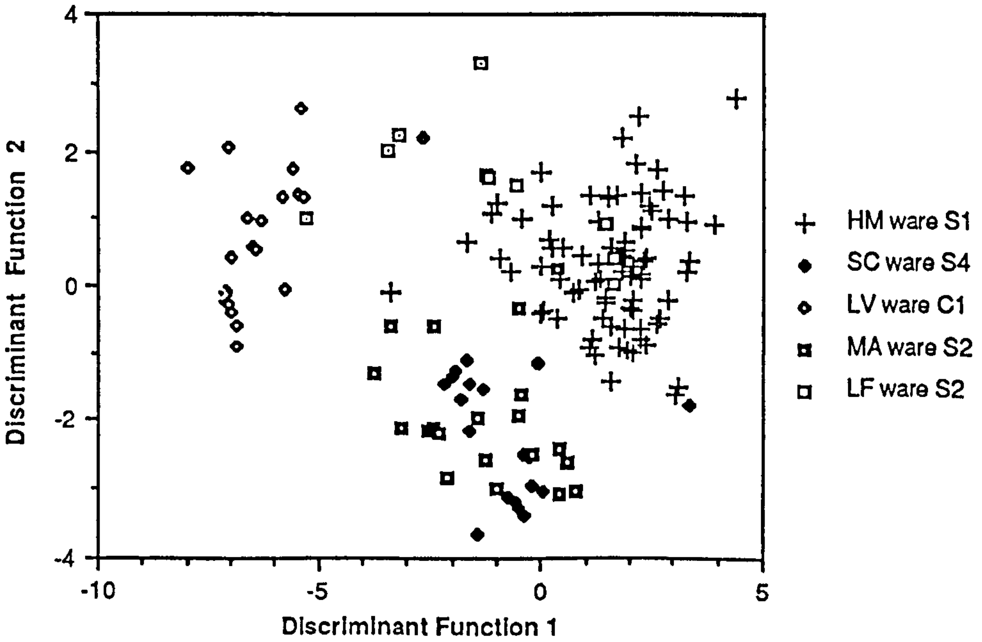


Figure 5.32



Scatterplot of Hermitage, Milton Abbas and Lodge Farm sandy sherds.
Principal components derived from sandy wares data.

Figure 5.33



Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. MA and LF sherds added as 'unknowns'.

Figure 5.34

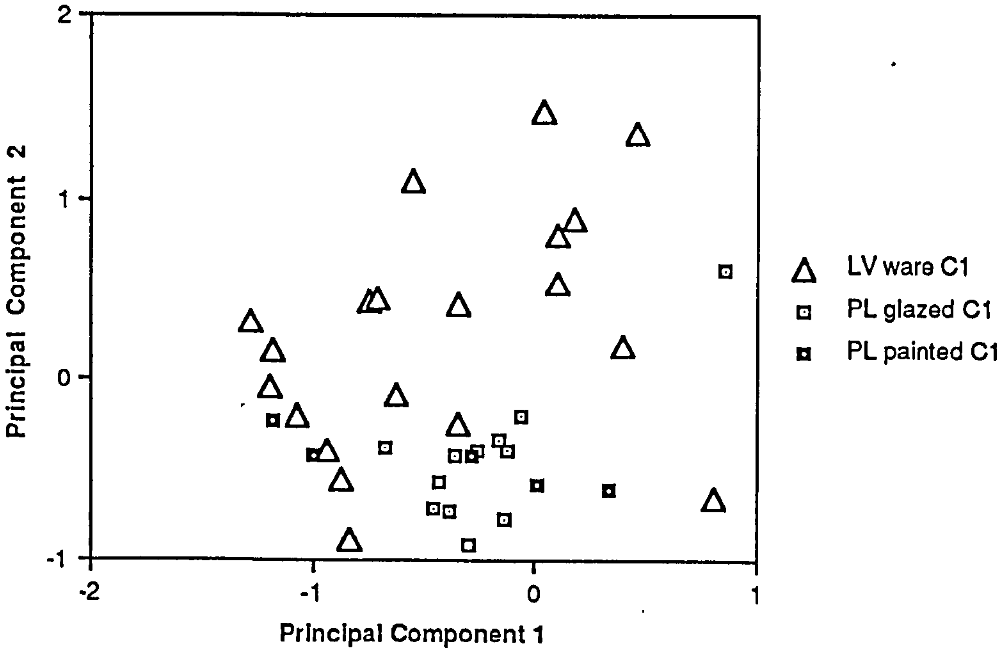

Scatterplot of Laverstock and Poole coarse wares.
Principal components derived from coarse & fine wares data.

Figure 5.35

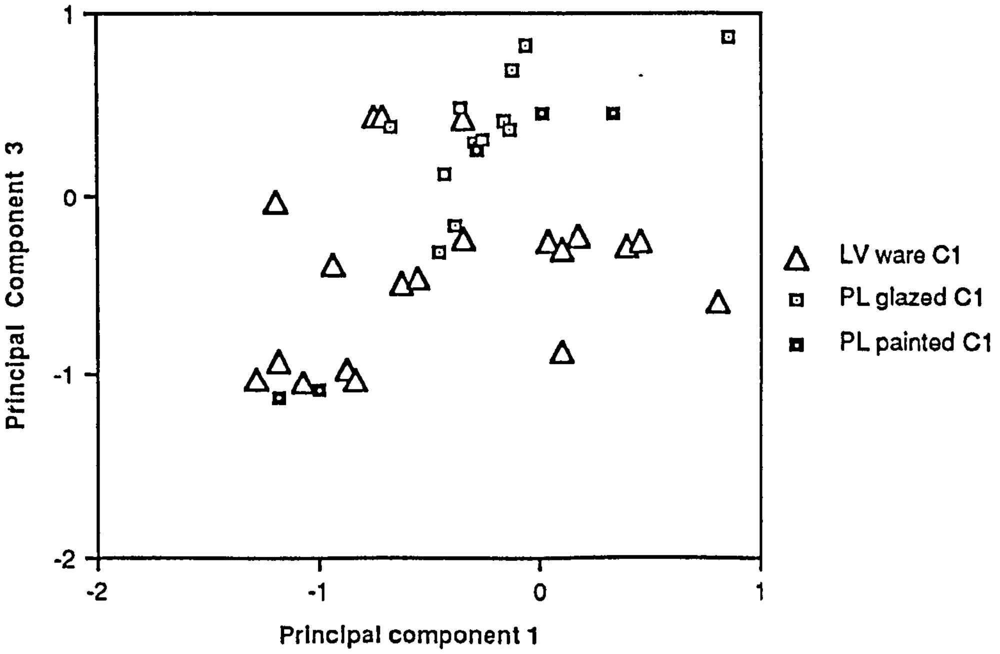

Scatterplot of Laverstock & Poole coarse wares.
Principal components derived from coarse & fine wares data.

Figure 5.36

Discriminant functions derived to separate Laverstock products and Southampton wasters. PL coarse ware sherds added as 'unknowns'.

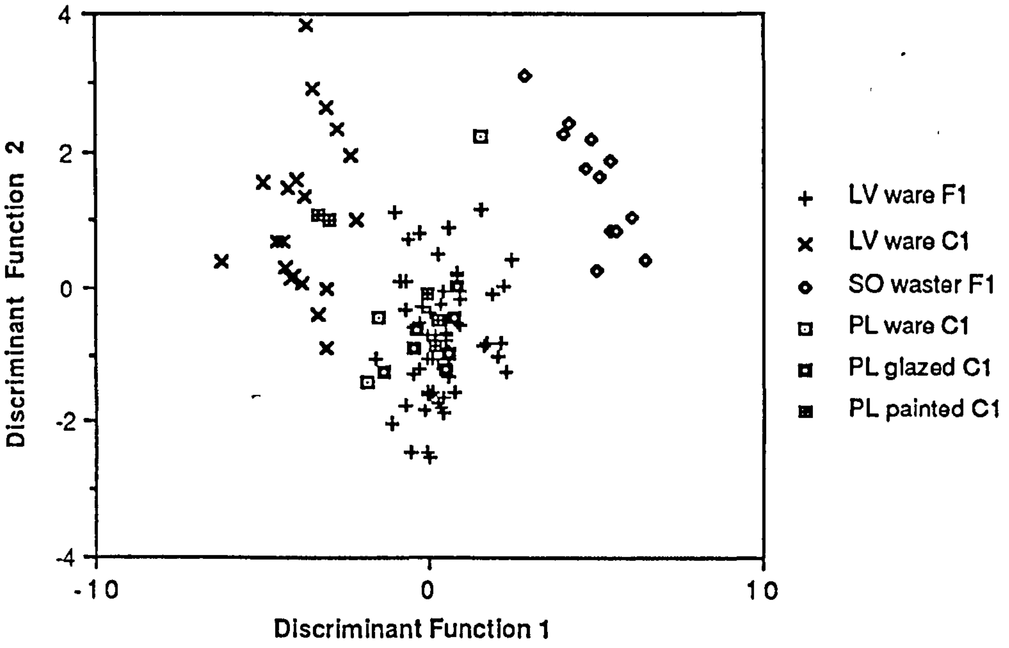


Figure 5.37

Scatterplot of Laverstock and Poole fine wares.
Principal components derived from coarse & fine wares data.

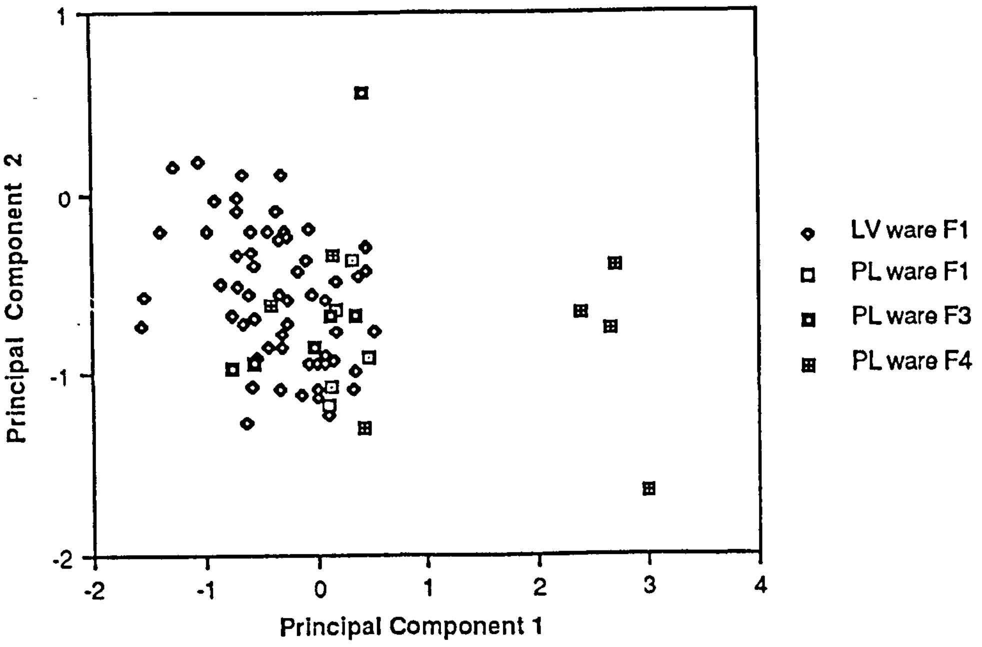


Figure 5.38

Scatterplot of Laverstock and Poole fine wares.

Principal components derived from coarse & fine wares data.

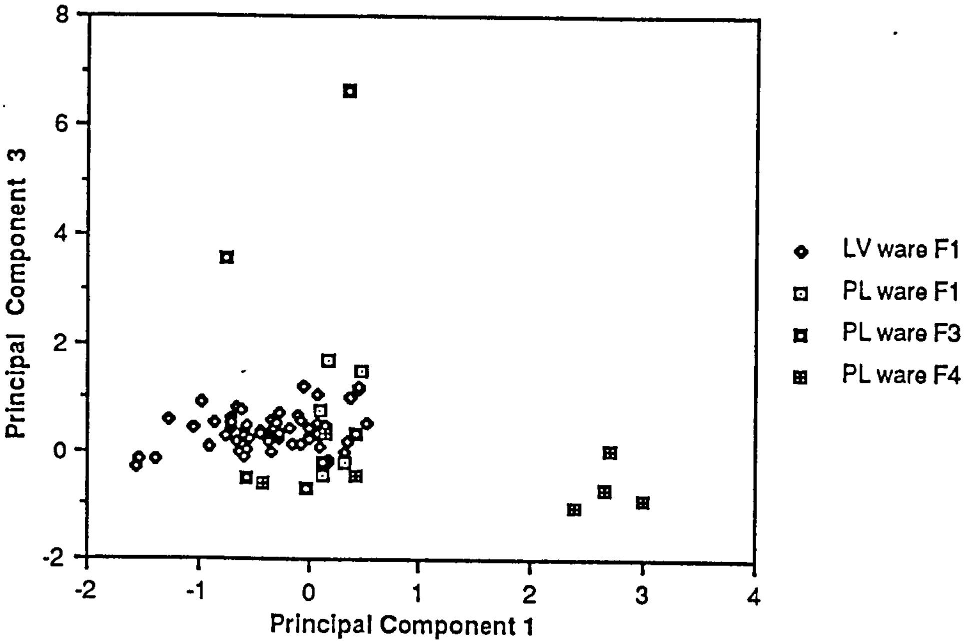


Figure 5.39

Discriminant functions derived to separate Laverstock products and Southampton wasters. PL fine ware sherds added as 'unknowns'.

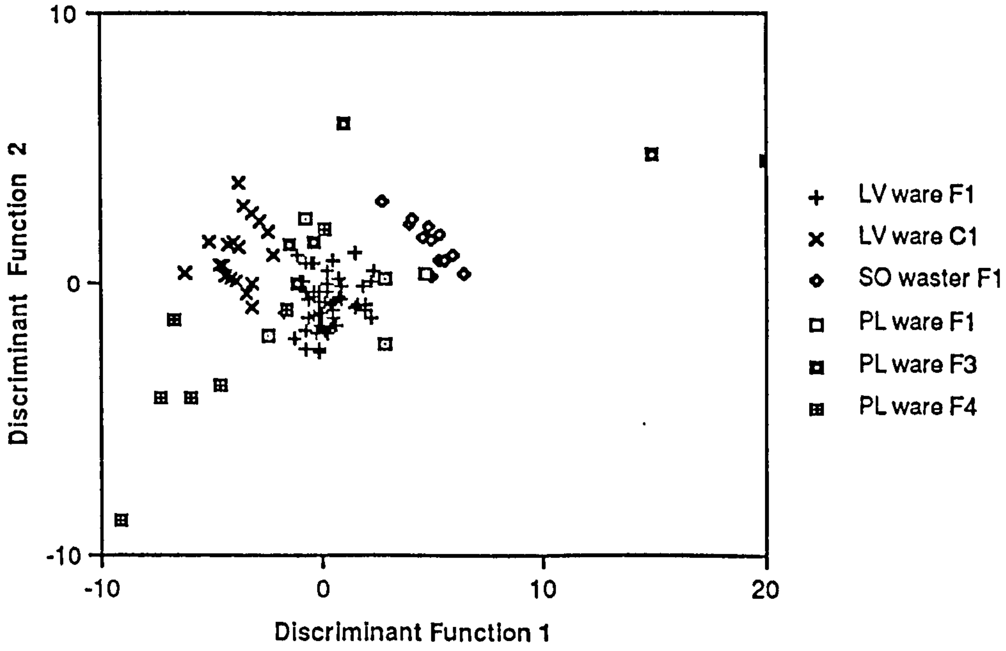
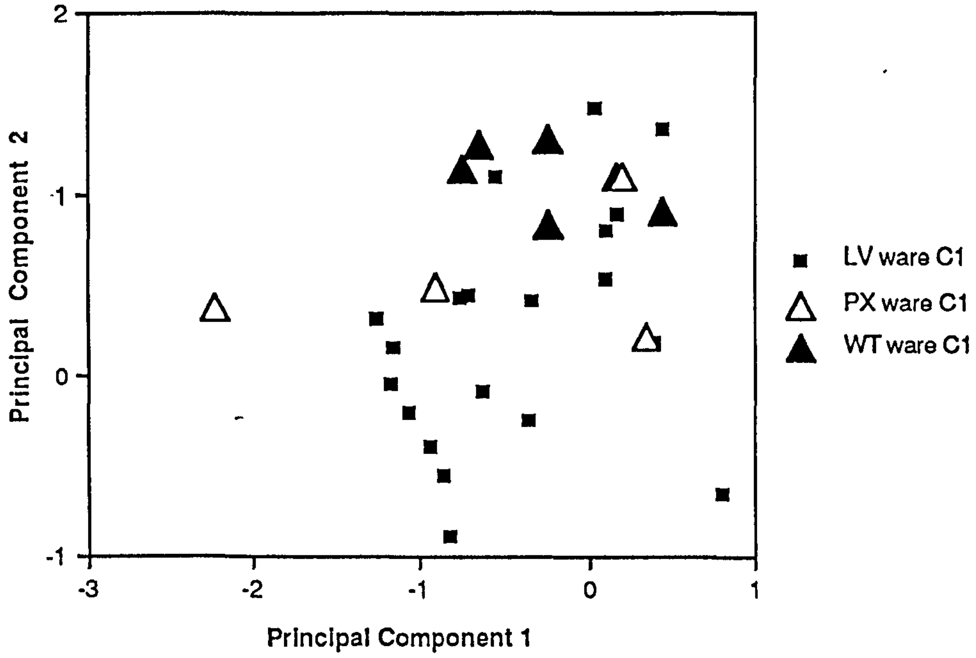
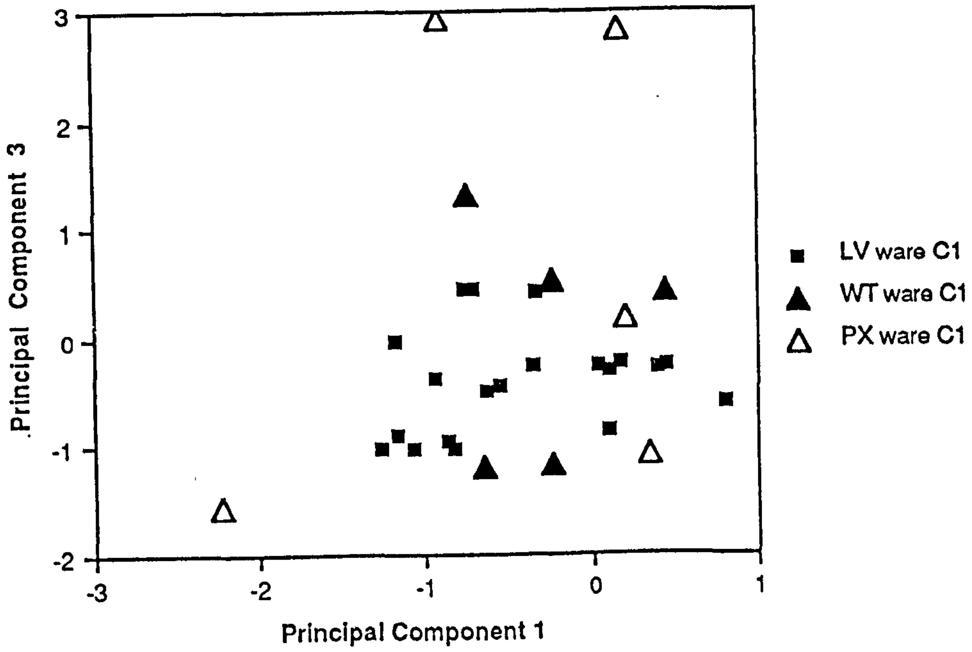


Figure 5.40



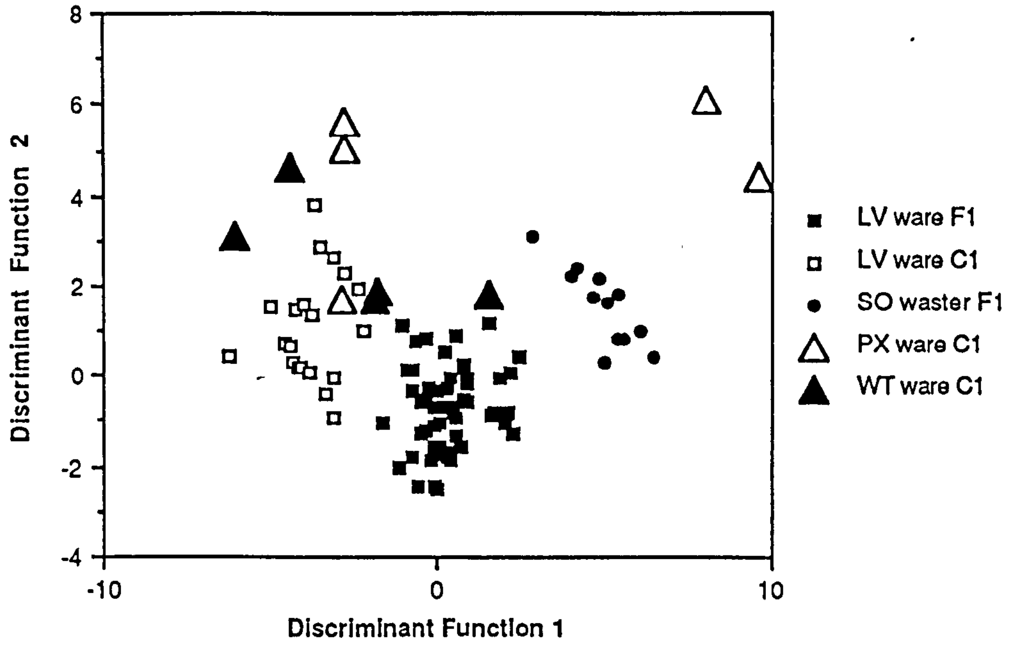
Scatterplot of Laverstock, Poxwell and Whitcombe coarse wares. Principal components derived from fine & coarse wares data.

Figure 5.41



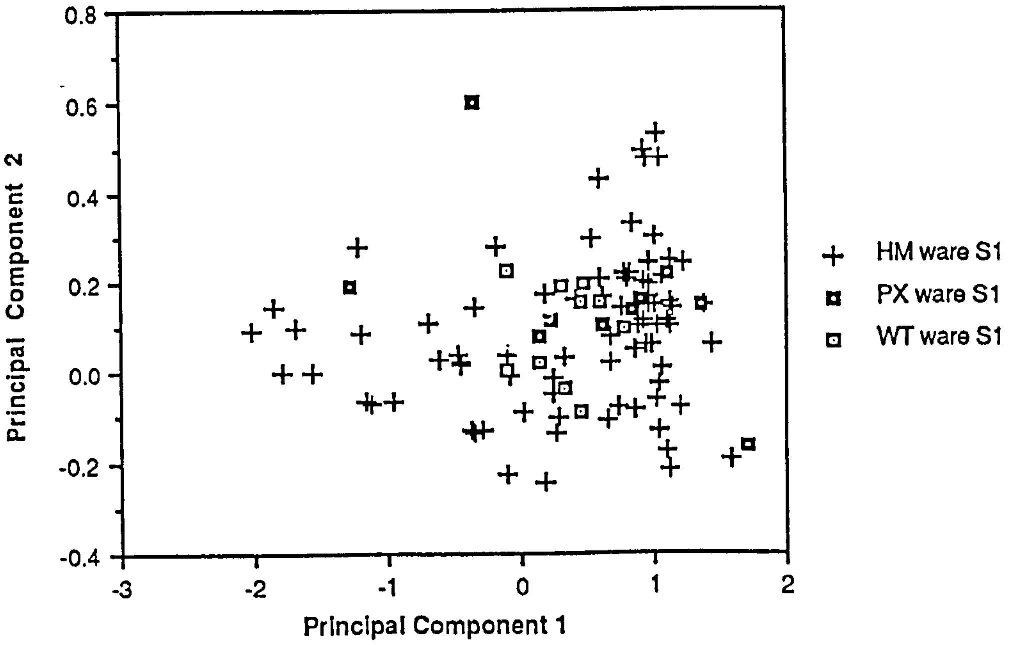
Scatterplot of Laverstock, Poxwell and Whitcombe coarse wares. Principal components derived from coarse & fine wares data.

Figure 5.42



Discriminant functions derived to separate Laverstock products and Southampton wasters. PX & WT sherds added as 'unknowns'.

Figure 5.43



Scatterplot of Hermitage, Poxwell and Whitcombe sherds. Principal components derived from sandy wares data.

Figure 5.44

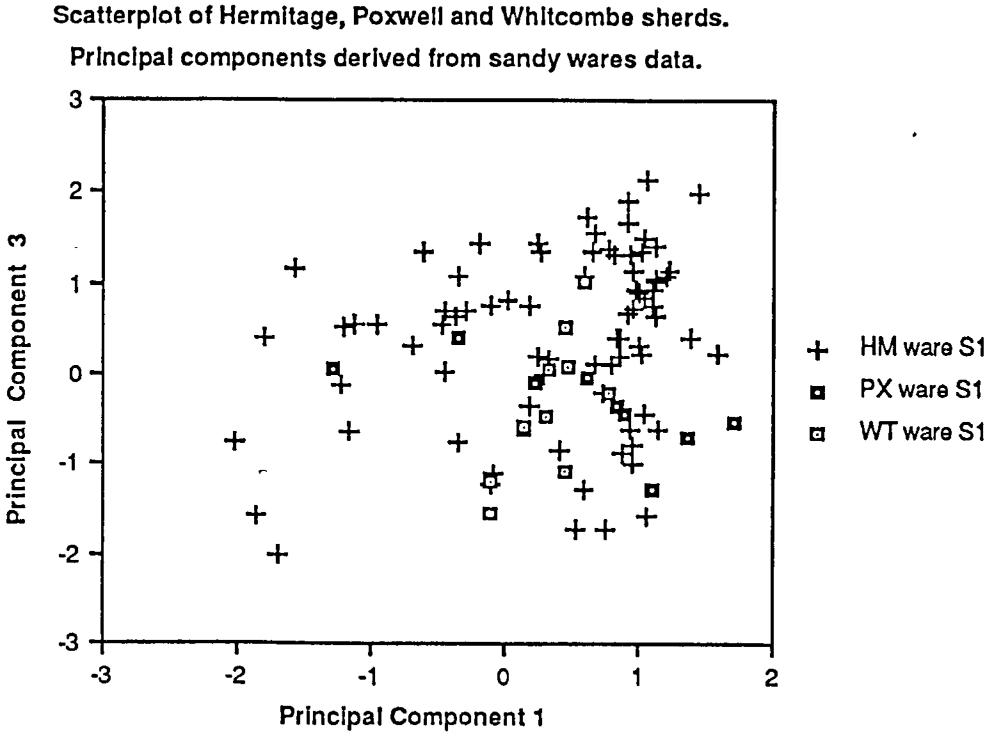


Figure 5.45

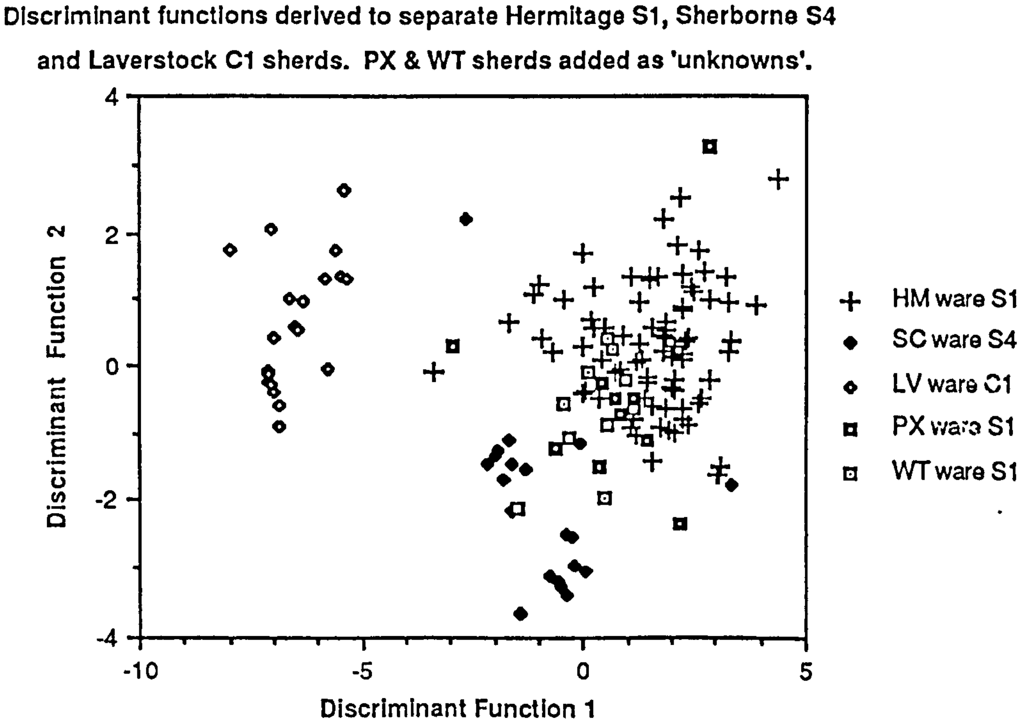


Figure 5.46

Scatterplot of Laverstock and Salisbury fine wares.

Principal components derived from coarse & fine wares data

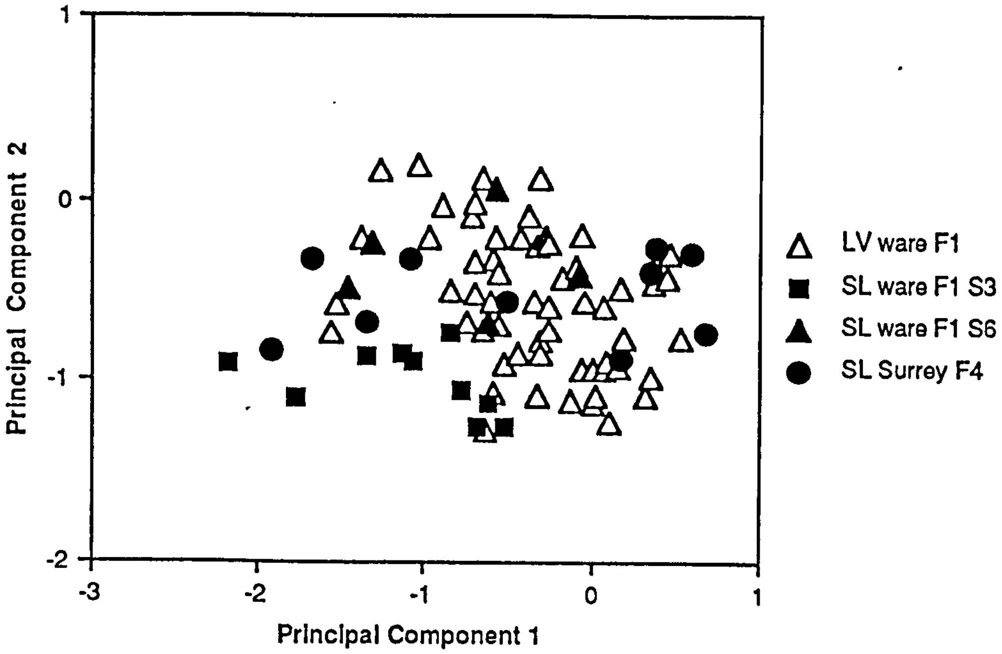


Figure 5.47

Scatterplot of Laverstock and Salisbury fine wares.

Principal components derived from coarse & fine wares data.

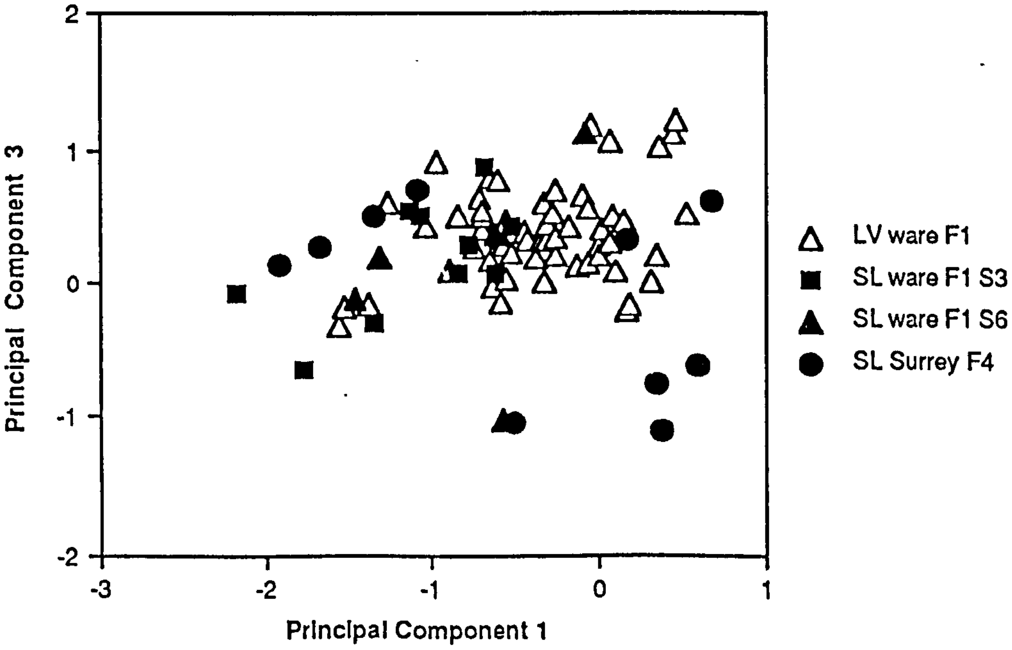


Figure 5.48

Discriminant functions derived to separate Laverstock products and Southampton wasters. SL sherds added as 'unknowns'.

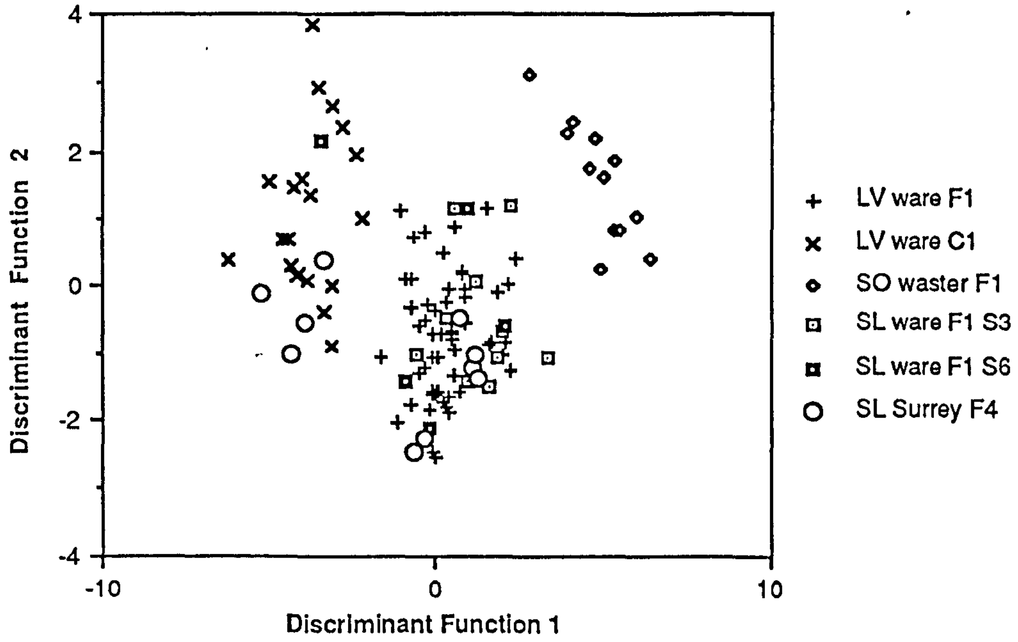


Figure 5.49

Scatterplot of Laverstock and Shaftesbury glazed coarse & fine wares. Principal components derived from coarse & fine wares data.

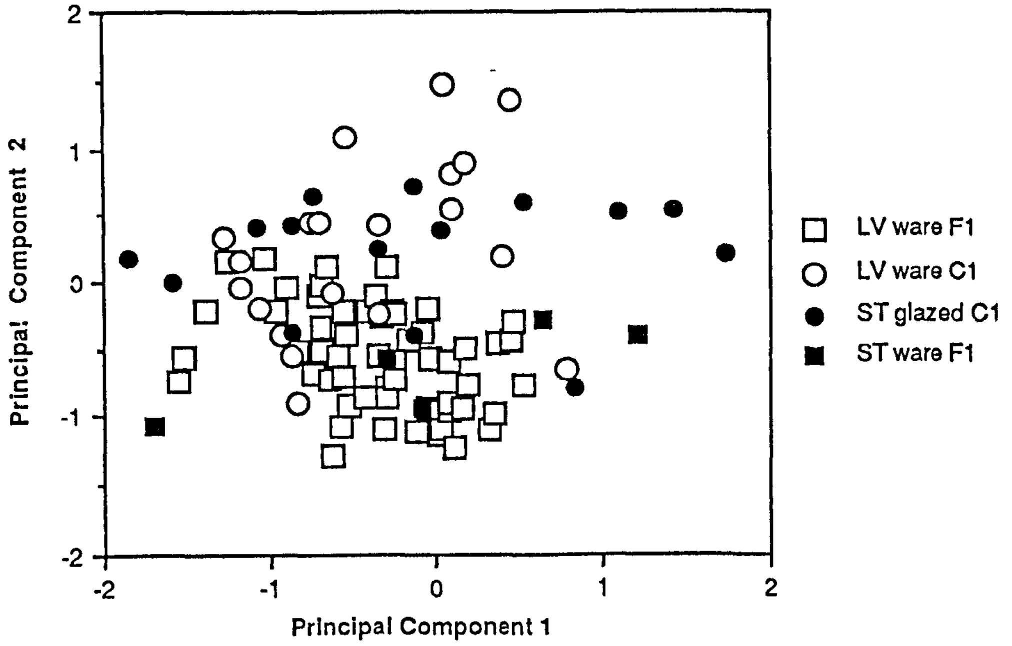


Figure 5.50

Scatterplot of Laverstock and Shaftesbury coarse & fine wares.

Principal components derived from coarse & fine wares data.

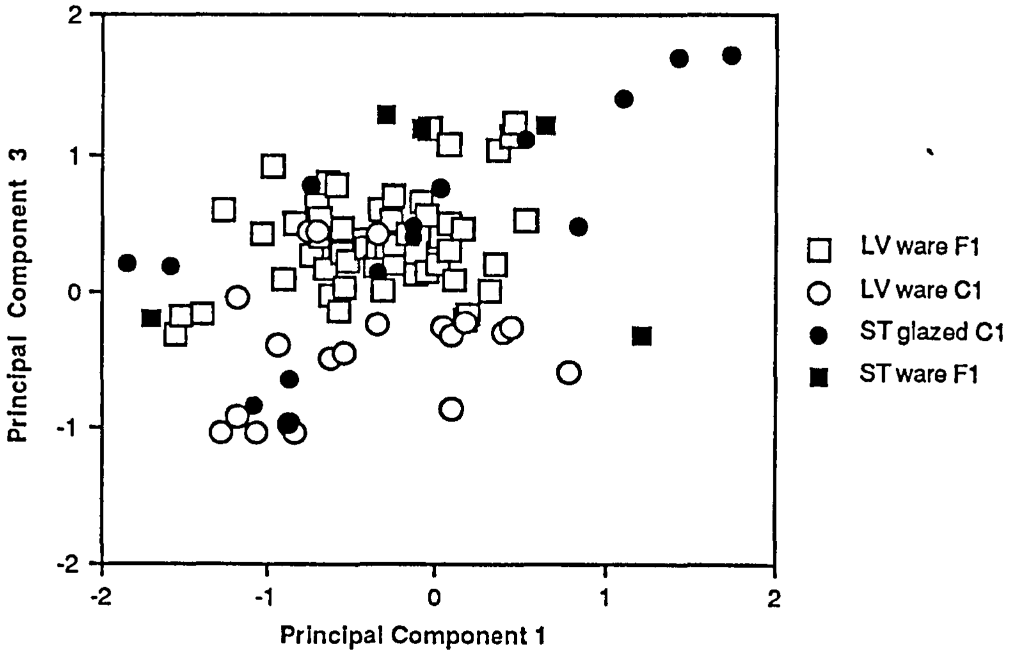


Figure 5.51

Discriminant functions derived to separate Laverstock products and Southampton wasters. ST sherds added as 'unknowns'.

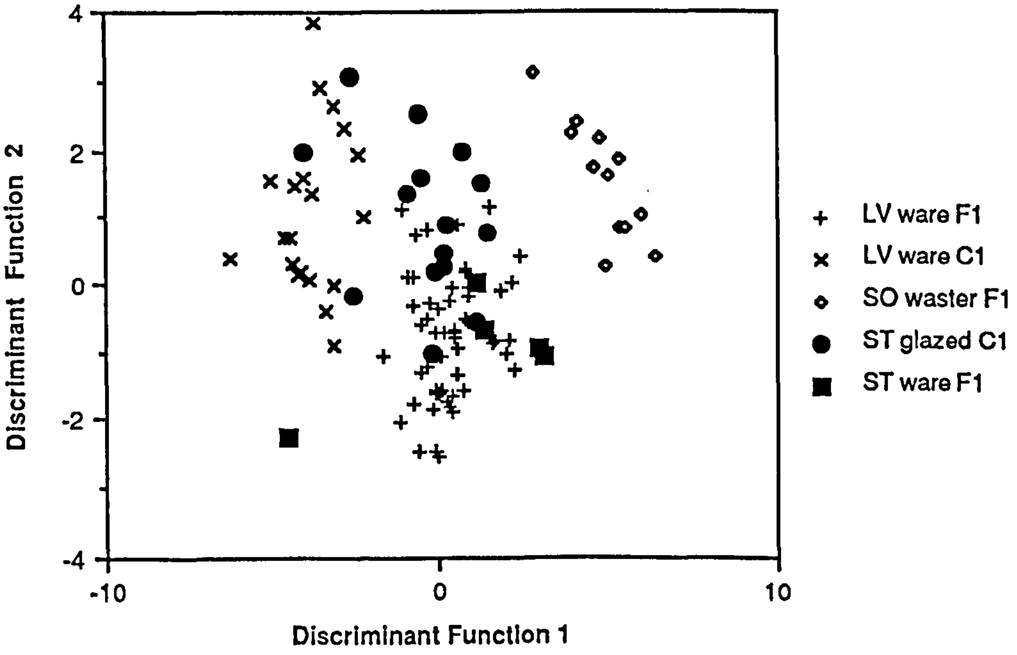


Figure 5.52

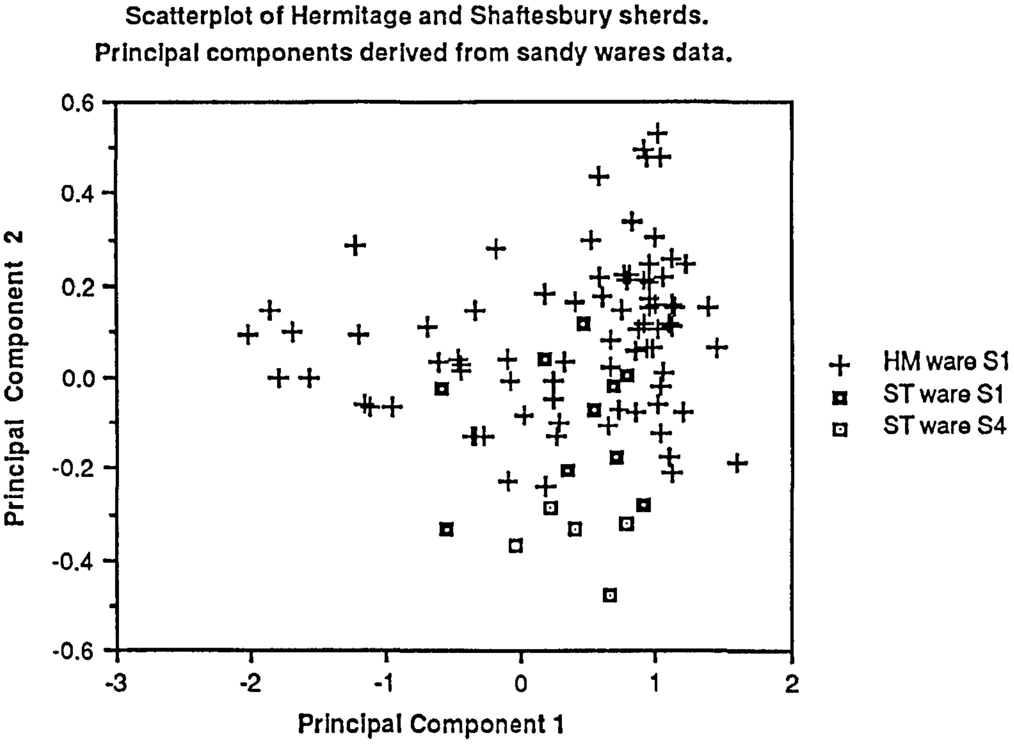


Figure 5.53

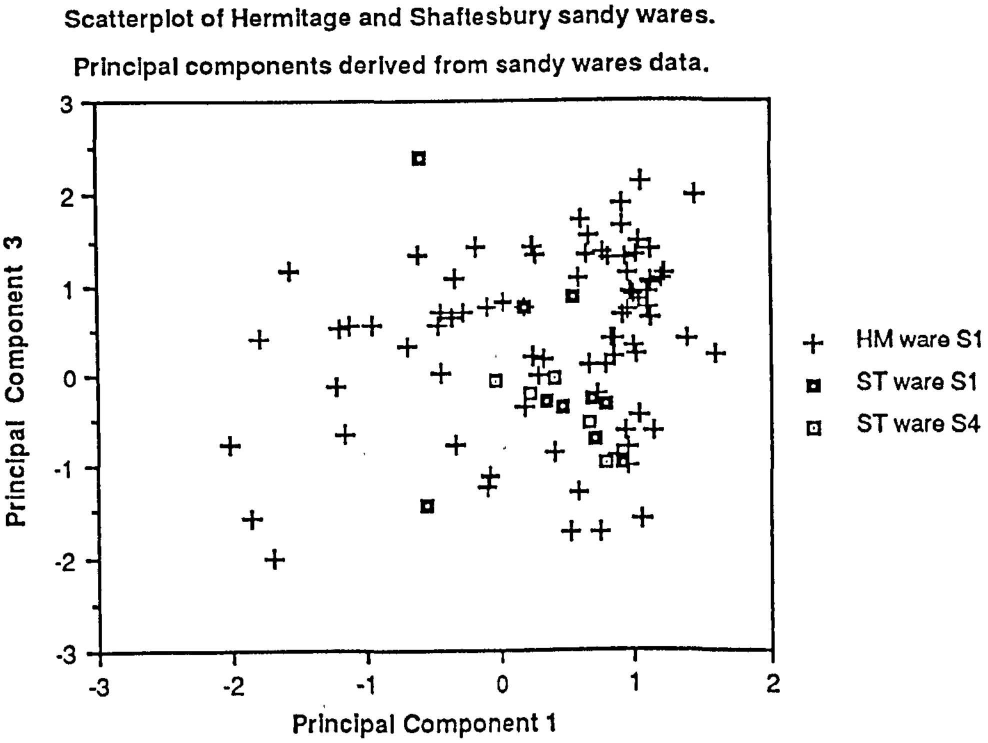


Figure 5.54

Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. ST sherds added as 'unknowns'.

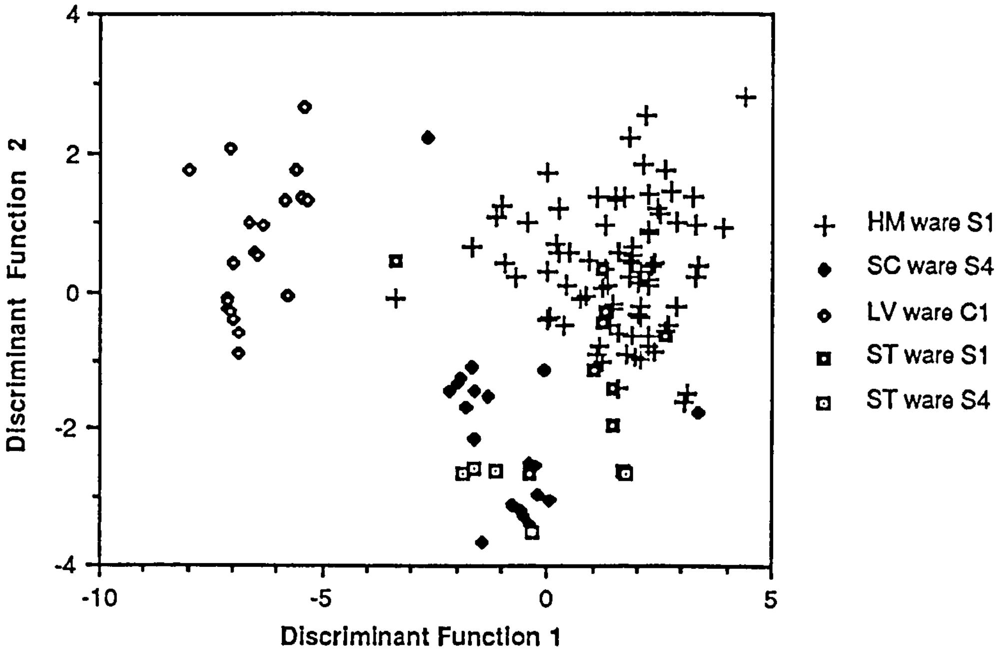


Figure 5.55

Scatterplot of Laverstock and Sherborne sherds.
Princial components derived from fine & coarse wares data

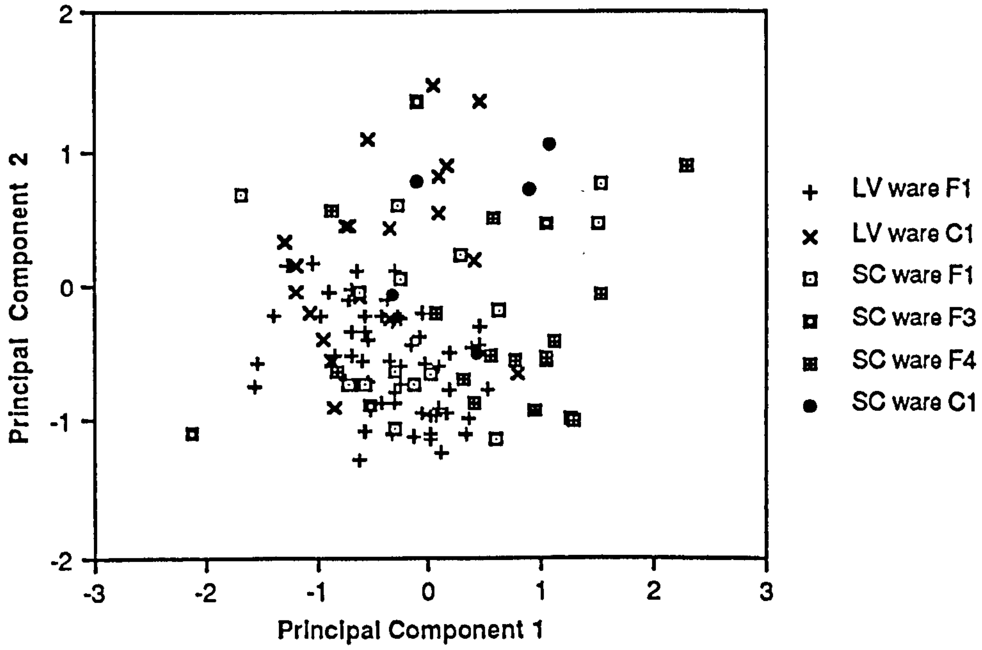


Figure 5.56

Scatterplot of Laverstock & Sherborne coarse & fine wares.

Principal components derived from coarse & fine wares data.

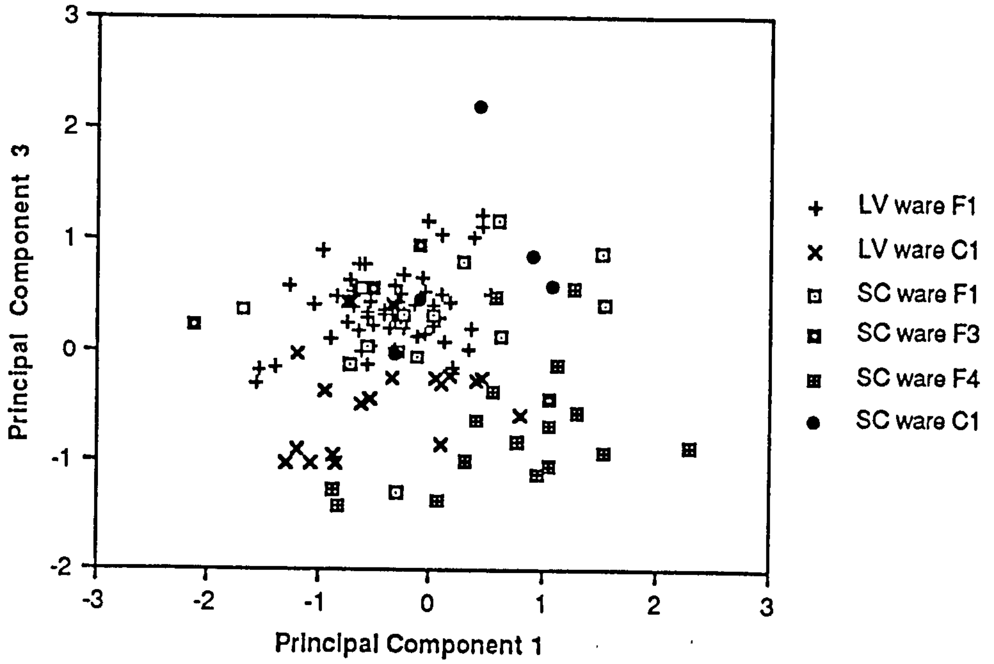


Figure 5.57

Discriminant functions derived to separate Laverstock products and

Southampton wasters. SC sherds added as 'unknowns'.

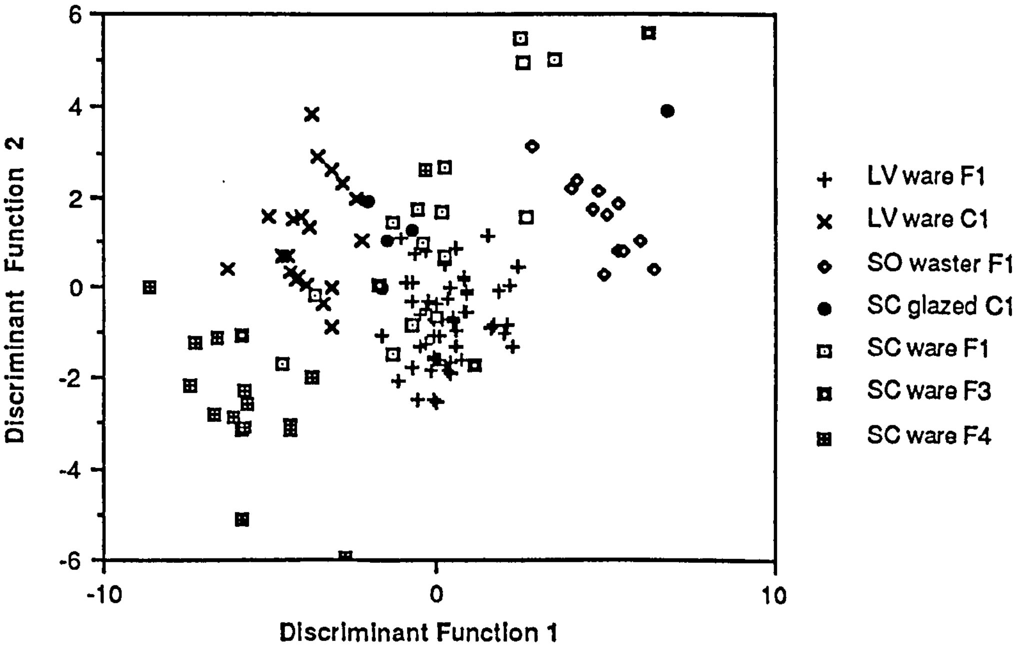


Figure 5.58

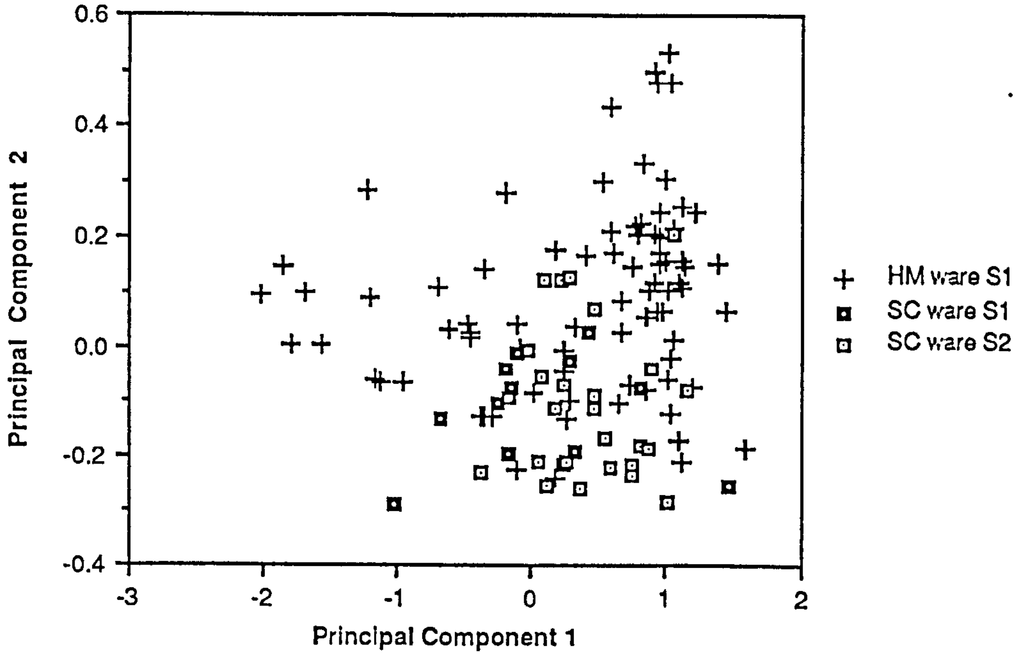

Scatterplot of Hermitage and Sherborne Old Castle sherds.
Principal components derived from sandy wares data.

Figure 5.59

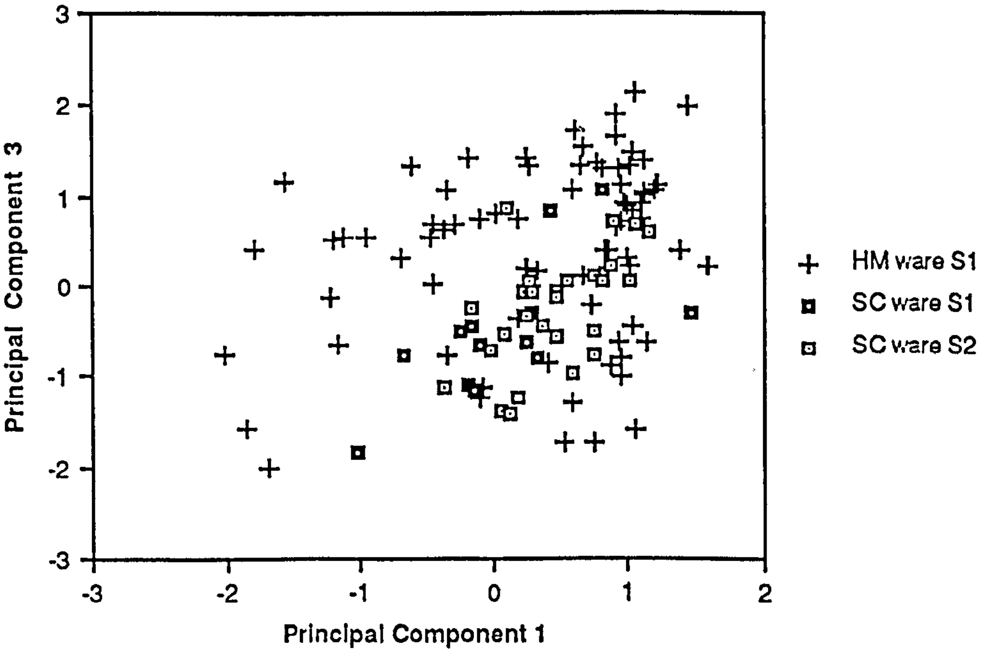

Scatterplot of Hermitage and Sherborne Old Castle sandy ware sherds.
Principal components derived from sandy wares data.

Figure 5.60

Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. SC sherds added as 'unknowns'.

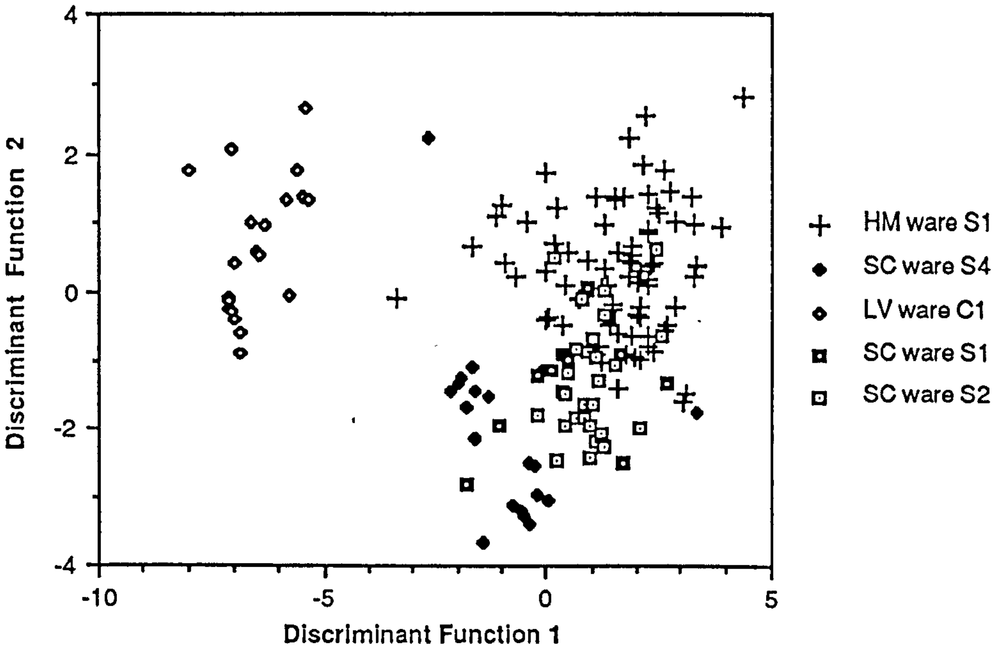


Figure 5.61

Scatterplot of Laverstock and Southampton coarse wares. Principal components derived from fine and coarse wares data.

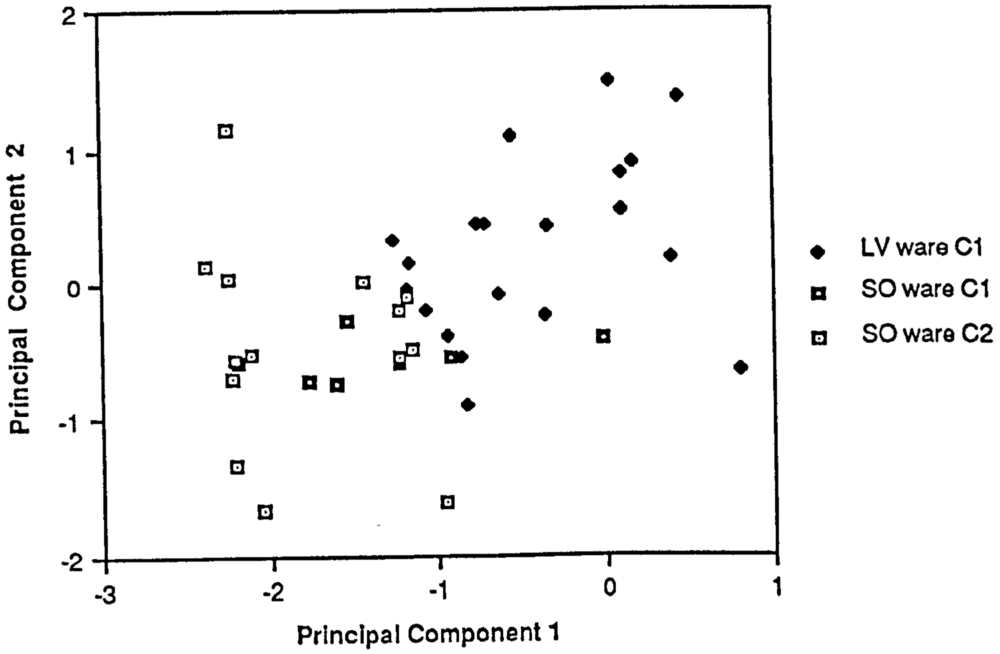
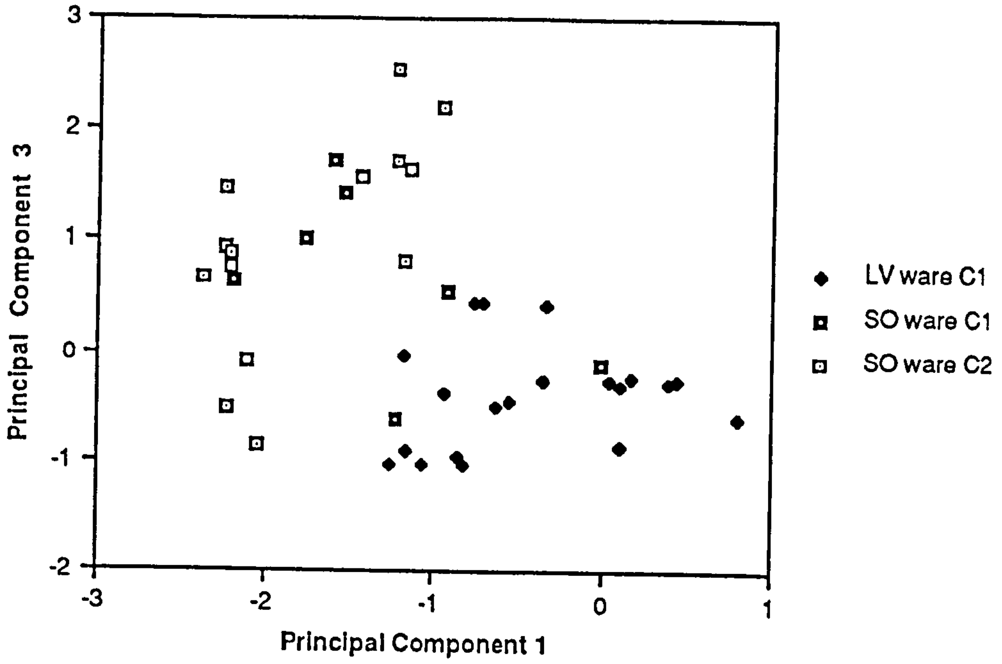
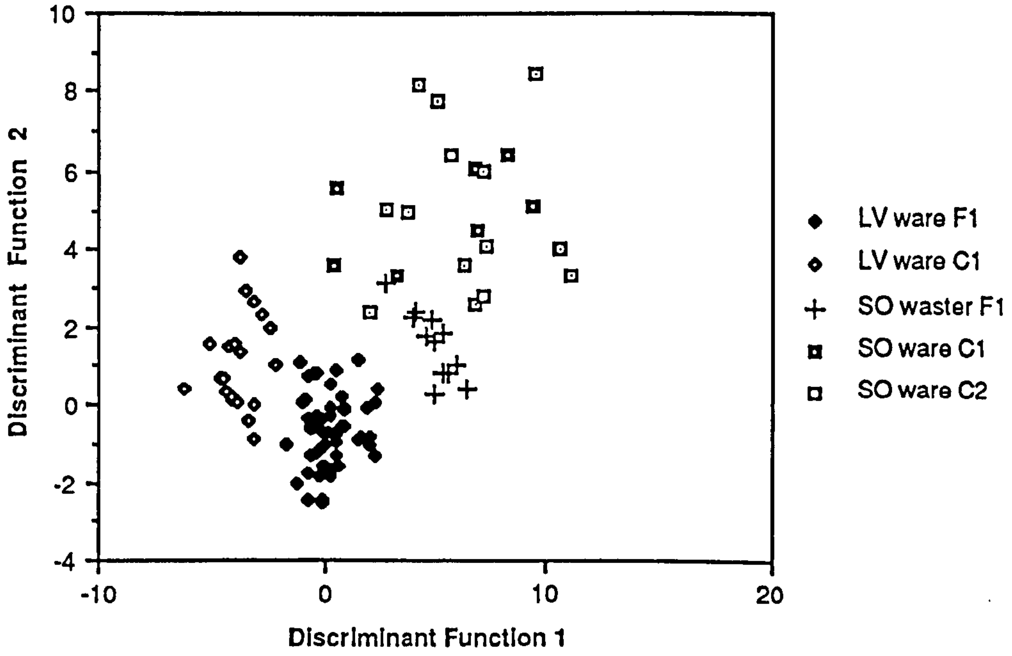


Figure 5.62



Scatterplot of Laverstock & Southampton coarse wares. Principal Components derived from coarse & fine wares data.

Figure 5.63



Discriminant functions derived to separate Laverstock products and Southampton wasters. SO coarse ware sherds added as 'unknowns'.

Figure 5.64

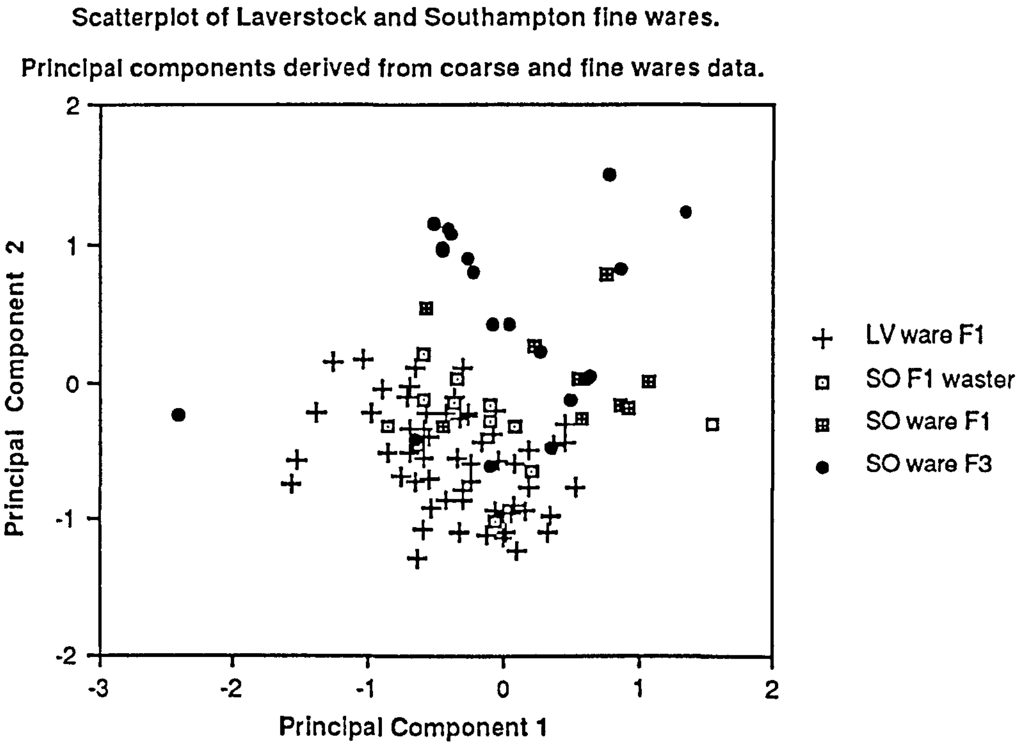


Figure 5.65

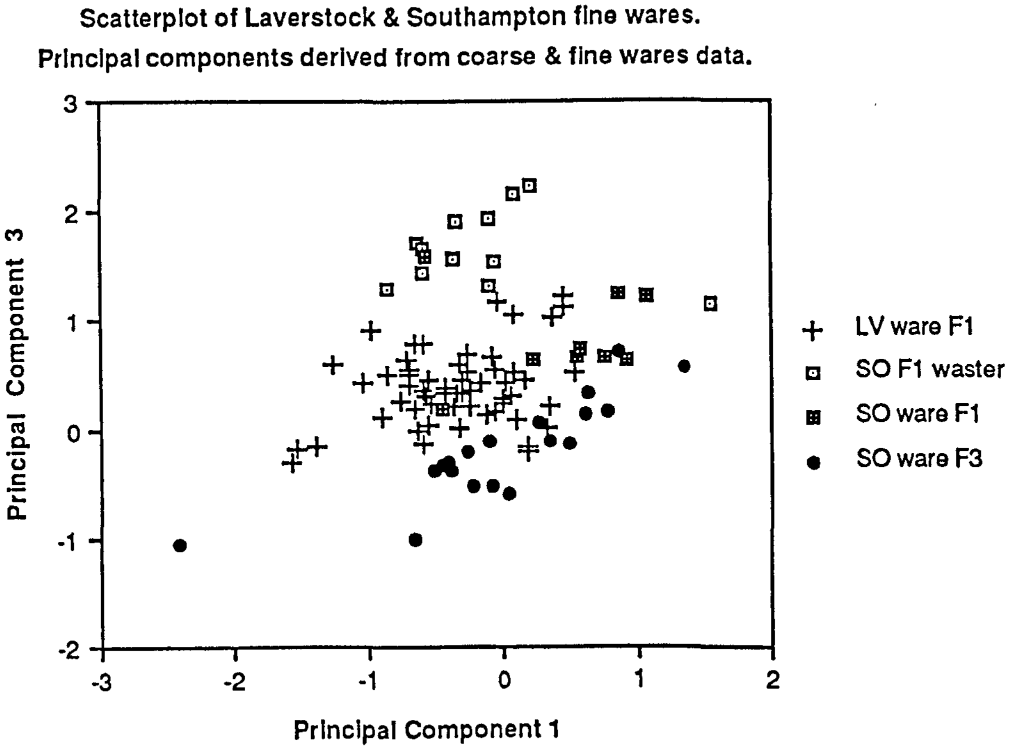


Figure 5.66

Discriminant functions derived to separate Laverstock products and Southampton wasters. SO fine ware sherds added as 'unknowns'.

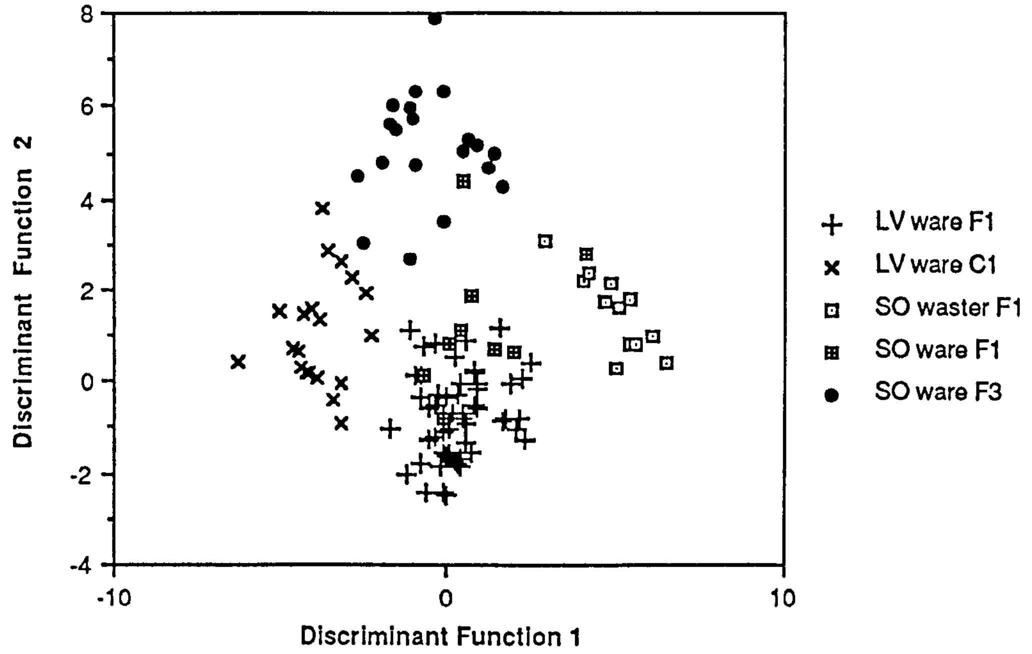


Figure 5.67

Scatterplot of Hermitage and Southampton sherds and wasters. Principal components derived from sandy wares data.

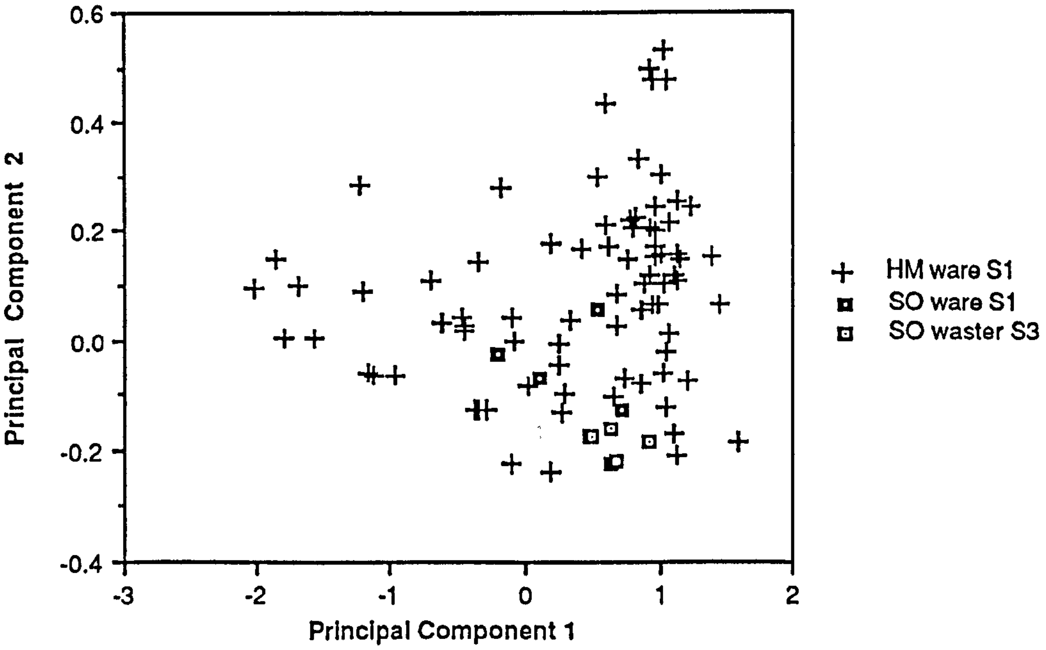


Figure 5.68

Scatterplot of Hermitage and Southampton sandy wares.
Principal components derived from sandy wares data.

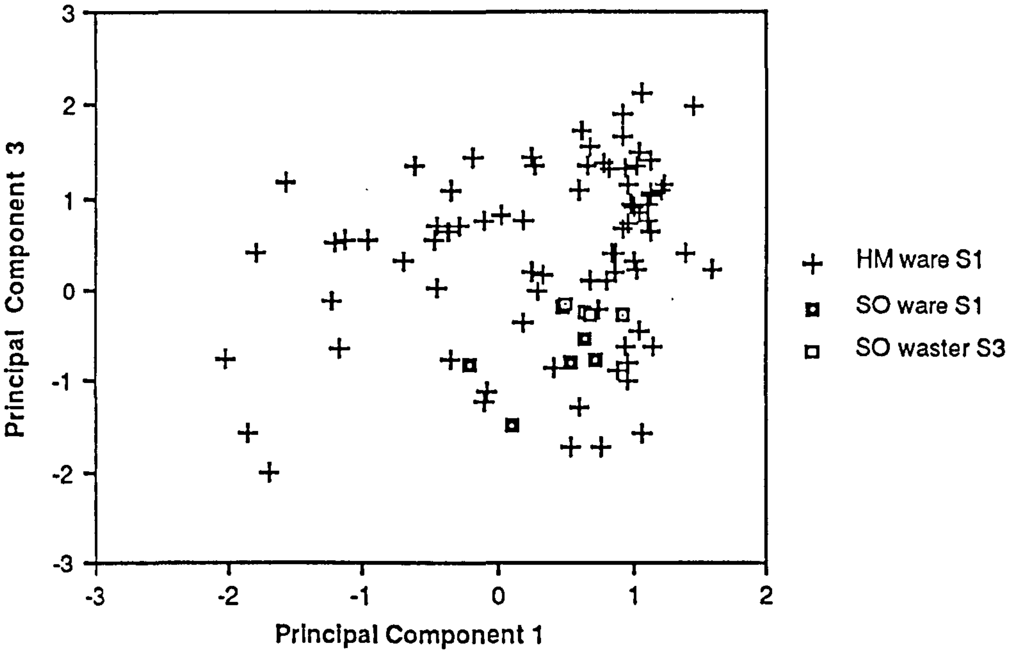


Figure 5.69

Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. SO sherds & wasters added as 'unknowns'.

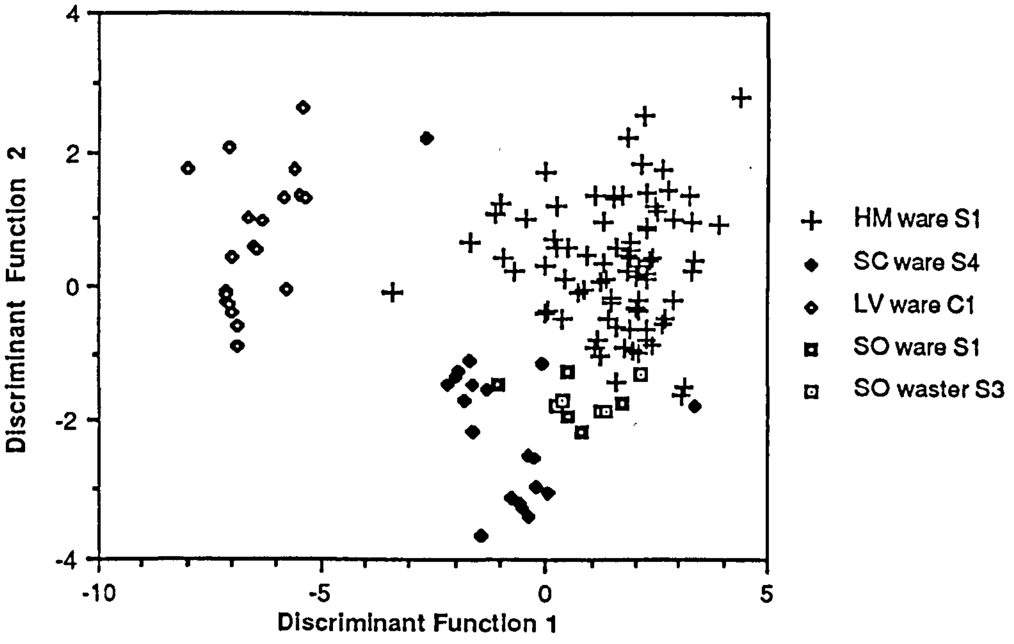


Figure 5.70

Scatterplot of Laverstock and Wareham coarse and fine wares.

Principal components derived from coarse & fine wares data.

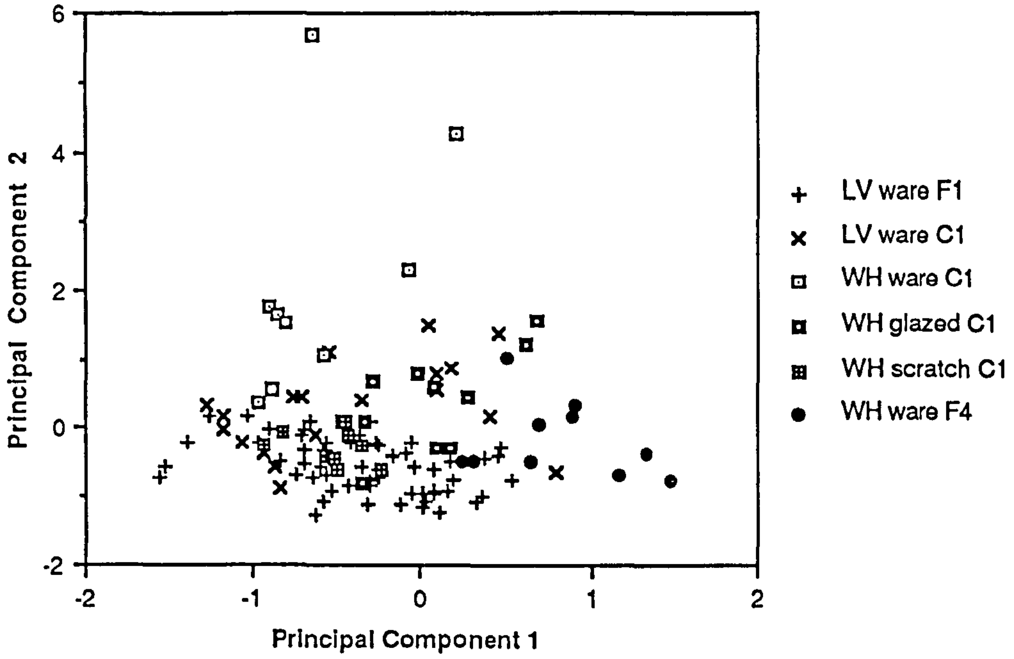


Figure 5.71

Scatterplot of Laverstock and Wareham fine & coarse wares.
Principal components derived from coarse & fine wares data.

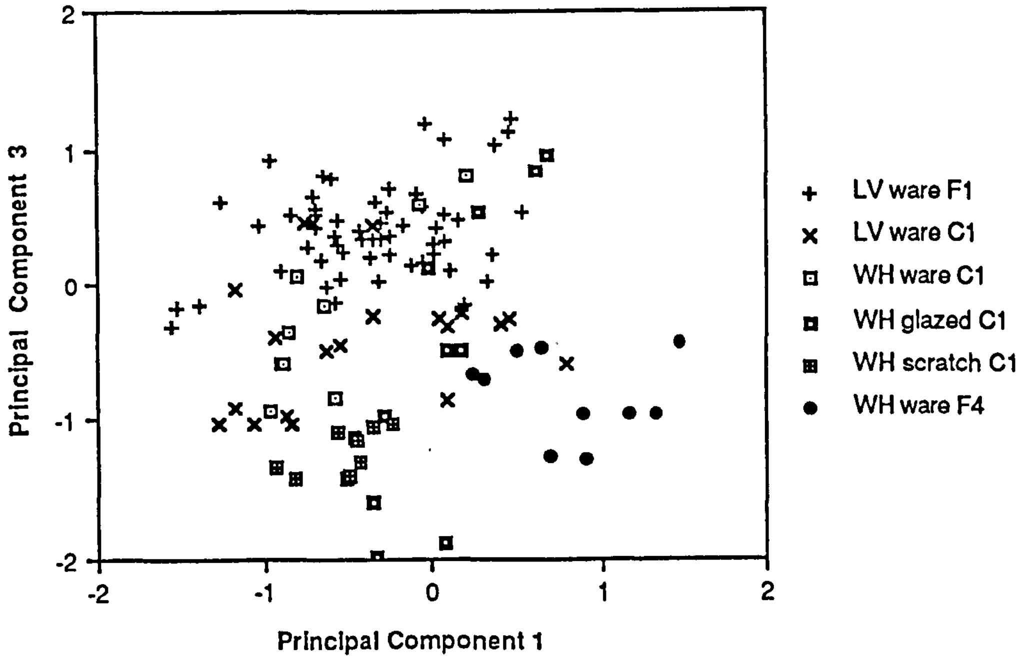


Figure 5.72

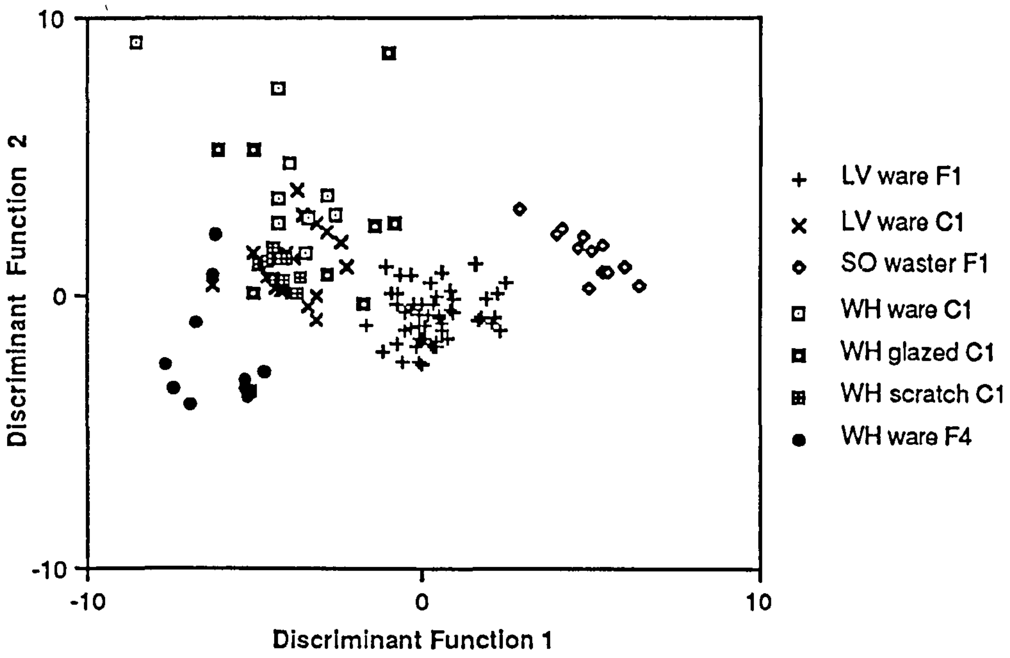

Discriminant functions derived to separate Laverstock products and Southampton wasters. WH sherds added as 'unknowns'.

Figure 5.73

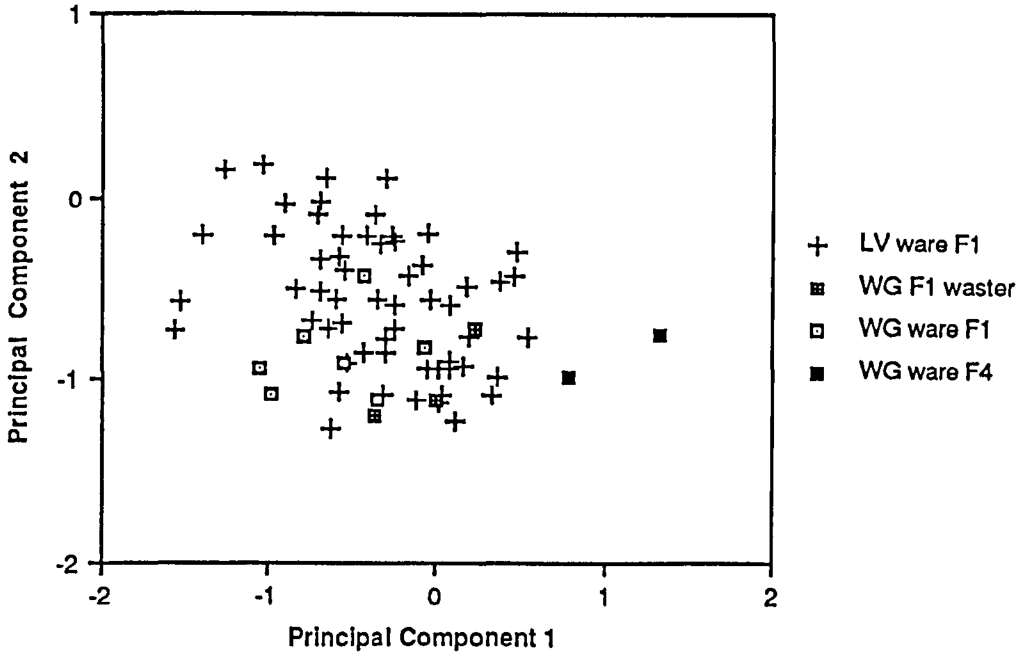
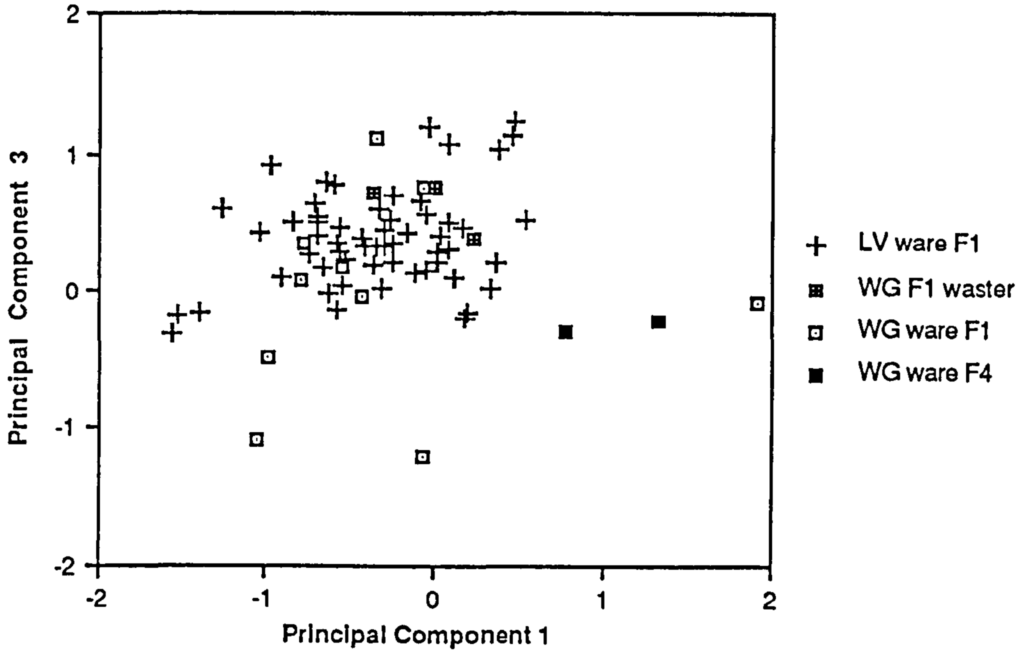

Scatterplot of Laverstock and West Grimstead fine wares. Principal components derived from fine & coarse wares data.

Figure 5.74


Scatterplot of Laverstock and West Grimstead fine wares.

Principal components derived from coarse & fine wares data.

Figure 5.75

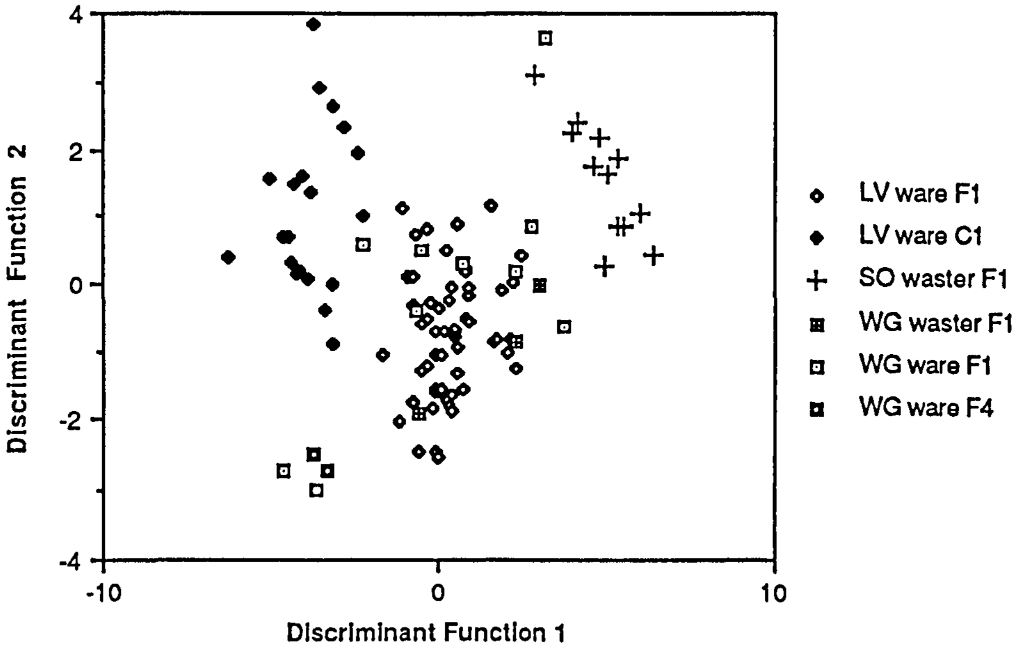

Discriminant functions derived to separate Laverstock products and Southampton wasters. WG sherds added as 'unknowns'.

Figure 5.76

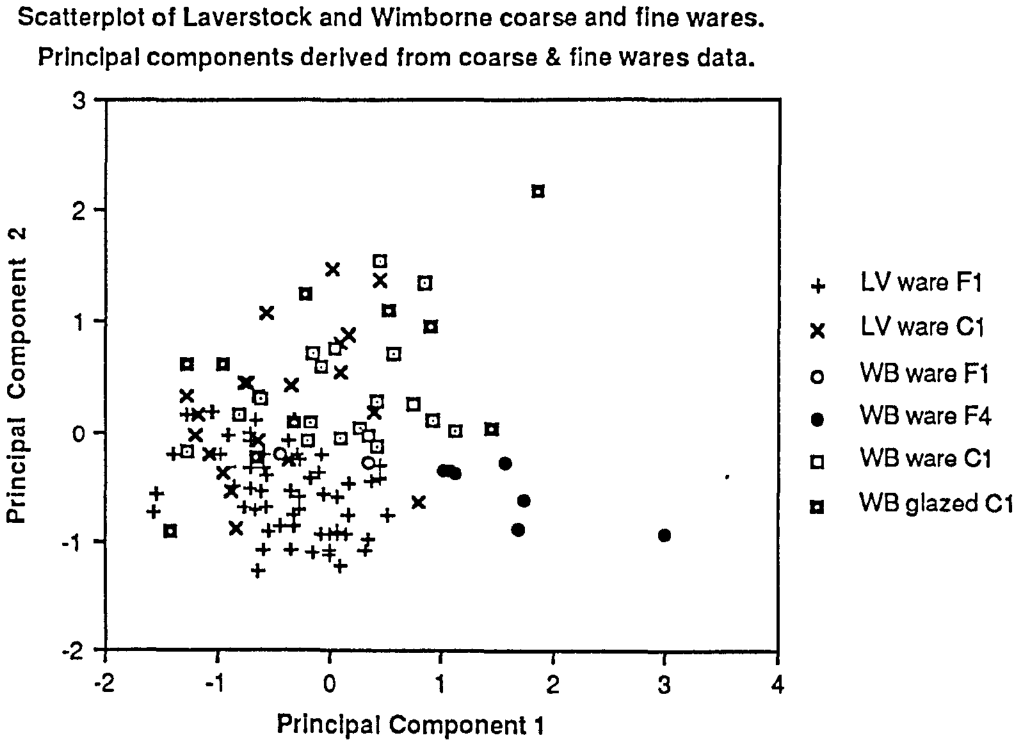


Figure 5.77

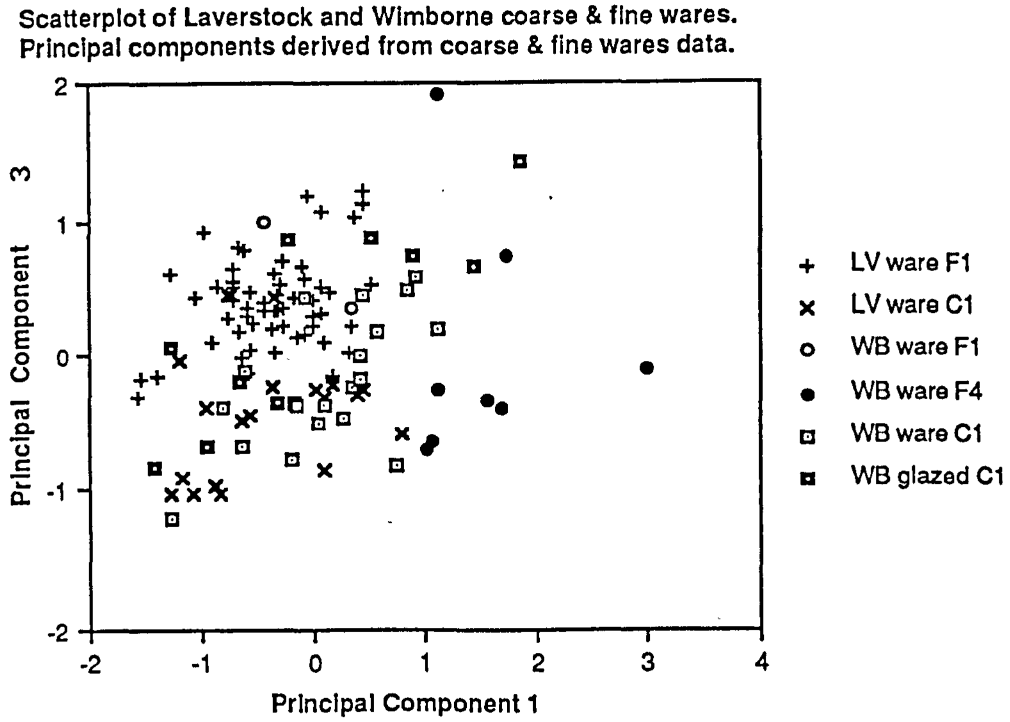


Figure 5.78

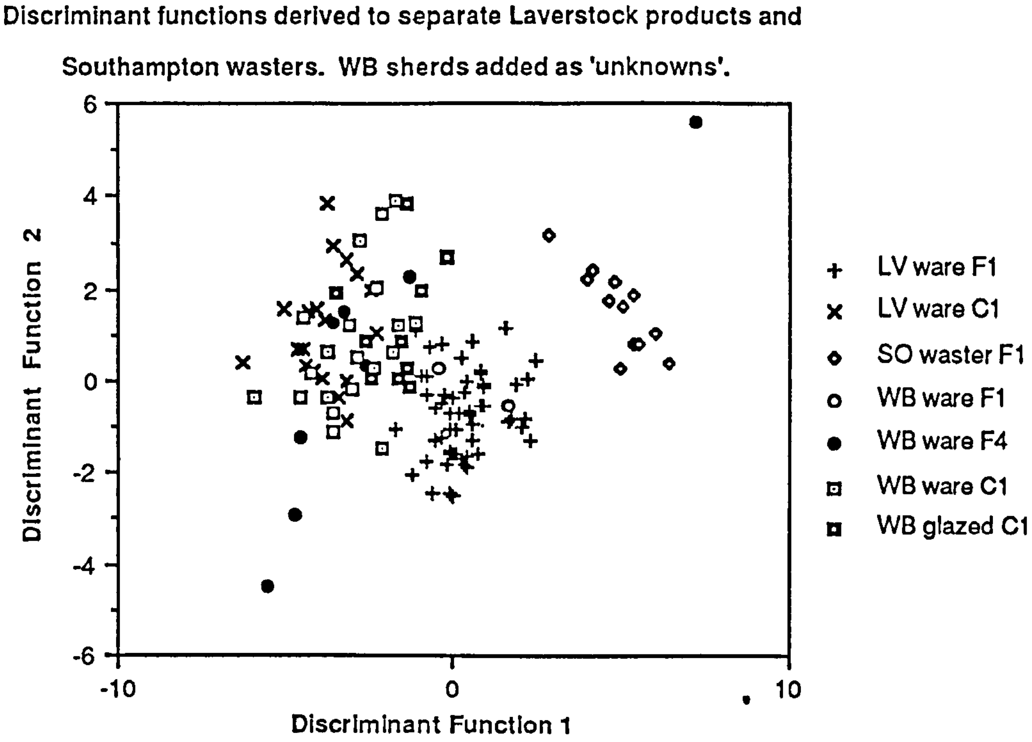


Figure 5.79

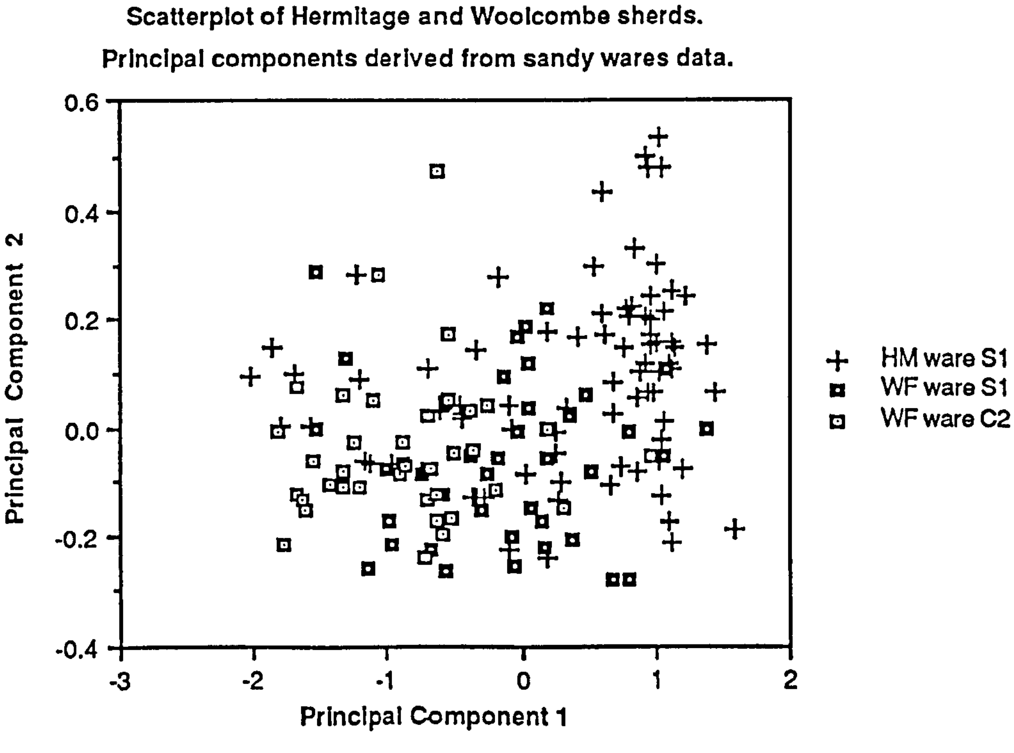


Figure 5.80

Scatterplot of Hermitage sherds and Woolcombe wares S1 & C1
Principal components derived from sandy wares data.

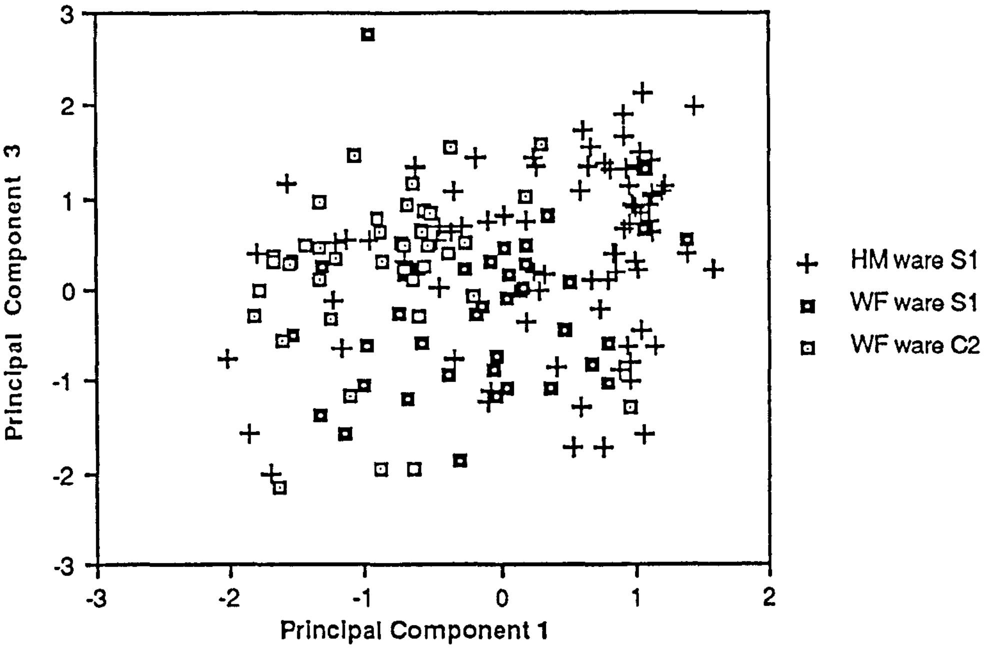


Figure 5.81

Discriminant functions derived to separate Hermitage S1, Sherborne S4 and Laverstock C1 sherds. WF sherds added as 'unknowns'.

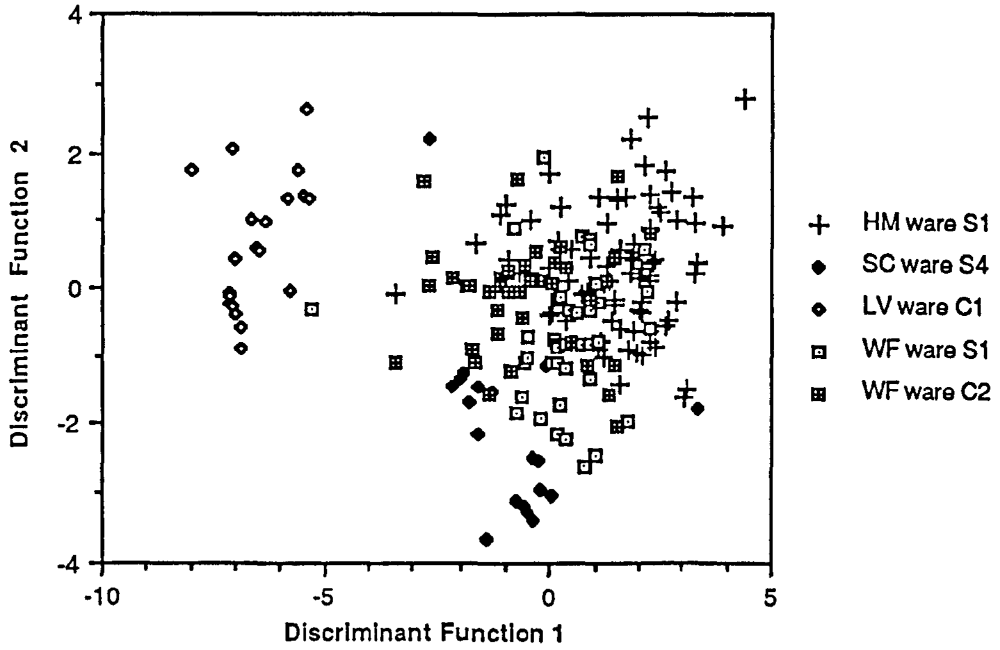


Figure 5.82

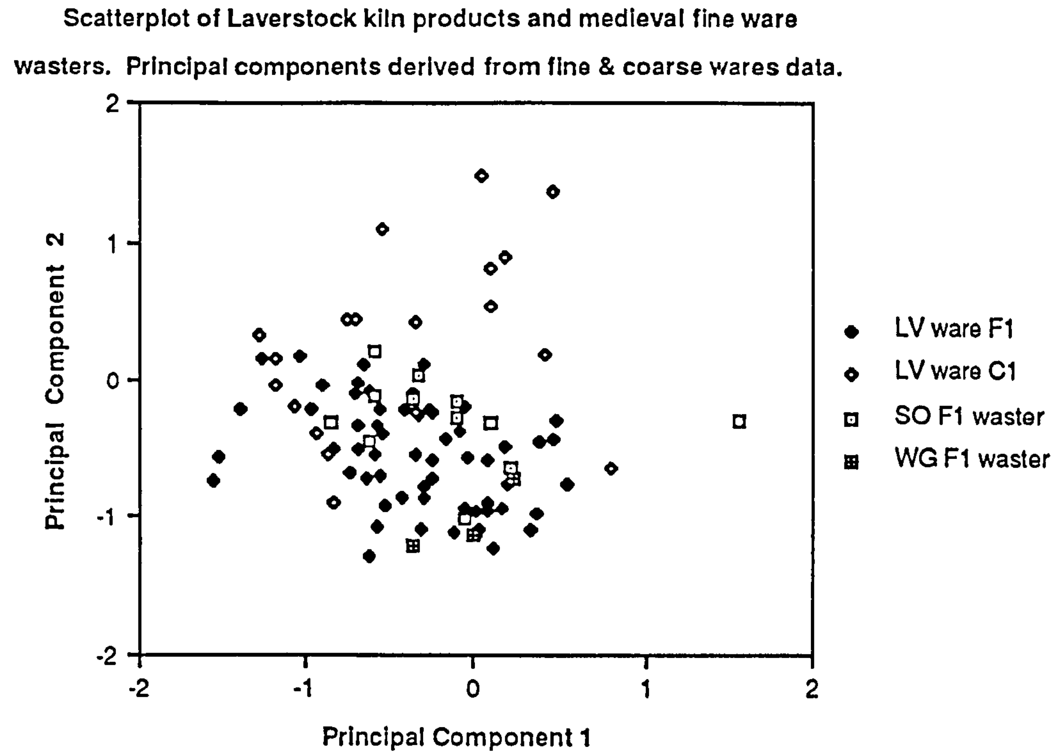

Scatterplot of Laverstock kiln products and medieval fine ware wasters. Principal components derived from fine & coarse wares data.

Figure 5.83

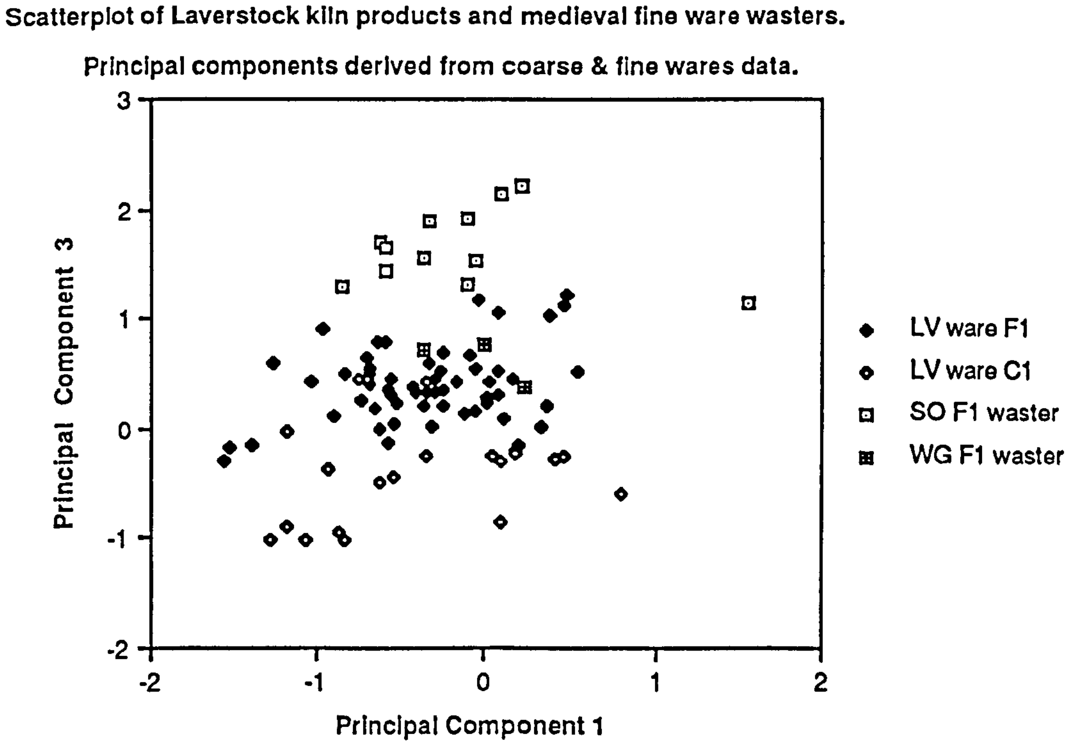
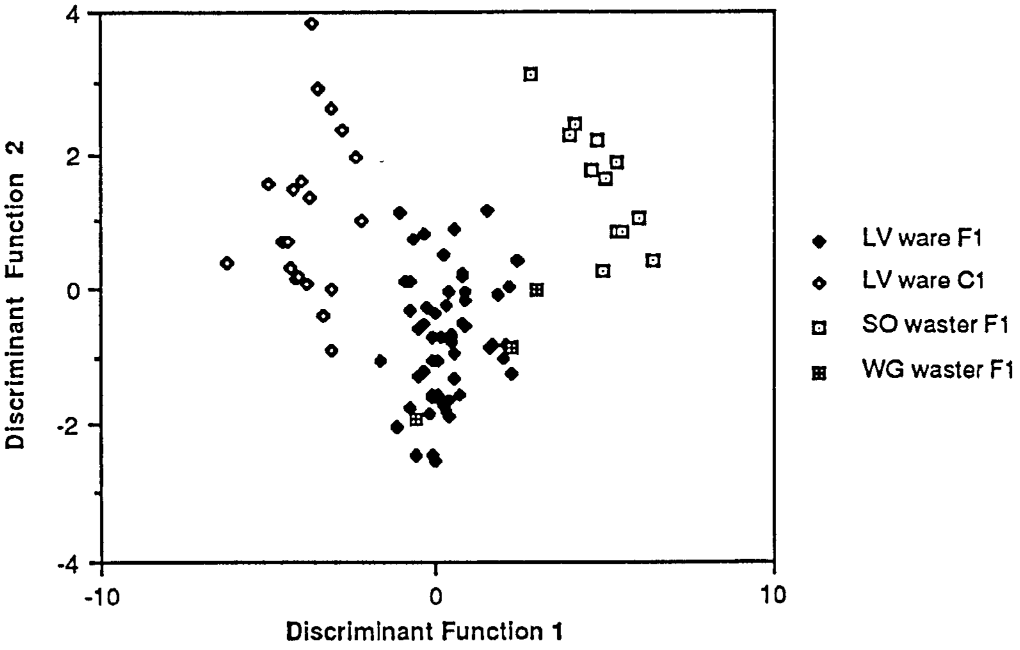
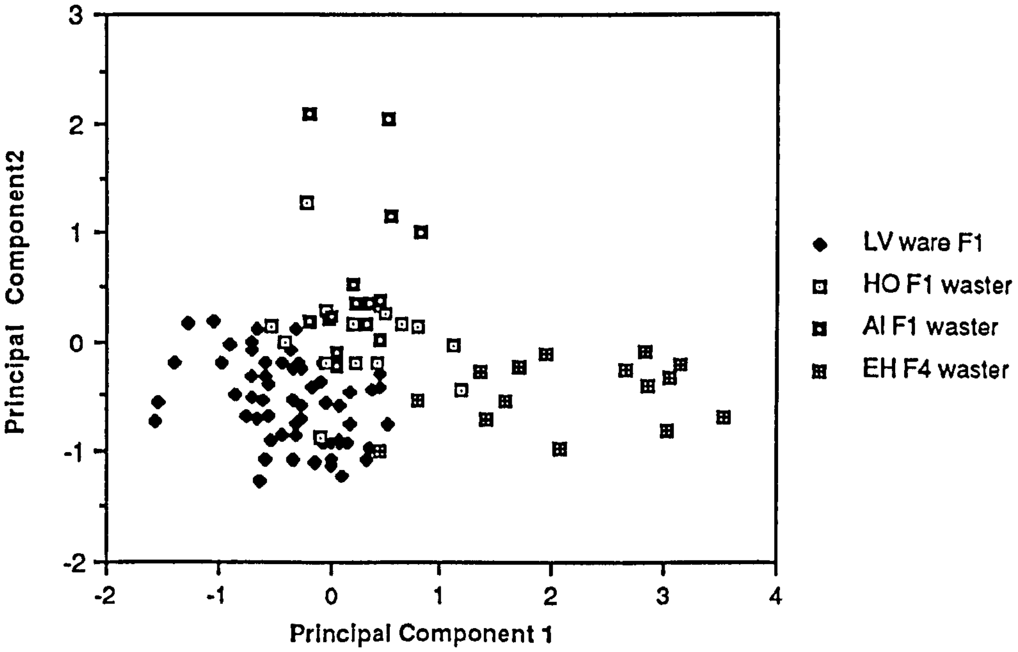

Scatterplot of Laverstock kiln products and medieval fine ware wasters. Principal components derived from coarse & fine wares data.

Figure 5.84



Discriminant functions derived to separate Laverstock products and Southampton wasters. West Grimstead wasters added as 'unknowns'.

Figure 5.85



Scatterplot of Laverstock, Horton, Alderholt and East Holme fine wares. Principal components derived from coarse & fine wares data.

Figure 5.86

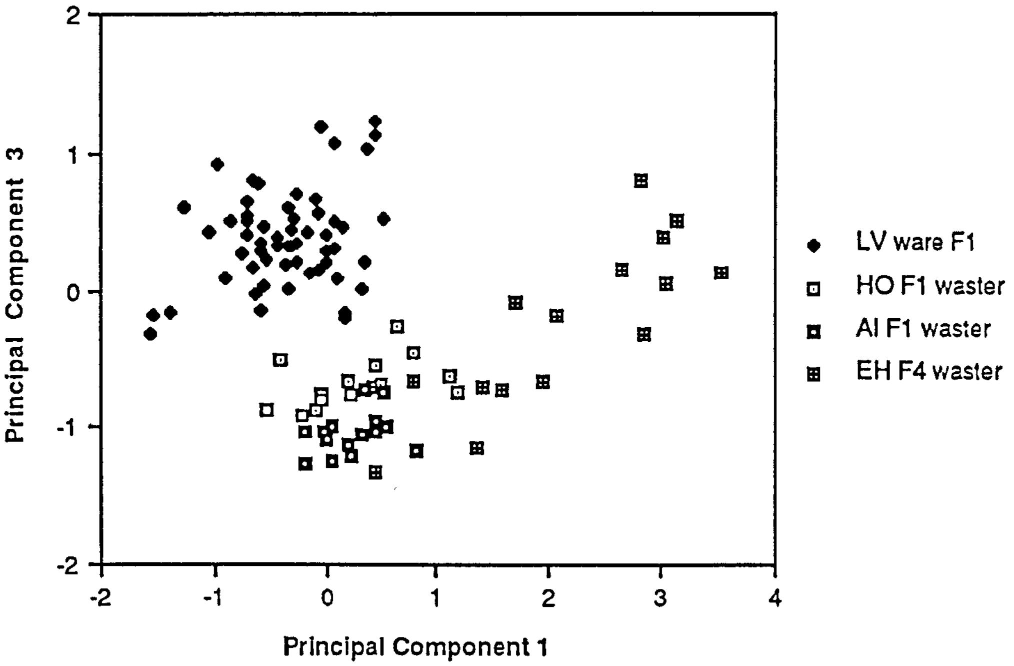

Scatterplot of Laverstock, Alderholt, East Holme & Horton fine wares.
Principal components derived fron fine & coarse wares data.

Figure 5.87

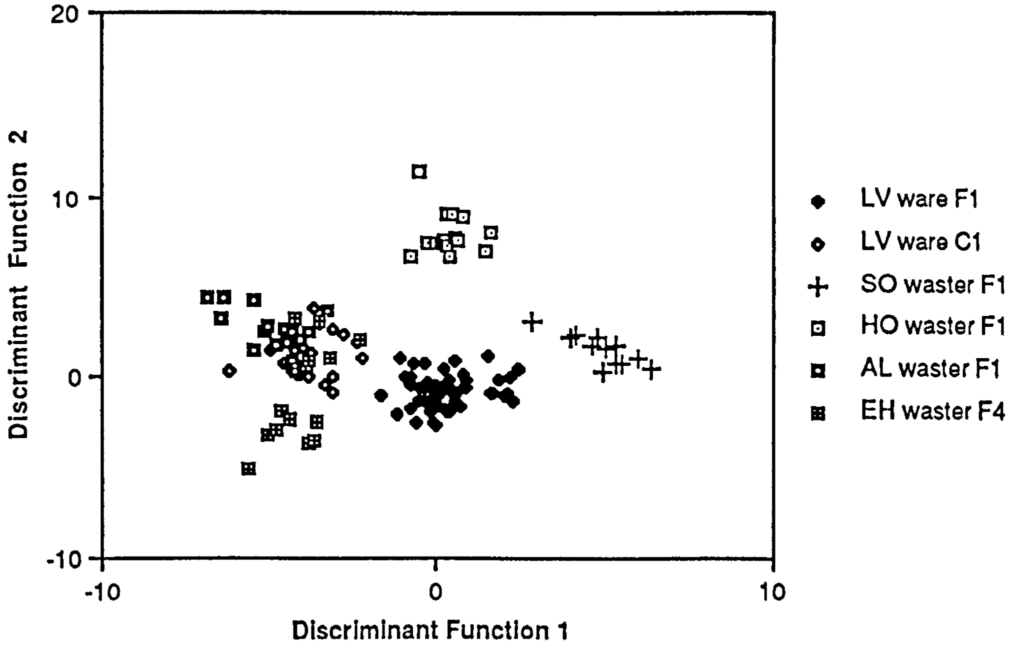

Discriminant functions derived to separate Laverstock products and Southampton wasters. HO, AL & EH wasters added as 'unknowns'.

Figure 5.88

Classification areas for grouping of similarly located sherds in the second coarse wares discriminant analysis. Functions derived to separate the three groups shown.

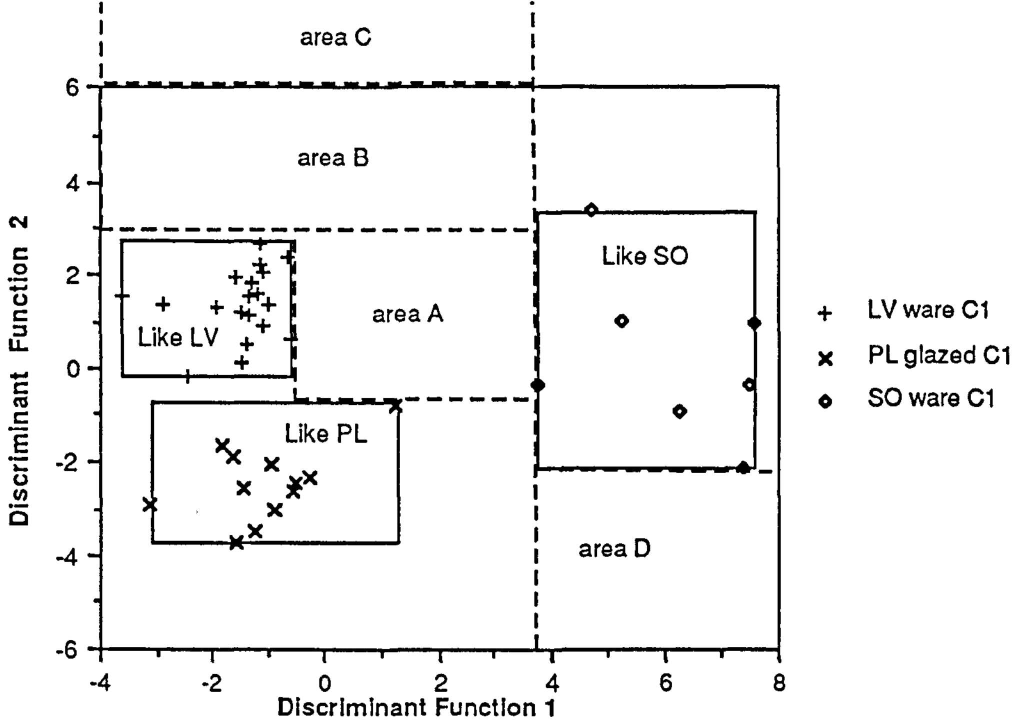


Figure 5.89

Discriminant functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. CH sherds added as 'unknowns'.

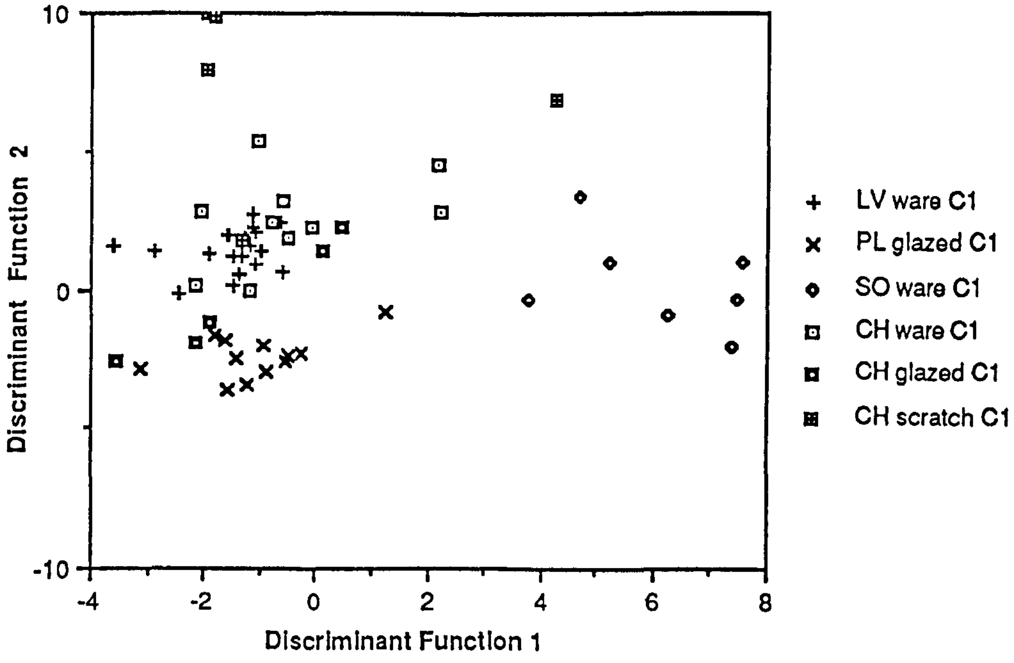


Figure 5.90

Discriminant Functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. CC and HW sherds added as 'unknowns'.

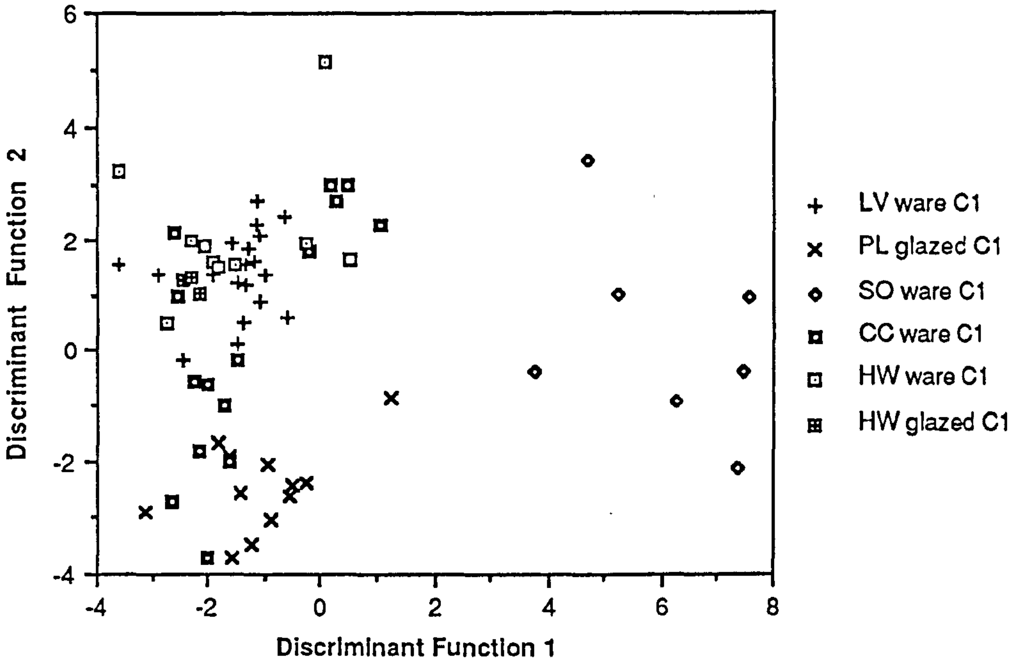


Figure 5.91

Discriminant functions derived to separate ware C1 sherds from Laverstock, Poole and Southampton. DP and PS sherds added as 'unknowns'.

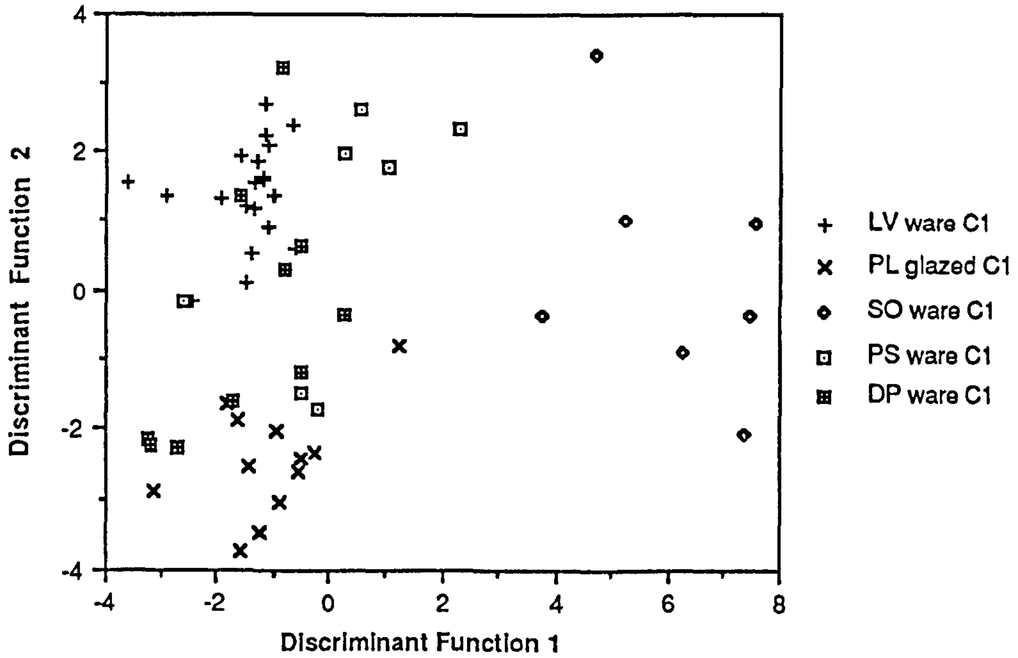


Figure 5.92

Discriminant functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. KM and WN sherds added as 'unknowns'.

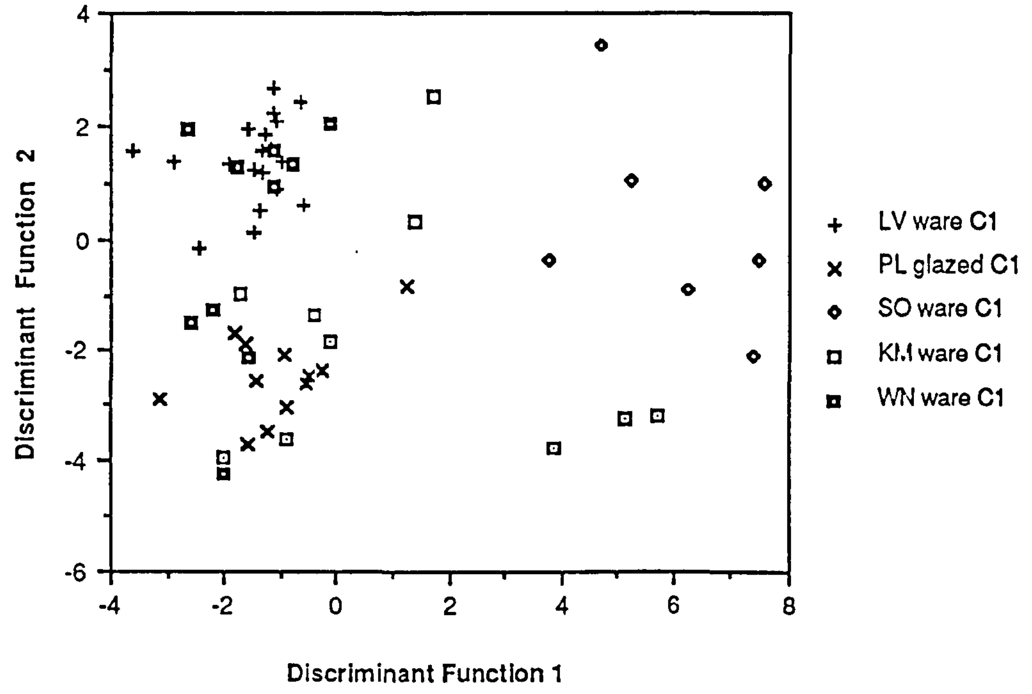


Figure 5.93

Discriminant functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. PL red-painted ware C1 and Southampton ware C2 sherds added as 'unknowns'

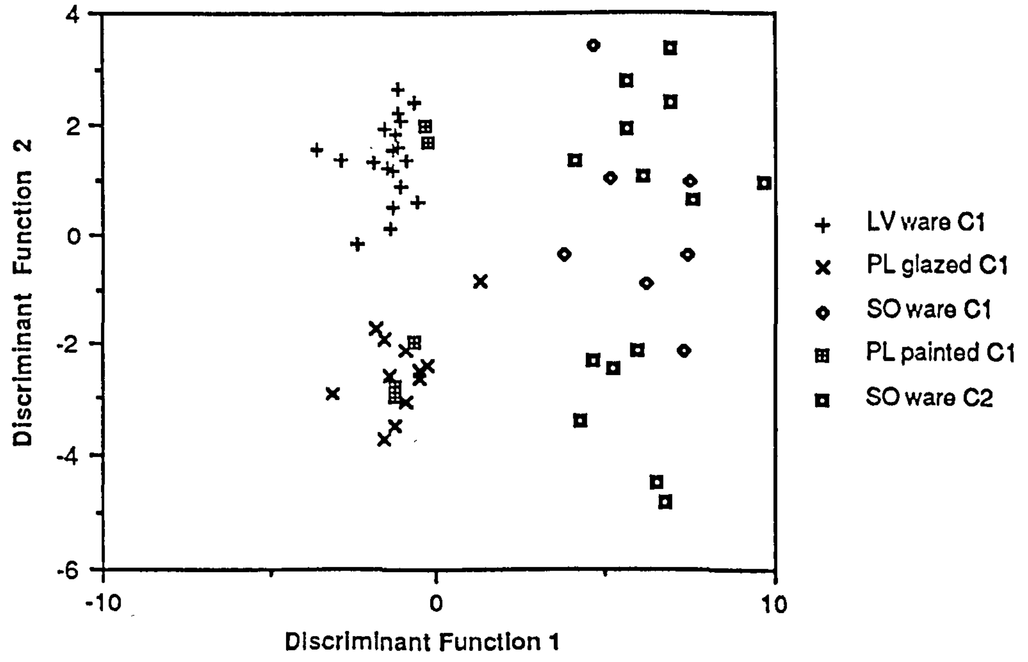


Figure 5.94

Discriminant functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. PX and WT sherds added as 'unknowns'.

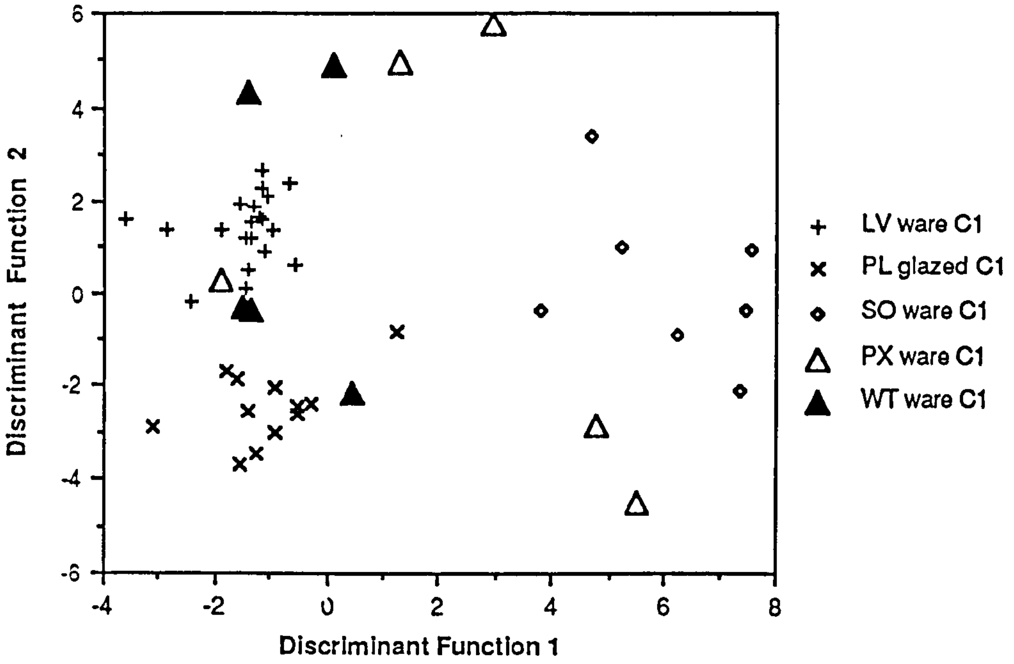


Figure 5.95

Discriminant functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. ST and SC sherds added as 'unknowns'.

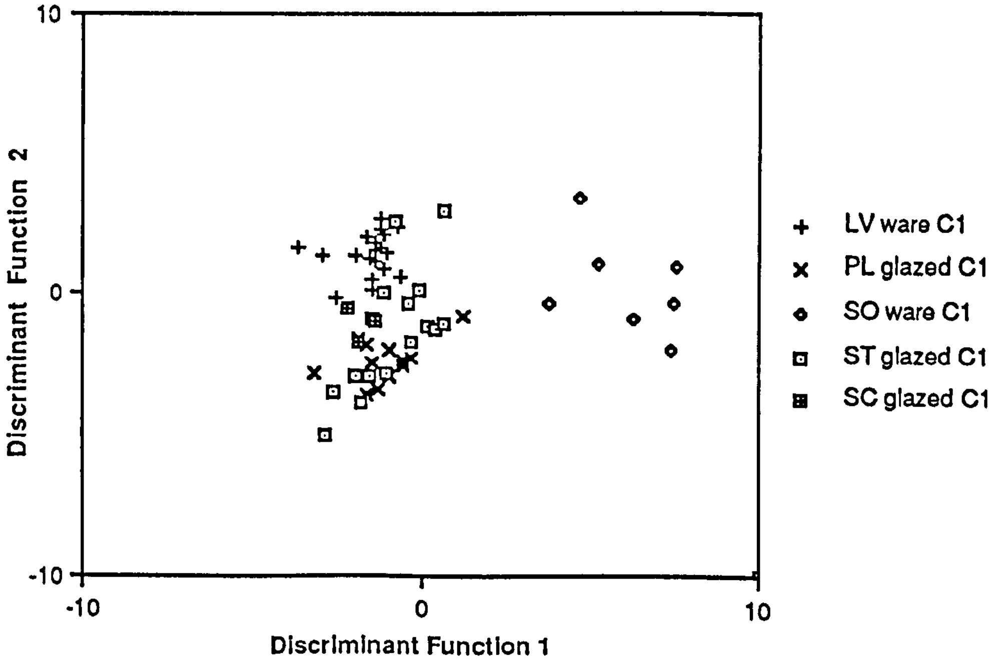


Figure 5.96

Discriminant functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. WB sherds added as 'unknowns'.

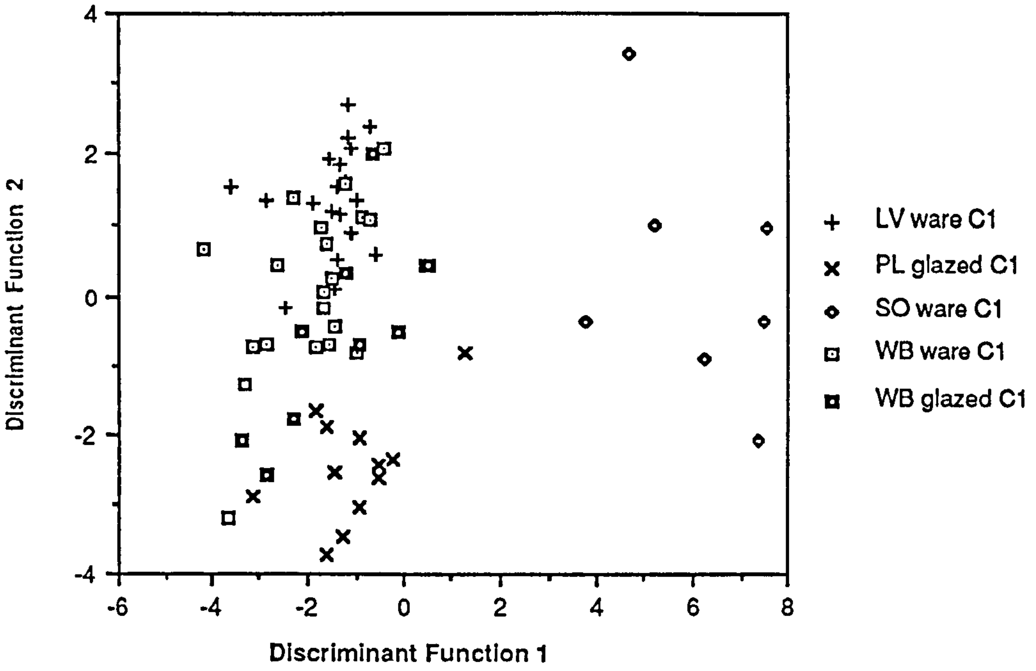


Figure 5.97

Discriminant functions derived to separate Laverstock, Poole and Southampton ware C1 sherds. WH sherds added as 'unknowns'.

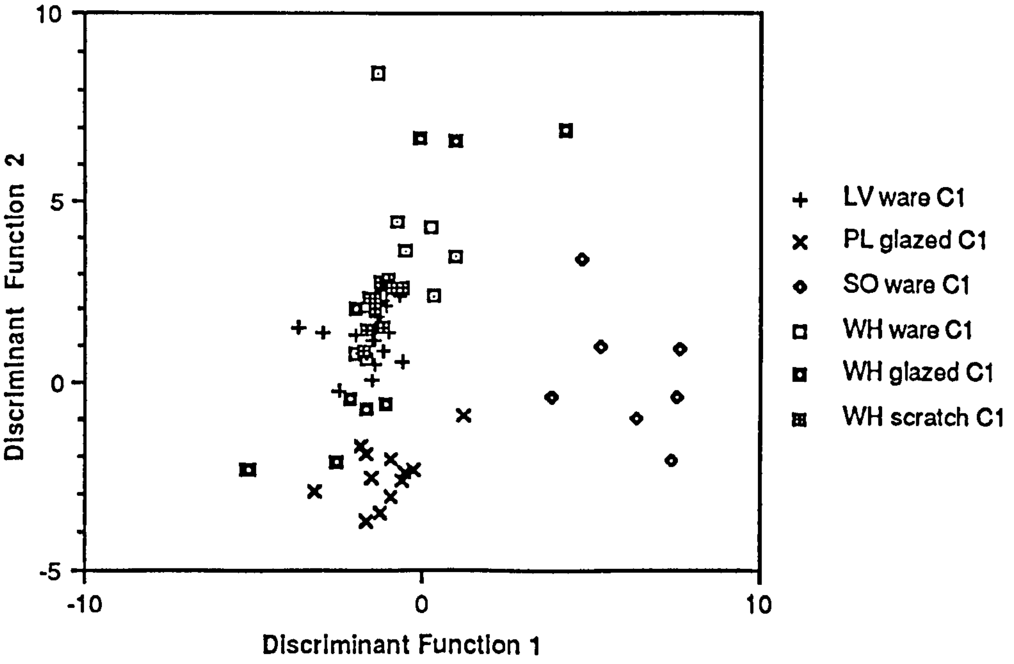
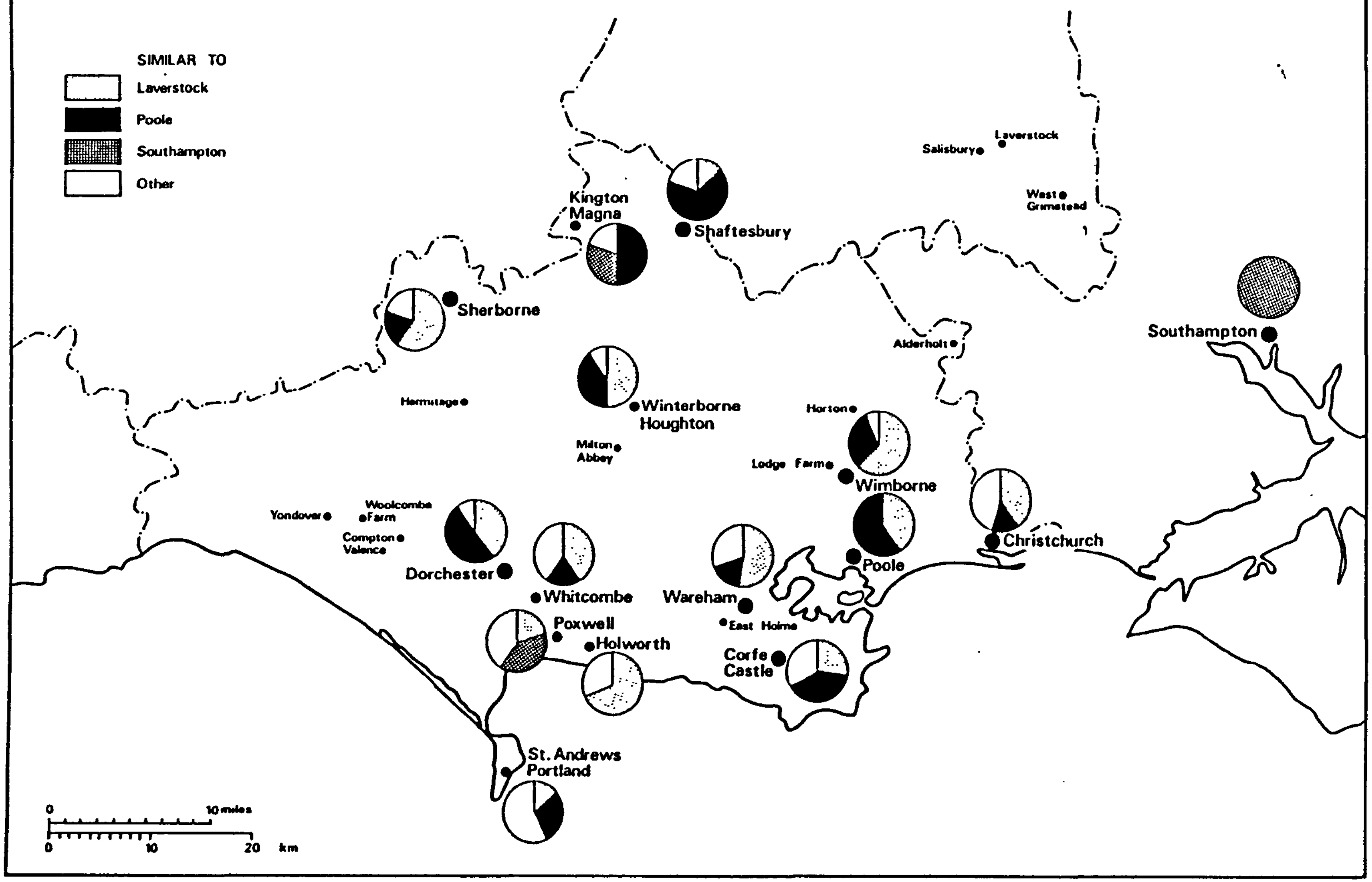


Figure 5.98

Figure 5·99

Percentage of coarse ware sherds analysed that are similar to the separated groups in the second discriminant analysis



Discriminant functions derived to separate Laverstock and Southampton wasters and Corfe sherds. AL, HO and EH wasters added as 'unknowns'.

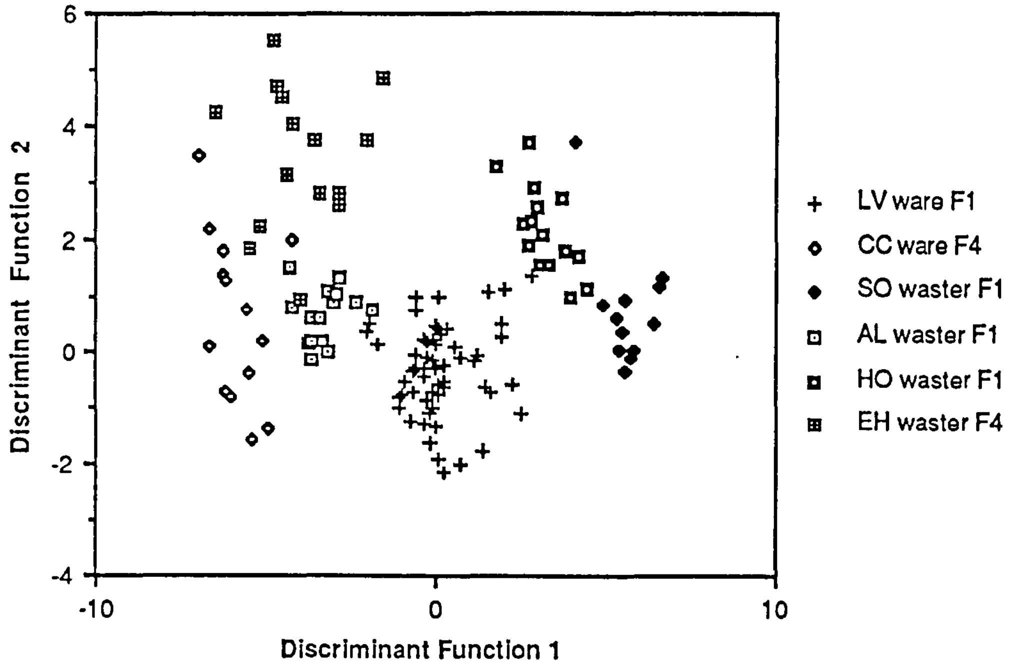


Figure 5.100

Discriminant functions derived to separate Laverstock & Southampton wasters and Corfe sherds. CH and WB sherds added as 'unknowns'.

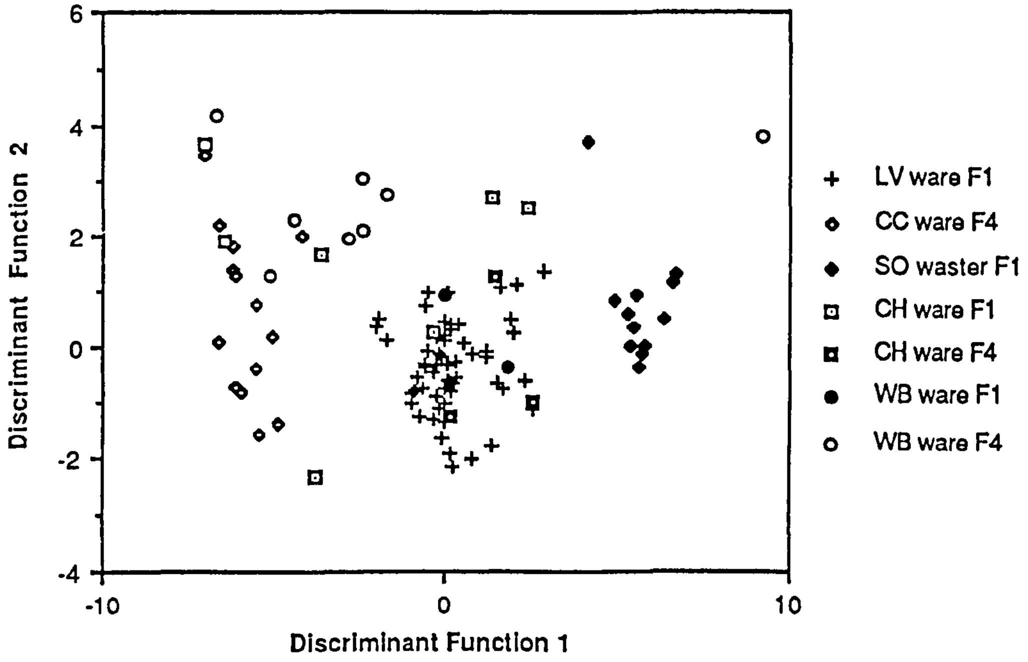
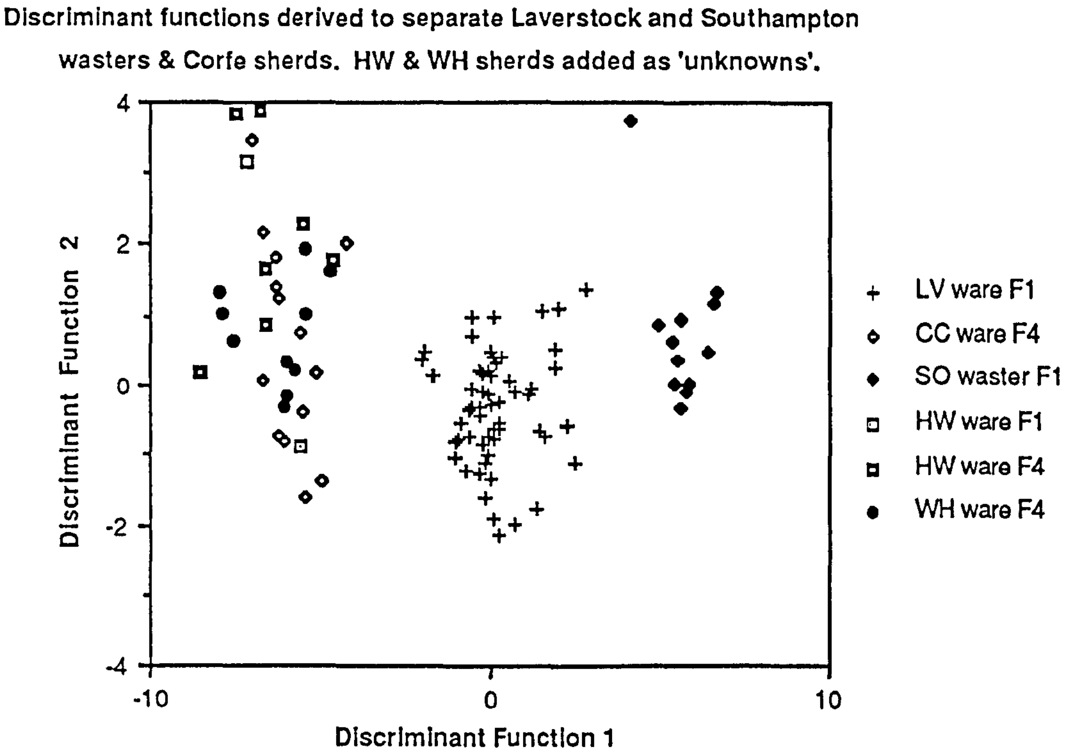
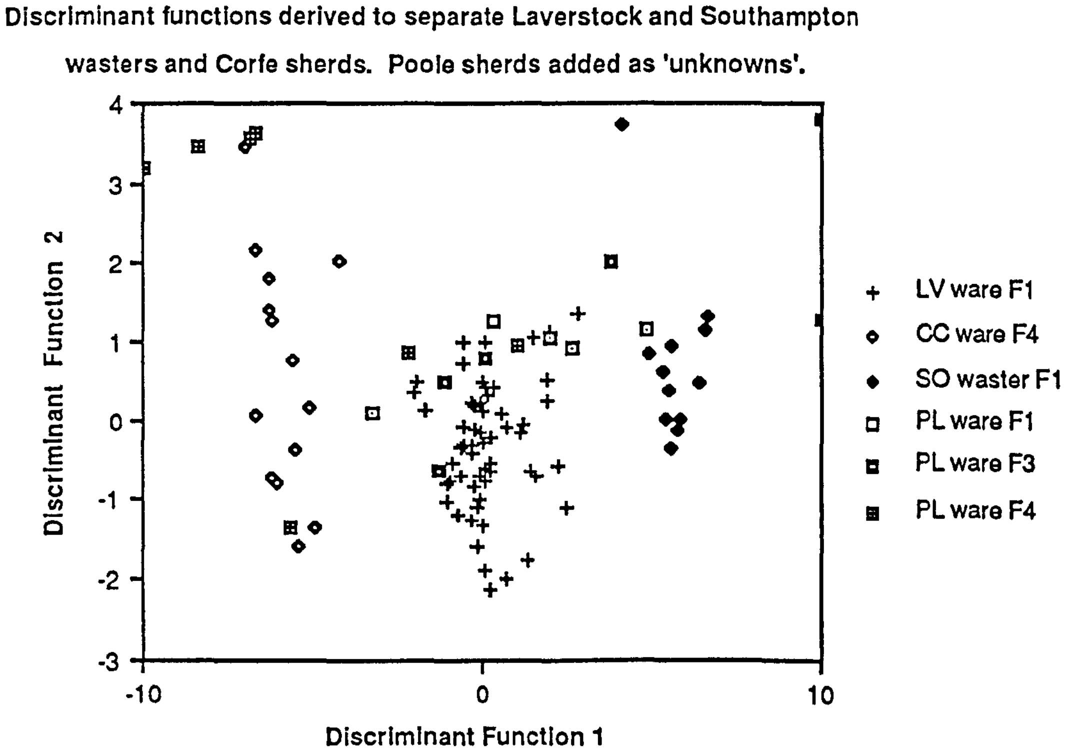


Figure 5.101



Discriminant functions derived to separate Laverstock and Southampton wasters & Corfe sherds. HW & WH sherds added as 'unknowns'.

Figure 5.102



Discriminant functions derived to separate Laverstock and Southampton wasters and Corfe sherds. Poole sherds added as 'unknowns'.

Figure 5.103

Discriminant functions derived to separate Laverstock and Southampton wasters and sherds from Corfe. Salisbury sherds added as 'unknowns'.

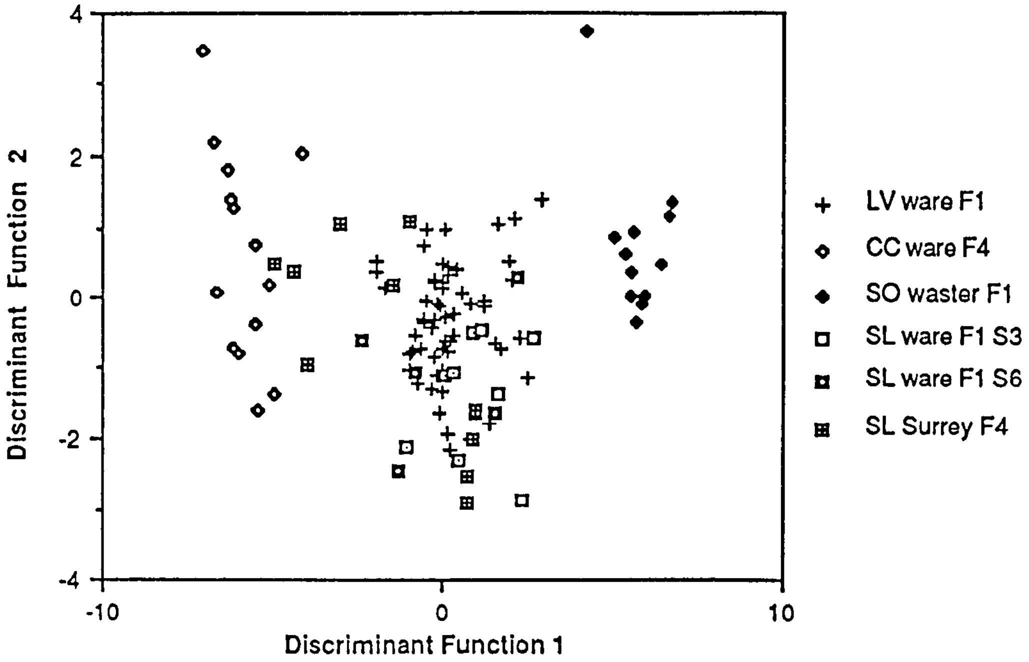


Figure 5.104

Discriminant functions derived to separate Laverstock and Southampton wasters and Corfe sherds. Shaftesbury sherds added as 'unknowns'.

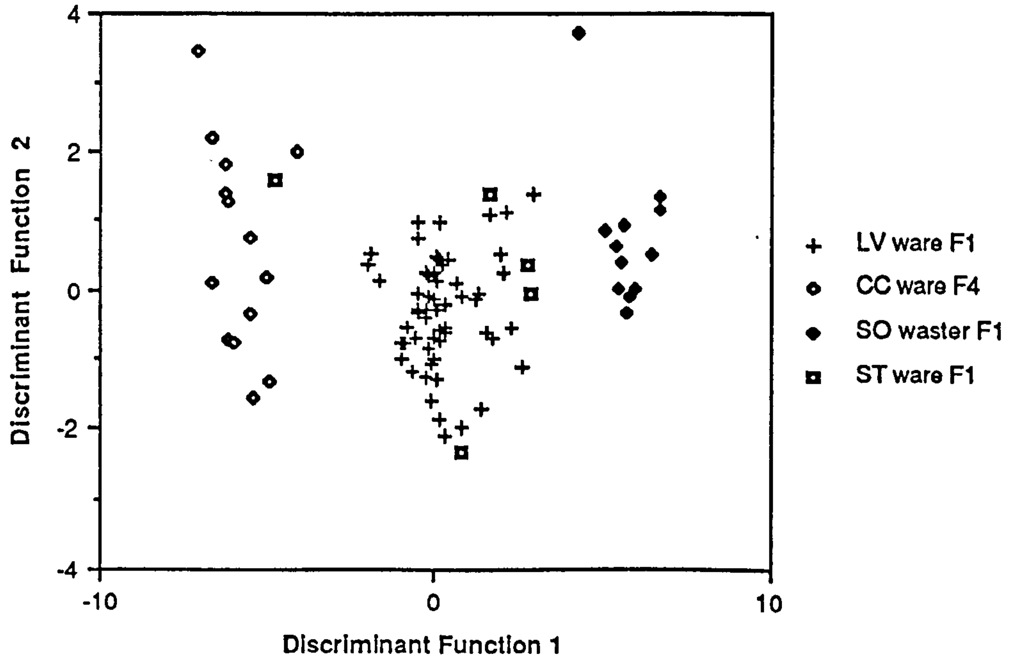


Figure 5.105

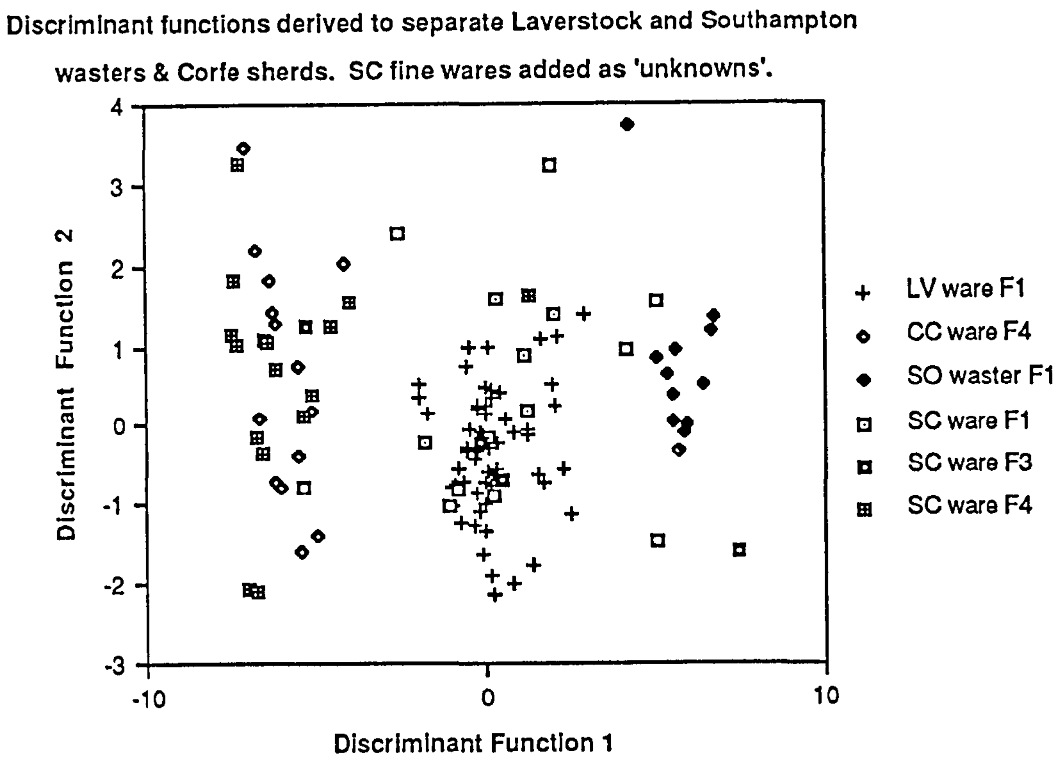

Discriminant functions derived to separate Laverstock and Southampton wasters & Corfe sherds. SC fine wares added as 'unknowns'.

Figure 5.106

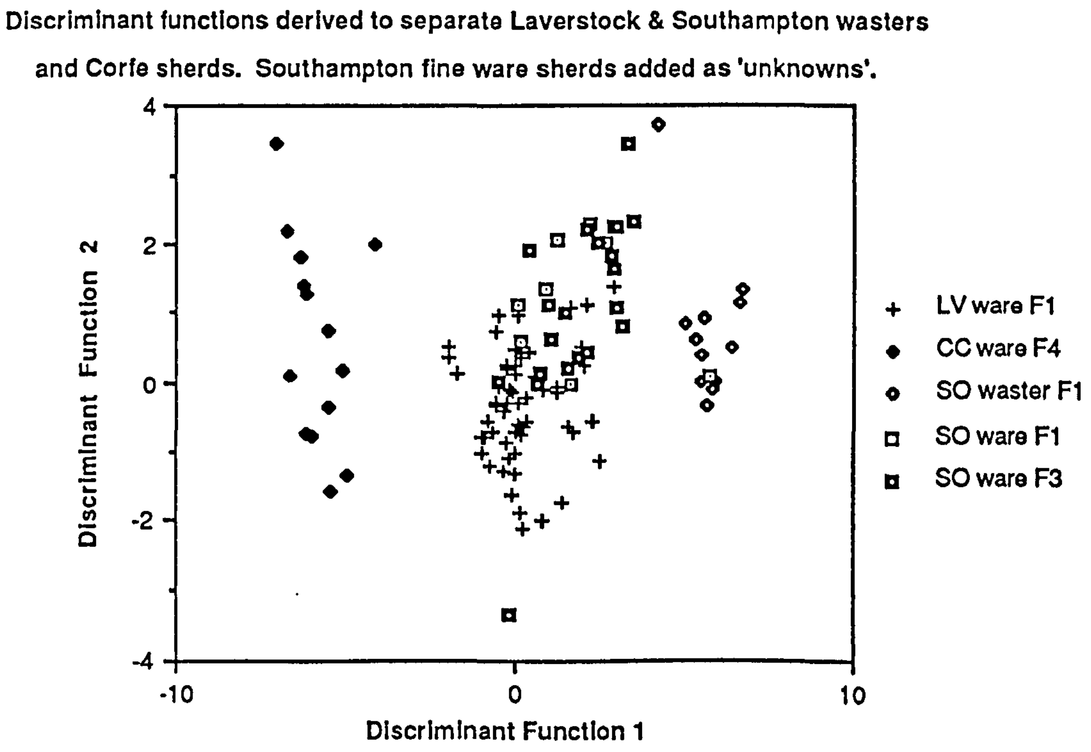

Discriminant functions derived to separate Laverstock & Southampton wasters and Corfe sherds. Southampton fine ware sherds added as 'unknowns'.

Figure 5.107

Discriminant functions derived to separate Laverstock and Southampton wasters and Corfe sherds. WG wasters and sherds added as 'unknowns'.

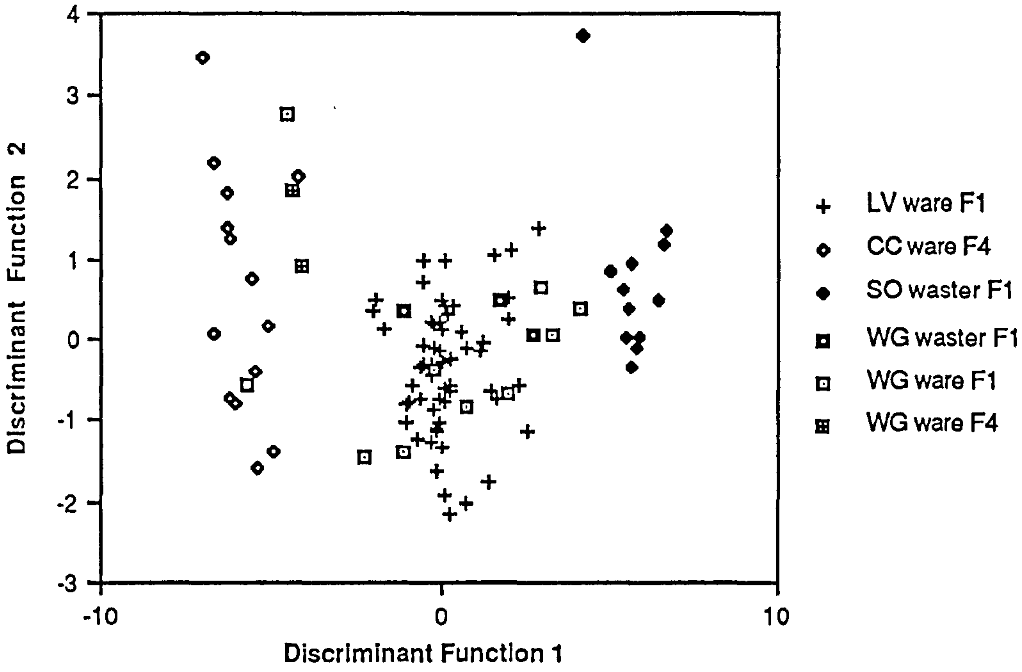


Figure 5.108

Figure 6·1

Sandy wares as percentages of the total 'site assemblage' (as defined in Chapter 2).

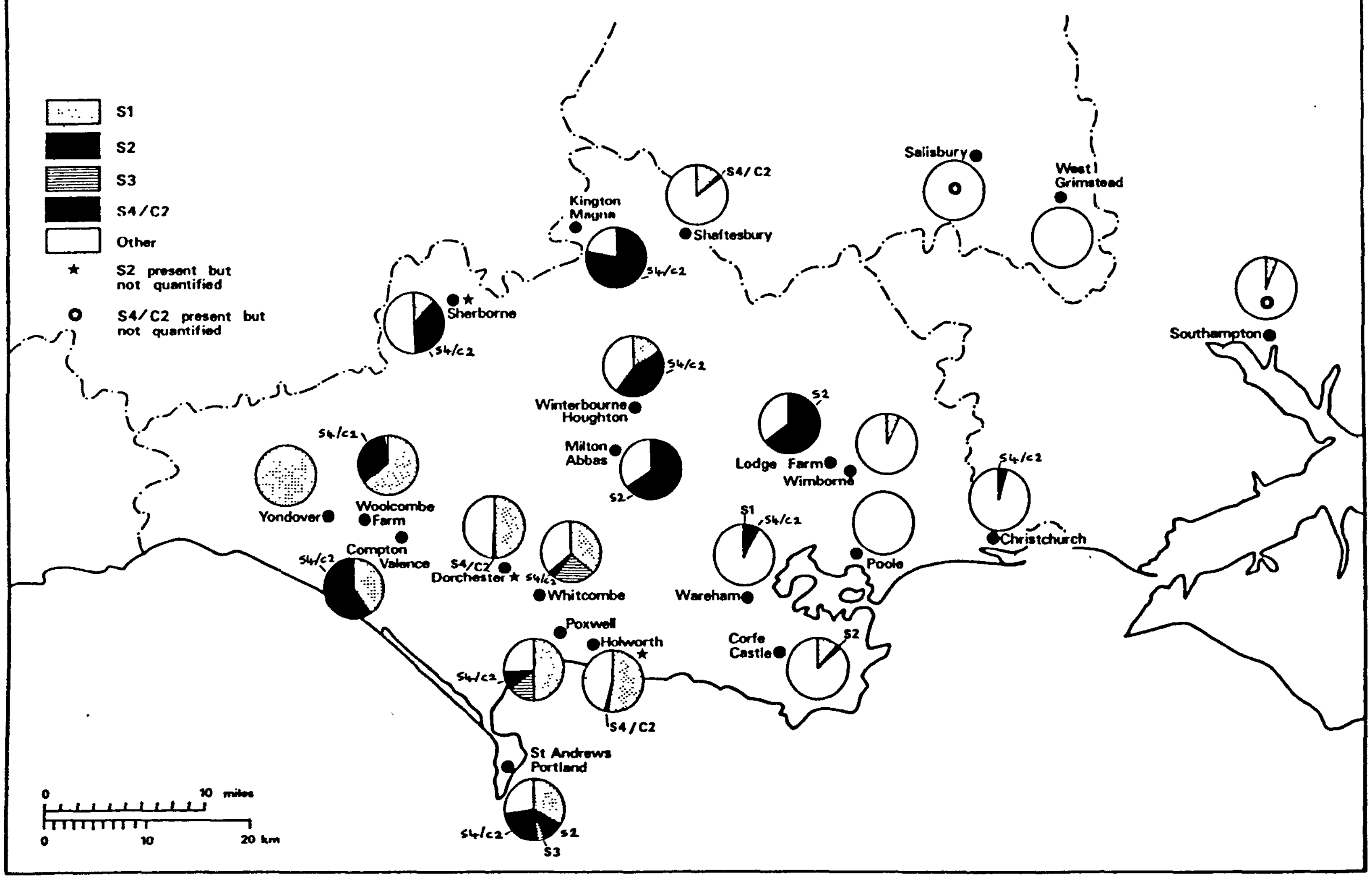


Figure 6·2

Wares S1, C1 and S4/C2 as percentages of the total 'site assemblage' (as defined in Chapter 2).

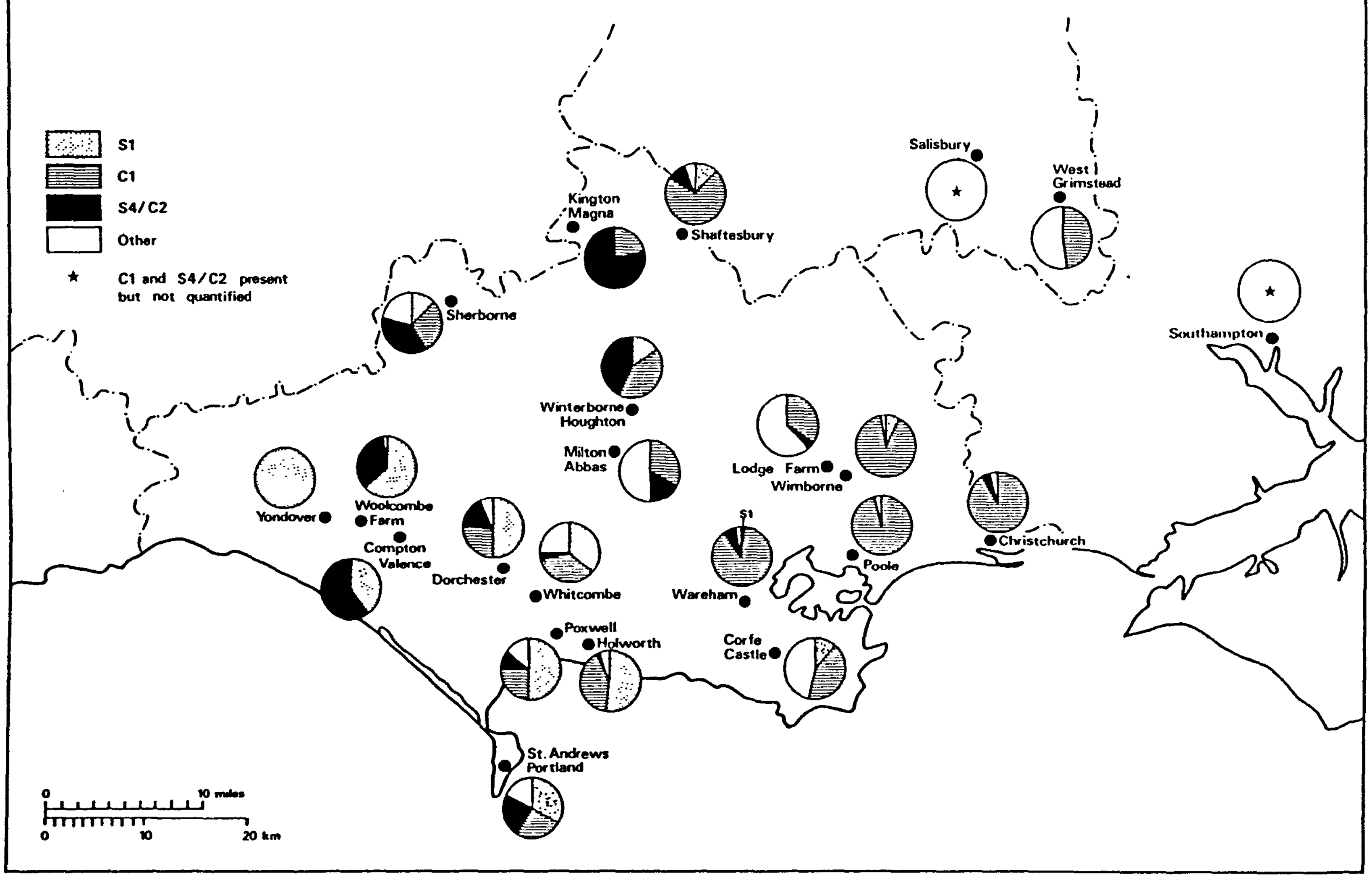


Figure 6·3

25% occurrence contours in central Dorset

(As explained in Section 6·1)

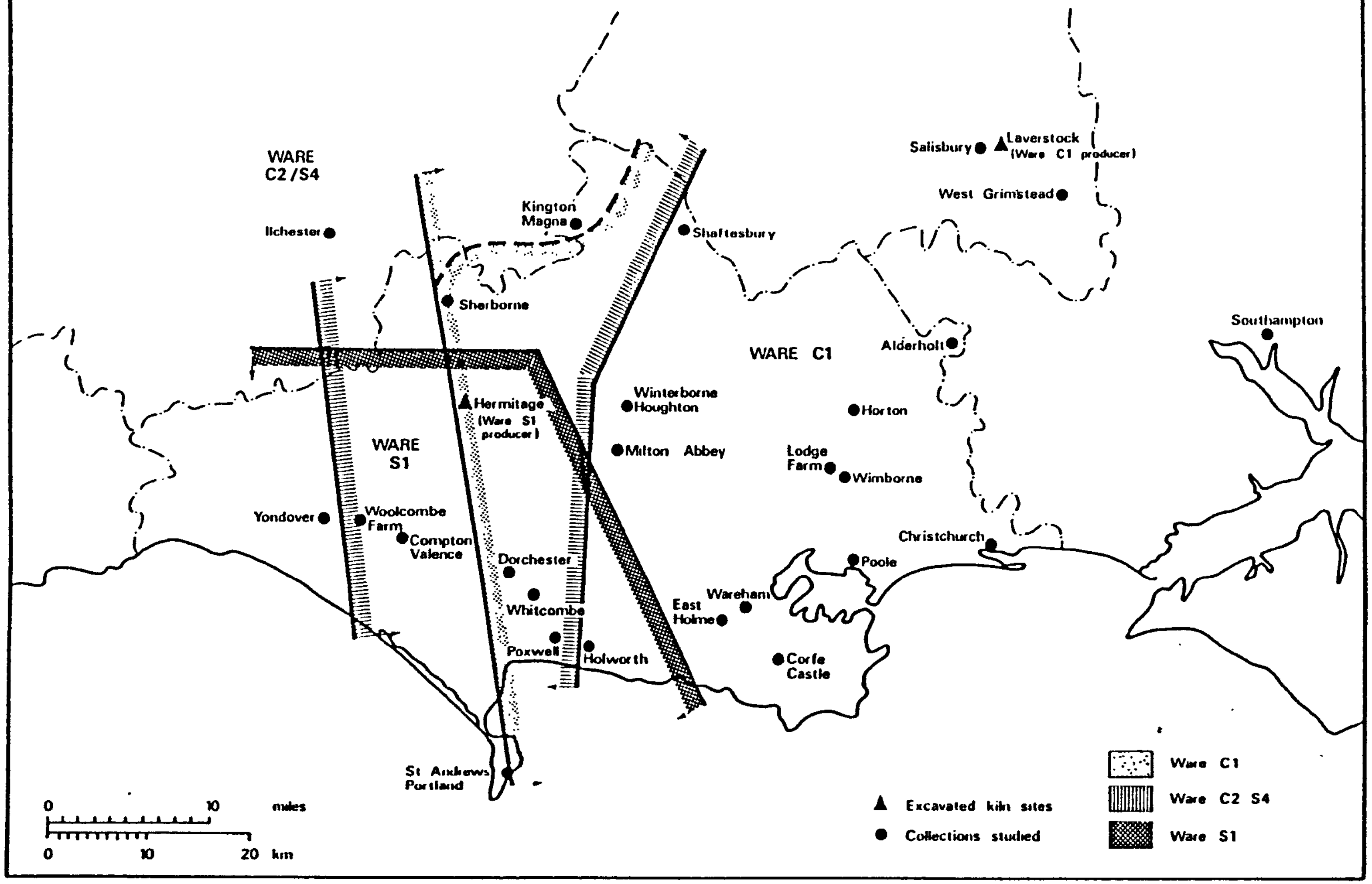


Figure 6·4

Presence of fine wares in collections studied

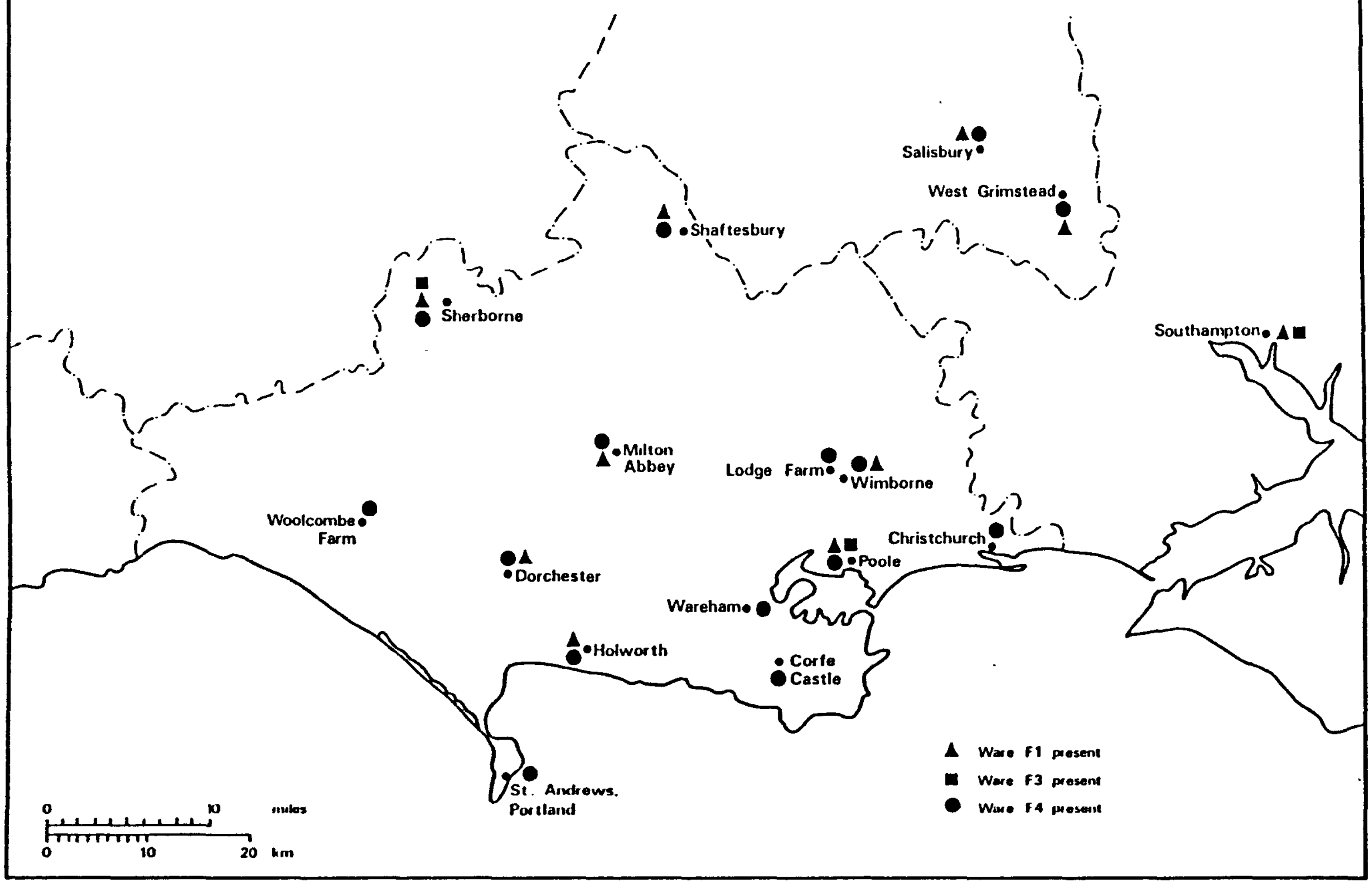


Figure 6·5

Chemically identified ware C1 types as percentages of the site assemblages

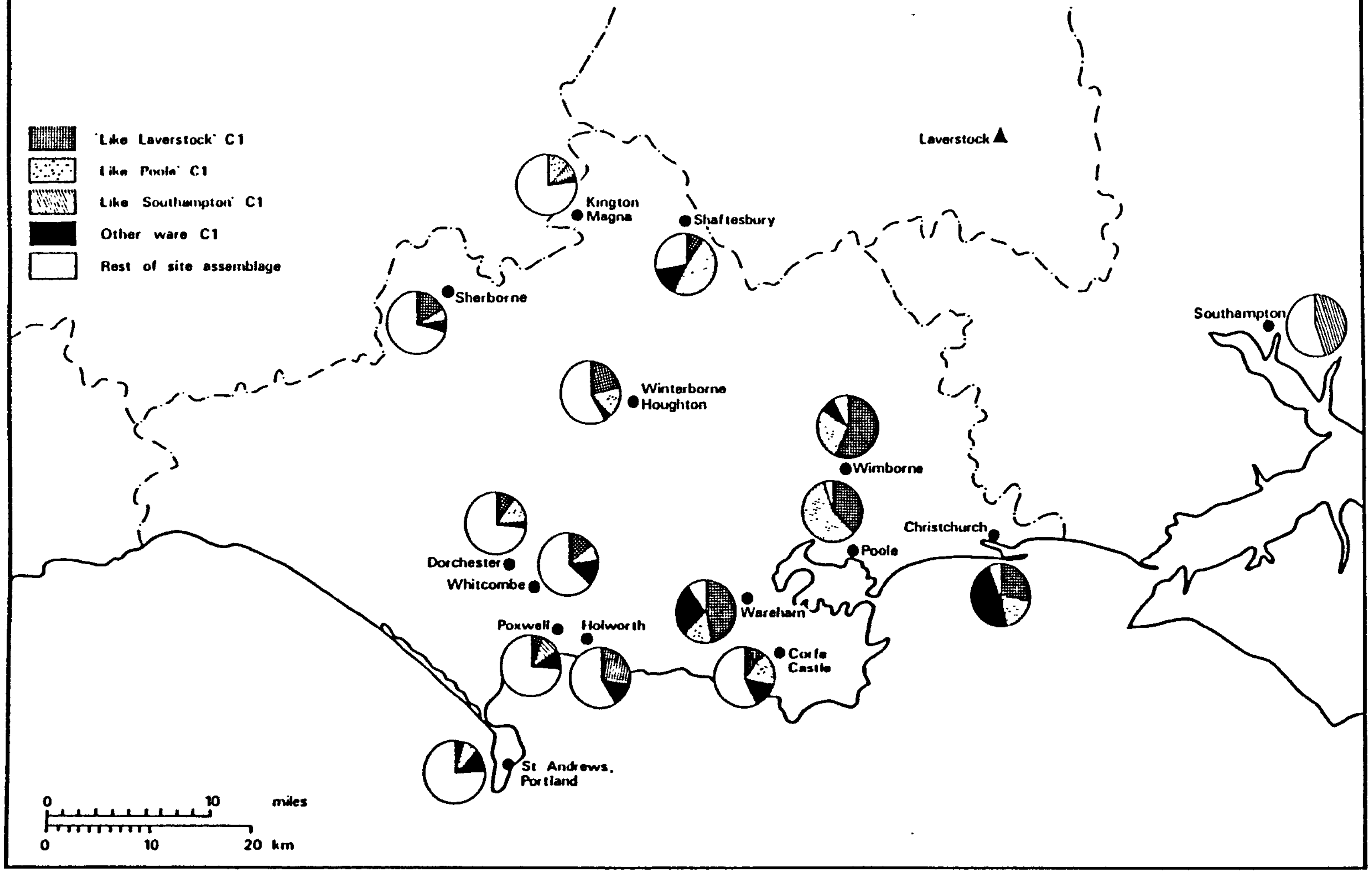


Figure 6 6

Representation of the 'Ideal Explanation' of the archaeological and analytical information concerning the provenace of fine white wares (ware F4) in the study region

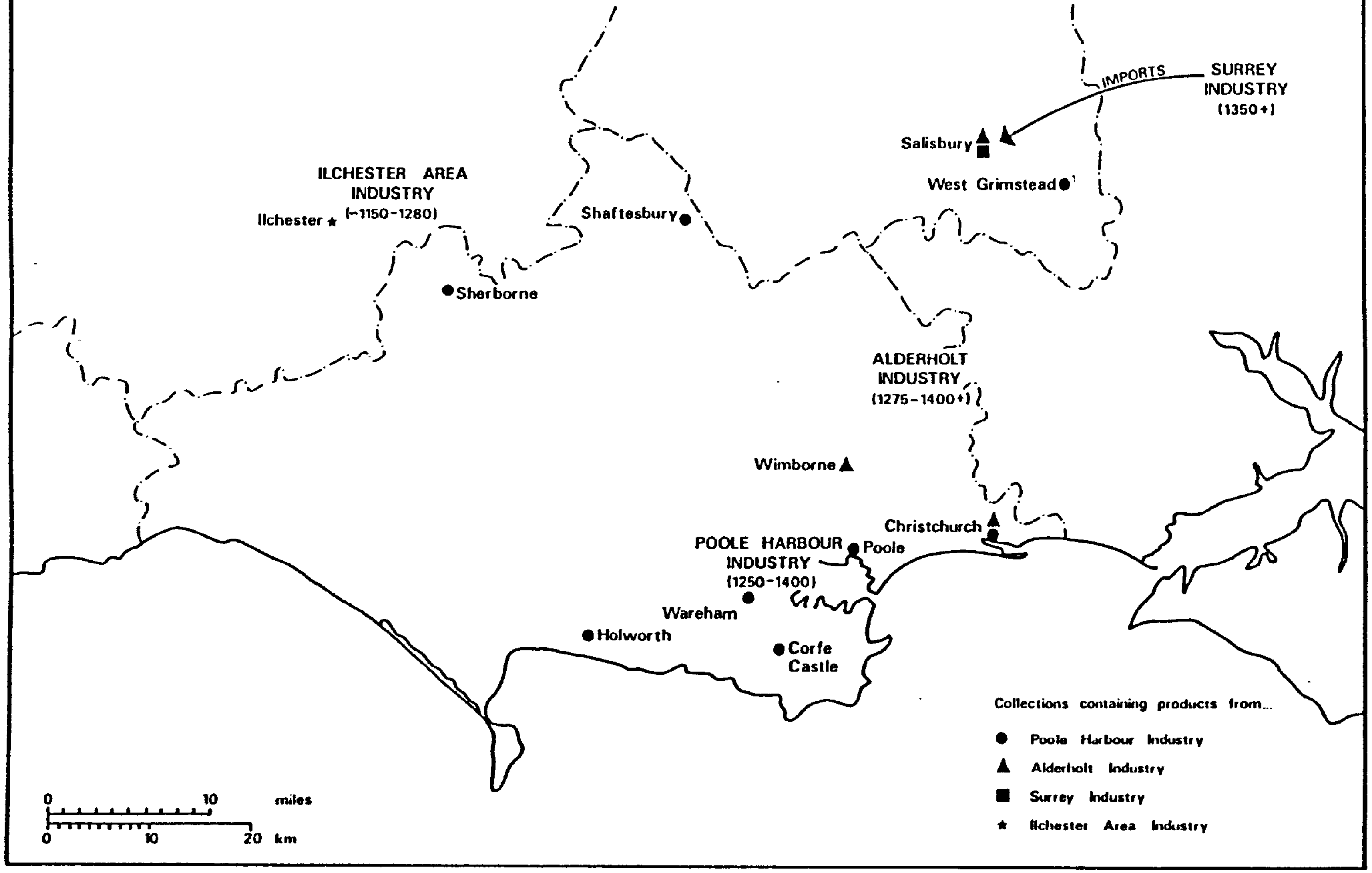


Table 1.1 Clays in Dorset and the surrounding region

Period	Clay Type	Used at?
Lias (Lower Jurassic)	Eype Clay	Lias clays used at Gloucester
	Downcliff Clay	
Middle Jurassic	Fullers Earth Clay	Not suitable
	Frome Clay	
	Forest Marble	Not suitable
Upper Jurassic	Kellaway Clay	Not suitable?
	Nothe and Sandfoot Clays	
	Oxford Clay	Hermitage-Blackmore Vale and Minety
	Kimmeridge	Shaftesbury?
Lower Cretaceous	Wealden Clay	
	Lower Greensand Clay	Not suitable?
	Gault Clay	Nash Hill, Crockerton & in South East
Tertiary	Reading Beds Clay	Laverstock, Verwood & in South East
	London Clay	Verwood
	Bracklesham pipe-clay	Poole Harbour?
	Barton Group Clays	
Pleistocene & Recent	Clay With Flints	Not Suitable
	Brickearth	Southampton?

Table 1.2 Ware types in production site material

Ware Description	Ware Code	Production site material in this ware
Sandy Ware	S1	Hermitage HM Fab A
Sandy Fine Ware	F1	Laverstock LV Fab A
		Southampton SOU Fab 1044
		Southampton SOU Fab 1053
		Alderholt Site 10 Fabric
		Horton Site 2 Fabric
Quartz-Gritted Coarse Ware	C1	Laverstock LV Fab B
Flint-Gritted Fine Ware	F2	One Laverstock sherd from pit
Hard Sandy Ware	S2	
Quartz and Flint-Gritted Coarse Ware	C2	
Red Fine Ware	F3	
White Fine Ware	F4	East Holme Kiln Fabric
Flint-Gritted Sandy Ware	S3	Southampton SOU Fab 1230
Coarse Quartz and Flint-Gritted Sandy Ware	S4	Ilchester Wares A and B

Table 1.3 Summary of the ceramics from the excavation at Hermitage

Material Type	No. of pieces	Percentage of total	Percentage of products
Medieval sherds	739	72.50%	84.17%
Medieval ridge tiles	138	13.55%	15.72%
Medieval floor tiles	1	0.10%	0.11%
Post-medieval sherds	131	12.85%	n/a
Fire-bars	11	1.00%	n/a
Totals	1020	100.00%	100.00%

Table 1.4 Form groups of sherds selected for study (Hermitage and Laverstock only)

Number of sherds	Hermitage Kiln	Laverstock Kiln 1	Laverstock Kiln 6
Form A (cooking pots)	10	6	5
Form B (jugs & jars)	10	14	12
Form C (bowls & Dishes	10	0	1
Form D (building materials)	10	0	2

Table 1.5 Additional production site material studied

Site	Ware category	Number of sherds	Date
Southampton SOU 105	F1	12	late 13th - early 14th
Southampton SOU 105	S3	5	late 13th century
West Grimstead	F1	3	late 13th - early 14th
East Holme	F4	15	17th century
Horton Kiln 2	F1	15	mid 17th - early 18th
Alderholt Kiln 10	F1	15	mid 17th - mid 18th

Table 2.1 Urban status points scores, by 1300, for all 'towns; in Dorset and the surrounding region

Centre	Points	Centre	Points	Centre	Points
Dorset		**East Hampshire**		**South Somerset**	
Abbotsbury	8	Andover	9	Bruton	9
Beaminster	4	Beaulieu	2	Castle Cary	6
Blandford Forum	10	Fordingbridge	3	Chard	8
Bridport	14	Lymington	9	Crewkerne	5
Cerne Abbas	8	Ringwood	3	Glastonbury	10
Charmouth	3	Romsey	11	Ilchester	14
Christchurch	14	Southampton	16	Ilminster	5
Corfe Castle	9	Stockbridge	7	Langport	10
Cranborne	7	Whitchurch	6	Milborne Port	7
Dorchester	16	Winchester	24	Montacute	11
Gillingham	4			Somerton	10
Lyme Regis	10	**South Wiltshire**		Stoford	8
Milton Abbas	6	Amesbury	8	Wincanton	6
Poole	10	Downton	8	Yeovil	9
Shaftesbury	14	Hindon	5		
Sherborne	14	Mere	6		
Stalbridge	4	Old Sarum	7		
Sturminster Newton	6	Salisbury	17		
Wareham	12	Wilton	13		
Weymouth/Melcombe	9				
Wimborne Minster	12				

Table 2.2 Urban centres in each 'natural region'

Natural region		Region size	Number of urban centres of group...			
No.	Name	(as def. in text)	1	2	3	4
1	Heathland	large	3	3	4	0
2	Chalk	large	0	5	1	0
3	South Dorset	small	0	3	0	0
4	Blackmore Vale	medium	1	4	2	0
5	W. Vales &Downs	small	2	1	1	0
6	Blackdown Hills	small	0	2	0	0
7	Somerset Plain	medium	1	7	1	0
8	Salisbury Plain	large	1	6	2	1

Table 2.3 Excavations in urban centres in each 'natural region'

Natural region		Region size	Number of urban centres of group...			
No.	Name	(as def. in text)	1	2	3	4
1	Heathland	large	1	2	4	X
2	Chalk	large	X	2	1	X
3	South Dorset	small	X	2	X	X
4	Blackmore Vale	medium	0	1	2	X
5	W. Vales &Downs	small	0	0	1	X
6	Blackdown Hills	small	X	0	X	X
7	Somerset Plain	medium	0	3	1	X
8	Salisbury Plain	large	0	2	2	1

Table 2.4 Excavations in main body of towns in each 'natural region'

Natural region		Region size	Number of urban centres of group...			
No.	Name	(as def. in text)	1	2	3	4
1	Heathland	large	0	1	4	X
2	Chalk	large	X	1	0	X
3	South Dorset	small	X	0	X	X
4	Blackmore Vale	medium	0	1	2	X
5	W. Vales &Downs	small	0	0	1	X
6	Blackdown Hills	small	X	0	X	X
7	Somerset Plain	medium	0	1	X	X
8	Salisbury Plain	large	0	2	2	1

Table 2.5 Excavations on monastic sites in 'natural regions'

Natural Regions		Number of monastic sites		Excavated monastic sites	
No.	Name	Rural	Urban	Rural	Urban
1	Heathland	9	6	0	4
2	Chalk	5	3	0	2
3	South Dorset	2	2	0	1
4	Blackmore Vale	1	2	0	1
5	W. Vales and Downs	2	1	0	0
6	Blackdown Hills	1	0	0	0
7	Somerset Plain	3	4	1	2
8	Salisbury Plain	3	21*	0	3

* 7 houses & 3 colleges identified in Winchester
2 houses & 4 colleges identified in Salisbury
2 houses identified in Wilton
From Knowles (1948)

Table 2.6 Settlement sites in alphabetic order

Number	Name	No. of sherds analysed
1	Christchurch	30
2	Compton Valence	20
3	Corfe Castle	30
4	Dorchester Prison	30
5	Holworth	42
6	Kington Magna	30
7	Lodge Farm	10
8	Milton Abbas	20
9	Poole	35
10	Portland, St. Andrews	17
11	Poxwell	15
12	Salisbury	25
13	Shaftesbury	35
14	Sherborne Old Castle	100
15	Southampton	72
16	Wareham, St. Martins	40
17	West Grimstead	15
18	Whitcombe	15
19	Wimborne, Leaze	40
20	Winterborne Houghton	20
21	Woolcombe	80
22	Yondover	20

Table 2.7 The assemblage from sites W8, W9 and W10 at Christchurch (data from Davies (unpub.), with additions)

Ware	Number of sherds				% of Assemblage
	Site W8	Site W9	Site W10	Total	
C1	952	244	1378	2574	91.80%
F4 & C1 glazed	35	0	73	108	3.85%
S4/C2	70	10	39	119	4.24%
Import	0	0	3	3	0.11%

Table 2.8 the assemblage from Compton Valence

Ware	No. of sherds	Percentage of total
Sandy ware S1	138	40.35%
Ware S4/C2	204	59.65%
Total	342	100.00%

Table 2.9 The medieval assemblage from the 1987 excavations at Corfe Castle

Ware	No. of sherds	% of assemblage
Coarse ware C1	113	41.50%
Glazed ware C1	<115	<42.3%
Sandy ware S1	29	10.70%
Sandy ware S2	2	0.70%
Fine ware F4	13+	4.8%+
Total	272	100%

Table 2.10 The assemblage from Dorchester Prison

	Ditch 1		Ditch 2		Both ditches	
Ware	no. of sherds	% of total	no. of sherds	% of total	no. of sherds	% of total
Fine wares	7	6%	5	7%	12	6%
ware C1	22	18%	26	34%	48	26%
ware S4/C2	16	13%	17	22%	33	18%
S1 & S2	116	63%	28	37%	144	50%
Total	161	100%	76	100%	237	100%

Table 2.11 The assemblage from Holworth (after Rahtz (1959), with additions)

Ware	Rahtz description and date	New date	no. sherds	% of total	% of this ware in diagnostic
F1 & F4	Glazed (mainly 13th c. jugs)	13-14 cent.	686	4.60%	21%
S1 & S2	Fine unglazed (14-15 cent.)	13-14 cent.	7396	52.40%	40%
C1	Med. unglazed (12-13 cent.)	12-13 cent.	5811	41.30%	37%
S4/C2	Coarse unglazed (12 cent.)	12-13 cent.	165	1.30%	2%
C1	Scratch-marked	12-13 cent.	36	0.30%	n/a
n/a	Post-medieval	16th cent.+	18	0.10%	n/a
Totals	n/a	n/a	14112	100%	100%

Table 2.12 The assemblage from Kington Magna

Ware	Number of sherds	Percentage of assemblage	Ware total percentages
C1	164	18.60%	22.30%
Glazed C1	30	3.40%	n/a
Red painted C1	1	0.10%	n/a
Applied strip C1	2	0.20%	n/a
S4/C2	687	77.70%	77.70%
Total	884	100%	100%

Table 2.13 The assemblage from Lodge Farm

Ware	No. of sherds	% of assemblage
S2	266	60.87%
C1	155	35.47%
S4/C2	11	2.52%
F4	5	1.14%
Totals	437	100.00%

Table 2.14 The assemblage from Milton Abbas Abbey

Ware	No. of sherds	% of assemblage
S2	202	47.53%
C1	140	32.94%
S4/C2	74	17.41%
F1 & F4	9	2.22%
Totals	425	100.00%

Table 2.15 The assemblage from ten medieval contexts at site PM3/75 in Poole

Ware	No. of sherds	% of assemblage
F1, F3 & F4	28	6.13%
glazed C1	115	25.16%
applied C1	17	3.72%
painted C1	12	2.63%
unglazed C1	285	62.36%
Totals	457	100.00%

Table 2.16 The assemblage from Portland, St. Andrews Old Church

Ware	No. of sherds	% of assemblage
S1	40	32.5%
S2	13	10.6%
S3	5	4.1%
unglazed C1	23	18.7%
glazed C1	8	6.5%
S4/C2	30	24.4%
F4	2	1.6%
Shelley	2	1.6%
Totals	123	100.0%

Table 2.17 The assemblage from Poxwell DMV

Ware	No. of sherds	% of assemblage
S1	44	50.00%
S3	12	13.64%
C1	23	26.14%
S4/C2	9	10.22%
Totals	88	100.00%

Table 2.18 The assemblage from two sites at Shaftesbury

Ware	6 Bimport	Parkwalks	Total	% in combined assemblage
F1 & F4	9	0	9	7%
S1	3	12	15	12%
S4/C2	0	12	12	10%
unglazed C1	0	4	4	3%
glazed C1	30	53	83	67%
painted C1	1	0	1	1%
Totals	43	81	124	100%

Table 2.19 The assemblage from selected contexts at Sherborne Old Castle (Info. after Harrison & Williams 1979)

		No. of vessels of this ware in ...					
	Williams	13th cent. contexts		late 13th-14th cent.		14th cent. garderobe	
Ware	Fabric	No.	%	No.	%	No.	%
C1	C	9	17%	25	30%	1	5%
F1	Lav	0	-	0	-	0	-
F4	D	2	4%	16	19%	1	5%
S1	E-Herm	0	-	10	12%	16	85%
S4/C2	A + B	43	79%	31	37%	1	5%
Donyatt	-	0	-	2	2%	19	-
Totals	n/a	54	100%	84	100%	38	100%

Table 2.20 Composite assemblage from contexts dated 1250 to 1350 from six excavations within the medieval town of Southampton

Ware type	Percentage of assemblage circa 1250 to 1350*
Late Saxon wares	3%
Ware C1 and C2 (early med. and med. forms)	45%
Ware F1 (including local wasters)	4%
Ware F3 (including Hants. Red Ware)	14%
Ware S1 (including some wasters)	8%
Other English wares	3%
Imports	14%
Late medieval wares	3%
Total number of sherds	100% = 10,171

*Based on Figures supplied by D. Brown

Table 2.21 The assemblage from refuse contexts in Wareham, St. Martins, Trench II

Ware	No. of sherds	% of total
C1	857	69.8%
glazed C1	127	11.7%
Scratched C1	82	7.6%
S1	8	0.8%
S4/C2	75	6.9%
F4	35	3.2%
Totals	1084	100.0%

Table 2.22 The assemblage from West Grimstead

Ware	No. of sherds	% of total
F1 & F4	83	46.6%
C1	86	48.4%
scratched C1	9	5.0%
totals	178	100.0%

Table 2.23 Whitcombe DMV

Ware	No. of sherds	% of total
S1	22	36%
S3	15	24%
C1	11	18%
scratched C1	11	18%
S4/C2	2	3%
Totals	61	100%

Table 2.24 The assemblage from The Leaze, Wimborne

Ware	No. of sherds	% of total
Post-med	38	n/a
C1	754	90.0%
S1	54	6.5%
F1	6	0.9%
F4	20	2.3%
Floor tiles	2	0.2%
Chalky S1	1	0.1%
Totals	837	100.0%

Table 2.25 Winterborne Houghton

Ware	No. of sherds	% of total
S1	24	16%
C1	63	41%
S4/C2	68	43%
Totals	155	100%

Table 2.26 The assemblage from contexts in Trench 1, Woolcombe farm, 1986

	Context 45/46 (late 12th-early 13th cent.)		Context 42 (late 13th-early 14th cent.)	
Ware	No. of sherds	% of total	No. of sherds	% of total
S4/C2	282	94.3%	343	35.2%
S1	15	5.0%	626	64.1%
F4	2	0.7%	8	0.8%
Totals	299	100.0%	977	100.0%

Table 3.1 Breakdown of complex standards

Element	Standard A (Laverstock)	Standard B (Hermitage)	Standard C (Composite)
Magnesium	4.0ppm	8.0ppm	8.0ppm
Calcium	20.0ppm	10.0ppm	20.0ppm
Iron	20.0ppm	50.0ppm	50.0ppm
Nickel	0.2ppm	0.3ppm	0.3ppm
Mangenese	0.1ppm	0.2ppm	0.2ppm
Copper	0.2ppm	0.1ppm	0.2ppm
Aluminium	80.0ppm	90.0ppm	90.0ppm
Titanium	5.0ppm	5.0ppm	5.0ppm
Chromium	0.1ppm	0.2ppm	0.2ppm
Potassium	12.0ppm	20.0ppm	20.0ppm

Table 3.2 A comparison of iron concentration in two standards as measured by three laboratories

Laboratory	Standard NPS1 percentage iron	Standard BMSP percentage iron
Bradford	5.84	4.32
British Museum	5.6	4.64
Dorset Institute	5.46	4.2

Table 3.3 A comparison of BCRA concentration determinations and Dorset Institute measurements on the Lefkandi Brick Standard LBS

Laboratory	%Aluminium	%Iron	%Magnesium	%Mangenese	%Nickel
BCRA	9.151 ± 0.1	4.420 ± 0.1	1.278 ± 0.1	0.086 ± 0.1	<0.01 ± 0.01
Dorset Institut	8.190	4.194	1.319	0.081	0.010

Table 4.1 Normality of distributions in data derived from Hermitage sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	-0.935	0.081
Ca	3.467	12.739
Fe	1.717	3.929
Ni	0.488	1.595
Mn	5.619	39.863
Cu	0.586	0.118
Al	-0.42	0.16
Ti	-0.25	0.178
Cr	0.051	0.465
K	-0.644	1.17

Table 4.2 Normality of distributions in data derived from Laverstock sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	-0.574	-0.013
Ca	2.105	3.697
Fe	-0.013	-0.894
Ni	0.756	0.325
Mn	2.725	12.315
Cu	4.505	24.174
Al	0.101	0.207
Ti	-0.594	1.685
Cr	-0.067	0.152
K	-0.667	-0.649

Table 4.3 Normality of distributions in data derived from Laverstock fine ware sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	0.528	1.325
Ca	2.196	3.556
Fe	-0.285	-0.687
Ni	0.204	-0.331
Mn	1.258	1.649
Cu	5.252	34.268
Al	-0.122	0.886
Ti	0.141	-0.632
Cr	0.035	0.096
K	0.279	2.263

Table 4.4 Normality of distributions in data derived from Laverstock coarse ware sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	0.735	0.197
Ca	3.077	11.876
Fe	0.662	-0.71
Ni	0.012	-0.607
Mn	2.775	9.679
Cu	3.638	15.241
Al	0.486	-0.615
Ti	-0.503	6.358
Cr	0.087	-0.333
K	2.718	10.031

Table 4.5 Normality of distributions in log-transformed data, derived from Hm sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	-1.353	1.244
Ca	0.996	4.324
Fe	1.329	2.494
Ni	-0.681	1.839
Mn	1.296	4.033
Cu	-0.022	-0.384
Al	-0.723	0.437
Ti	-1.016	2.894
Cr	-0.308	0.439
K	-1.633	5.184

Table 4.6 Normality of distributions in log-transformed data, derived from Lv sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	-1.278	0.952
Ca	-0.951	5.879
Fe	-0.235	-0.928
Ni	-0.177	-0.093
Mn	0.69	2.023
Cu	1.939	7.949
Al	-0.145	0.33
Ti	-2.367	12.205
Cr	-0.649	1.713
K	-1.359	0.873

Table 4.7 Normality of dist.ns in log-transformed data, derived from Laverstock fine ware sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	-0.271	2.636
Ca	-0.688	5.133
Fe	-0.521	-0.617
Ni	-0.545	0.141
Mn	0.3	0.836
Cu	2.03	9.905
Al	-0.423	1.245
Ti	-0.106	-0.597
Cr	-0.563	1.494
K	-0.634	2.249

Table 4.8 Normality of dist.ns in log-transformed data, derived from Laverstock coarse ware sherds

ELEMENT	normal = 0.0 SKEWNESS	normal = 3.0 KURTOSIS
Mg	0.166	-0.993
Ca	1.466	4.171
Fe	0.473	-0.963
Ni	-0.608	0.307
Mn	1.032	2.167
Cu	1.992	7.163
Al	0.346	-0.8
Ti	11.749	-2.718
Cr	-0.174	-0.156
K	0.254	2.003

Table 4.9. T-tests and F-tests on 10 element data, comparing Laverstock and Hermitage material

						If f-value exceeds1.32, then Ho is rejected at 5% lvl, with155 d.f.		If t-value exceeds 1.96, then Ho is rejected. Therefore the gps of sherds are not from the same population		
ELEMENT	GROUP	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	TWO-TAIL PROBABILITY	T VALUE	DEGREES OF FREEDOM	TWO-TAIL PROBABILITY
MAGNESIUM	Hermitage	79	0.7334	0.140	0.016					
	Laverstock	78	0.3627	0.103	0.012	1.88	0.006	18.87	155	0.000
CALCIUM	Hermitage	79	1.0316	0.749	0.084					
	Laverstock	78	1.1657	0.893	0.101	1.42	0.122	-1.02	155	0.309
IRON	Hermitage	79	4.2125	0.439	0.049					
	Laverstock	78	1.4707	0.205	0.023	4.56	0.000	50.03	155	0.000
NICKEL	Hermitage	79	0.0180	0.004	0.001					
	Laverstock	78	0.0132	0.005	0.001	1.16	0.526	6.49	155	0.000
MANGANESE	Hermitage	79	0.0279	0.023	0.003					
	Laverstock	78	0.0066	0.003	0.000	83.11	0.000	8.03	155	0.000
COPPER	Hermitage	79	0.0113	0.003	0.000					
	Laverstock	78	0.0143	0.006	0.001	4.98	0.000	-3.77	155	0.000
ALUMINIUM	Hermitage	79	8.2454	0.898	0.101					
	Laverstock	78	8.0855	0.603	0.068	2.22	0.001	1.31	155	0.193
TITANIUM	Hermitage	79	0.4589	0.078	0.009					
	Laverstock	78	0.4748	0.085	0.010	1.19	0.442	-1.22	155	0.225
CHROMIUM	Hermitage	79	0.0137	0.001	0.000					
	Laverstock	78	0.0108	0.002	0.000	1.18	0.469	12.74	155	0.000
POTASSIUM	Hermitage	79	1.5163	0.251	0.028					
	Laverstock	78	1.0301	0.423	0.048	2.85	0.000	8.77	155	0.000

Table 4.10. T-tests and F-tests on 10 element data, comparing Laverstock fine and coarse wares

						If f-value exceeds1.81, then Ho is rejected at 5% lvl, with76 d.f.		If t-value exceeds 1.98, then Ho is rejected. Therefore the gps of sherds are not from the same population		
ELEMENT	GROUP	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	TWO-TAIL PROBABILITY	T VALUE	DEGREES OF FREEDOM	TWO-TAIL PROBABILITY
MAGNESIUM	Lav fine	57	0.4104	0.060	0.008					
	Lav coarse	21	0.2332	0.079	0.017	1.74	0.107	10.56	76	0.000
CALCIUM	Lav fine	57	1.0825	0.970	0.128					
	Lav coarse	21	1.3914	0.604	0.132	2.58	0.022	-1.36	76	0.177
IRON	Lav fine	57	1.4842	0.199	0.026					
	Lav coarse	21	1.4340	0.224	0.049	1.26	0.482	0.96	76	0.342
NICKEL	Lav fine	57	0.0113	0.003	0.000					
	Lav coarse	21	0.0183	0.005	0.001	2.11	0.030	-7.51	76	0.000
MANGANESE	Lav fine	57	0.0065	0.002	0.000					
	Lav coarse	21	0.0068	0.004	0.001	3.84	0.000	-0.46	76	0.648
COPPER	Lav fine	57	0.0137	0.006	0.001					
	Lav coarse	21	0.0158	0.007	0.002	1.54	0.208	-1.28	76	0.203
ALUMINIUM	Lav fine	57	8.0963	0.564	0.075					
	Lav coarse	21	8.0562	0.711	0.155	1.59	0.178	0.26	76	0.796
TITANIUM	Lav fine	57	0.5068	0.062	0.008					
	Lav coarse	21	0.3877	0.080	0.017	1.67	0.135	6.96	76	0.000
CHROMIUM	Lav fine	57	0.0106	0.002	0.000					
	Lav coarse	21	0.0111	0.001	0.000	1.84	0.132	-1.36	76	0.178
POTASSIUM	Lav fine	57	1.2514	0.199	0.026					
	Lav coarse	21	0.4295	0.246	0.054	1.53	0.215	15.17	76	0.000

Table 4.11 Summary of simple statistics

	Hermitage vs Laverstock				Laverstock fine vs coarse			
ELEMENT	0 =0	0 ≠0	U =U	U ≠U	O =O	O ≠O	U =U	U ≠U
EL1 Mg		√		√	√			√
EL2 Ca		√	√			√	√	
EL3 Fe		√		√	√		√	
EL4 Ni	√			√		√		√
EL5 Mn		√		√		√	√	
EL6 Cu		√		√	√		√	
EL7 Al		√	√		√		√	
EL8 Ti	√		√		√			√
EL9 Cr	√			√		√	√	
EL10 K		√		√	√			√

Table 4.12 Correlation matrix for ten elements on data derived from Hermitage sherds

ELEMENT	Magnesium	Calcium	Iron	Nickel	Manganese	Copper	Aluminium	Titanium	Chromium	Potassium
Magnesium										
Calcium	0.40722									
Iron	-0.27833	-0.05219								
Nickel	0.25080	0.05016	-0.04537							
Manganese	0.00958	0.00088	0.16625	-0.09306						
Copper	0.35442	0.32162	0.10330	0.28743	-0.01483					
Aluminium	0.50365	0.24508	0.28009	-0.00250	0.08866	0.39444				
Titanium	0.41708	0.18564	0.20812	0.07349	0.13603	0.39475	0.72183			
Chromium	0.21350	0.00121	-0.05739	-0.07451	0.09047	0.10627	0.32542	0.16318		
Potassium	0.76613	0.39201	-0.24881	0.17283	0.01214	0.30283	0.63244	0.44686	0.23209	

Table 4.13 Correlation matrix for ten elements on data derived from Laverstock fine ware sherds

ELEMENT	Magnesium	Calcium	Iron	Nickel	Manganese	Copper	Aluminium	Titanium	Chromium	Potassium
Magnesium										
Calcium	-0.31938									
Iron	0.28515	0.12696								
Nickel	-0.45566	-0.22698	-0.60669							
Manganese	0.14734	0.34929	0.11525	-0.21995						
Copper	-0.09508	-0.05212	-0.12042	0.16877	-0.02744					
Aluminium	0.29306	-0.05286	0.10799	-0.07741	-0.06197	-0.18464				
Titanium	0.51839	-0.17027	-0.07057	-0.09448	0.17984	-0.12919	0.42485			
Chromium	0.07875	0.18230	0.39088	-0.34143	-0.11194	0.06234	-0.09125	-0.07846		
Potassium	0.52470	-0.13776	0.32154	-0.28190	0.27069	-0.05920	0.16419	0.28936	0.14493	

Table 4.14 Correlation matrix for ten elements on data derived from Laverstock coarse ware sherds

ELEMENT	Magnesium	Calcium	Iron	Nickel	Manganese	Copper	Aluminium	Titanium	Chromium	Potassium
Magnesium										
Calcium	-0.47808									
Iron	0.64932	-0.33488								
Nickel	0.20578	-0.24186	0.05871							
Manganese	-0.41532	0.39276	-0.22436	-0.15670						
Copper	-0.11073	0.17540	-0.35552	0.18810	0.09241					
Aluminium	0.84050	-0.48781	0.50729	-0.13871	-0.40644	-0.04570				
Titanium	0.53199	-0.16279	0.27265	-0.16193	-0.05968	-0.12525	0.61044			
Chromium	0.09878	-0.03633	0.46931	0.09980	-0.09240	-0.14362	0.13417	-0.14659		
Potassium	0.76651	-0.24438	0.48648	0.07018	-0.16361	-0.04752	0.52384	0.59042	-0.12389	

Table 4.15
Inter-element correlations above the critical limit (0.5)

Hermitage	Lav fine	Lav coarse
Mg-Al	Mg-Ti	Mg-Fe
Mg-K	Mg-K	Mg-Al
Al-Ti	Fe-Ni	Mg-K
Al-K		Fe-Al
		Al-Ti
		Al-K
		Ti-K

Table 4.16 Example of table showing probabilities of group membership from a discriminant analysis. The actual analysis was carried out on the 10 element data set and the derived function separated the kiln sites.

```
 CASE    MIS           ACTUAL        HIGHEST PROBABILITY       2ND HIGHEST       DISCRIMINANT
SEQNUM   VAL   SEL      GROUP         GROUP P(D/G) P(G/D)      GROUP P(G/D)        SCORES...

     1                      1             1  .3357 1.0000          2  .0000       -6.4719
     2                      1             1  .3441 1.0000          2  .0000       -5.3185
     3                      1             1  .6045 1.0000          2  .0000       -6.0331
     4                      1             1  .7825 1.0000          2  .0000       -5.7913
     5                      1             1  .2957 1.0000          2  .0000       -4.4694
     6                      1             1  .4825 1.0000          2  .0000       -4.8129
     7                      1             1  .6464 1.0000          2  .0000       -5.0564
     8                      1             1  .3334 1.0000          2  .0000       -4.5478
     9                      1             1  .4735 1.0000          2  .0000       -6.2320
    10                      1             1  .1978 1.0000          2  .0000       -6.8029
    11                      1             1  .1337 1.0000          2  .0000       -4.0344
    12                      1             1  .0616 1.0000          2  .0000       -3.6461
    13                      1             1  .4815 1.0000          2  .0000       -6.2191
    14                      1             1  .5740 1.0000          2  .0000       -6.0773
    15                      1             1  .9360 1.0000          2  .0000       -5.4349
    16                      1             1  .4649 1.0000          2  .0000       -6.2460
    17                      1             1  .4983 1.0000          2  .0000       -4.8380
    18                      1             1  .2847 1.0000          2  .0000       -4.4453
    19                      1             1  .2145 1.0000          2  .0000       -4.2739
    20                      1             1  .2003 1.0000          2  .0000       -4.2346
    21                      1             1  .3430 1.0000          2  .0000       -5.3171
    22                      1             1  .9522 1.0000          2  .0000       -5.4553
    23                      1             1  .9702 1.0000          2  .0000       -5.4778
    24                      1             1  .9642 1.0000          2  .0000       -5.5601
    25                      1             1  .3438 1.0000          2  .0000       -5.3181
    26                      1             1  .5933 1.0000          2  .0000       -4.9667
    27                      1             1  .5158 1.0000          2  .0000       -6.1649
    28                      1             1  .3834 1.0000          2  .0000       -6.3776
```

Table 4.17 Classification results from Fig. 4.7 Discriminant analysis on material from the Hermitage and Laverstock kiln sites

		Predicted group membership	
Actual group	No. of cases	1	2
Hermitage	78	78	0
Per cent		100.00%	0.00%
Laverstock	78	0	78
Per cent		0.00%	100.00%

Per cent of "grouped" cases correctly classified: 100.0%

Table 4.18 Classification results from Fig. 4.9 Discriminant analysis of Hermitage sherds and Laverstock fine and coarse wares

		Predicted group membership		
Actual group	No. of cases	1	2	3
Hermitage	78	78	0	0
Per cent		100.00%	0.00%	0.00%
Lav Fine	57	0	55	2
Per cent		0.00%	96.50%	3.50%
Lav coarse	21	0	1	20
per cent		0.00%	4.80%	95.20%

Per cent of "grouped" cases correctly classified: 97.23%

Table 4.19 Classification results from Fig. 4.10 Discriminant analysis of material from Hermitage and Laverstock, Kiln 1 and Kiln 6

		Predicted group membership		
Actual group	No. of cases	1	2	3
Hermitage	79	79	0	0
Per cent		100.00%	0.00%	0.00%
Lav K1	19	0	16	3
Per cent		0.00%	84.20%	15.80%
Lav K6	59	0	12	47
per cent		0.00%	20.30%	79.90%

Per cent of "grouped" cases correctly classified: 88.03%

Table 4.20 Factor score coefficient matrix for principal components analysis on 10 element data (first two factors only)

ELEMENT	FACTOR 1	FACTOR 2
Magnesium	.22520	.12365
Calcium	.07968	-.26360
Iron	.27805	-.05510
Nickel	.24584	-.13980
Manganese	.19507	-.03971
Copper	-.00507	.14799
Aluminium	-.00672	.42269
Titanium	-.13647	.48124
Chromium	.26066	-.05112
Potassium	.10546	.23993

Table 5.1 Percentage of variance contributed by factors from principal components anaysis on coarse and fine wares data

Factor	Eigenvalue	Percentage of variance	Cumulative % of variance
1	1.66340	41.6	41.6
2	1.02748	25.7	67.3
3	0.83843	21.0	88.2
4	0.47068	11.8	100.0

Table 5.2 Percentage of variance contributed by factors from principal components anaysis on sandy wares data

Factor	Eigenvalue	Percentage of variance	Cumulative % of variance
1	1.71241	42.8	42.8
2	1.01328	25.3	68.1
3	0.69488	17.4	85.5
4	0.57944	14.5	100.0

Table 5.3 Factor matrix showing elemental 'loadings'for principal components analysis on coarse & fine wares data.

Element	Factor Loadings		
	Factor 1	Factor 2	Factor 3
Nickel	0.26961	0.86877	-0.39428
Iron	0.83565	0.12134	0.21687
Magnesium	0.81064	-0.11849	0.33938
Aluminium	-0.48505	0.49392	0.72164

Table 5.4 Factor matrix showing elemental 'loadings'for principal components analysis on sandy wares data.

Element	Factor Loadings		
	Factor 1	Factor 2	Factor 3
Nickel	0.00898	0.98573	0.16433
Iron	0.78096	-0.10504	0.27230
Magnesium	0.70674	0.16551	-0.68680
Aluminium	0.77650	-0.05641	0.34934

Table 5.5 Standardized canonical discriminant function coefficients for coarse and fine wares data

Elements	Function 1	Function 2
Nickel	-0.51602	0.67194
Iron	0.22949	0.88632
Magnesium	1.06401	-0.19701
Aluminium	-0.51700	-0.39685

Table 5.6 Standardized canonical discriminant function coefficients for sandy wares data

Elements	Function 1	Function 2
Nickel	-0.07421	0.72951
Iron	0.88509	0.30807
Magnesium	0.86963	-0.50973
Aluminium	-0.46404	0.70274

Table 5.7 Multivariate tests of significance comparing ware S1 wasters from Hermitage with ware S3 wasters from Southampton

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	0.24483	6.48411	4.00	80.00	.000
Hotellings	0.32421	6.48411	4.00	80.00	.000
Wilks	0.75517	6.48411	4.00	80.00	.000

Table 5.8 Univariate F-tests, with (1,83) degrees of freedom, comparing values for Hermitage ware S1 & Southampton ware S3 sherds

Variable	Hypoth. sums of squares	Error of sums of squares	Hypoth. mean squares	Error of mean sq.s	F-value	Significance of F
Nickel	0.00013	0.00118	0.00013	0.00001	9.04628	0.003
Iron	2.77890	23.61678	2.77890	0.28454	9.76629	0.002
Magnesium	0.00005	1.59705	0.00005	0.01924	0.00279	0.958
Aluminium	3.26565	85.04469	3.26565	1.02463	3.18714	0.078

Table 5.9 Group membership at the 8 groups level in a cluster analysis using the 'Baverage' method of clustering on the sandy wares data set

Site and	Group							
ware codes	1	2	3	4	5	6	7	8
LV S1*•	1	43	33	3				
SC S4/C2*			19			1		
SO S3•			5					
CV S4/C2		6	14					
DP S1		4	16					
HW S1		2	17		1			
S4/C2			19		1			
LF S2		5	2		3			
MA S2			20					
PS S1			10					
PX S1		1	9					
SC S1		2	10	1				
SC S2		4	23					
SO S1			5					
ST S1		2	7		1			
ST S4/C2			5					
WF S1		4	34	1	1			
WF S4/C2		7	29		1	3		
WN S1		1	7		1			1
WT S1		1	9					
YO S1		7	10		1		2	
Totals	1	89	303	5	10	4	2	1

* Separated groups from which discriminant functions were derived

• Wasters

Table 5.10 Group membership at the 8 groups level in a cluster analysis using Wards method of clustering on the sandy wares data set

Site and	Group							
ware codes	1	2	3	4	5	6	7	8
LV S1*•	27	18	15	11	6	3		
SC S4/C2*				10	1	1		8
SO S3•				5				
CV S4/C2	4	1	8	5	2			
DP S1	2	2		2	8			6
HW S1	2		1	13	2		1	1
KM S4/C2				8			1	11
LF S2	4		2				4	
MA S2			4	1	4			11
PS S1			1	6	2			1
PX S1	1			5	1			3
SC S1	2			6	2	1		2
SC S2	2		4	15	5			1
SO S1				2	2			1
ST S1	2			5	2		1	
ST S4/C2					1			4
WF S1	2	1	11	12	12	1	1	
WF S4/C2	7	1	14	10	2	3	3	
WN S1			2	2	2		2	2
WT S1	1		1	4	2			2
YO S1	5	3	1	3			2	6
Totals	61	26	64	125	56	9	15	59

* Separated groups from which discriminant functions were derived

• Wasters

Table 5.11 Composite assessment of the comparison of sandy ware sherds with provenanced types and 'other' groups, over all the multivariate statistical tests carried out on the sandy wares data

Site and ware codes	Total no. of sherds	Like Hm ware S1	Like SC ware S4	Like LV ware C1	Other 1 (low DF1)	Other 2 (high DF2)	Other 3 (high DF1)
CV S1	20	10+	≤7			2	
DP S1	20	6 to 8	8 to 11				1
HW S1	20	≤3	15+	1			
KM S4/C2	20	≤1	17+		1		
LF S2	10	≤7		1		≤3	
MA S2	20	≤4	13+		≤3		
PS S1	10	≤4	6+				
PX S1	10	≤6	2+		1	1	
SC S1	13	≤8	2+				
SC S2	27	14 to 21	13 to 21				
SO S1	5	≤1	4 to 5				
ST S1	10	≤8	1+		1		
ST S4/C2	5		5				
WF S1	40	19 to 25	12 to 20	1			
WF S4/C2	40	16 to 32	10 to 23		≤2		
WN S1	10	≤2	6+	2			
WT S1	10	6+	≤4				
YO S1	20	≤12	≤4		5		

Table 5.12 Classification of the sandy ware sherds into groups matching deliberately separated material and groups showing mutual similarity (based on Wards cluster analysis and discriminant analysis)

Site and ware codes	Like HM ware S1 (a)	Like SC ware S4 (b)	Between a & b (group V)	Like LV ware C1	Other Group 1	Other Group 2	Outliers
CV S4/C2			90%			10%	
DP S1	30%	35%	30%				5%
HW S1			95%	5%			
KM S4/C2	10%	85%			5%		
LF S2	30%			10%			60%
MA S2	10%	90%					
PS S1			100%				
PX S1	50%		30%				20%
SC S1			100%				
SC S2			100%				
SO S1			100%				
SO S3•			100%				
ST S1		10%	80%				10%
ST S4/C2		100%					
WF S1			97.50%				2.50%
WF S4/C2			100%				
WN S1			80%	20%			
WT S1			100%				
YO S1	65%				25%		5%

• = wasters

Table 5.13 Summary table of broad classifications in the first discriminant analysis on the coarse wares data

Site and ware codes	Total no. of sherds	Like LV ware C1	Like LV ware F1	Other
CH ware C1	10	7	0	3
CH glazed C1	5	5	0	0
CH scratch C1	5	1	0	4
CC ware C1	15	11+	≤4	0
PS ware C1	7	≤4	2	1+
DP ware C1	10	6+	≤3	1
HW ware C1	10	10	0	0
HW glazed C1	3	3	0	0
KM ware C1	10	1	5	4
PL glazed C1	10	0	9	1
PL painted C1	5	2	3	0
PX ware C1	5	3	0	2
SC glazed C1	5	1+	≤3	1
SO ware C1	7	0	0	7
SO ware C2	14	0	0	14
ST glazed C1	15	3+	≤12	0
WB ware C1	20	19	1	0
WB glazed C1	10	10	0	0
WH ware C1	10	8	0	2
WH glazed C1	10	5+	1	≤4
WH scratch C1	10	10	0	0
WN ware C1	10	8	2	0
WT ware C1	5	4	1	0

Table 5.14 Summary table of classifications in the second discriminant analysis on the coarse wares data

Site and ware codes	Total no. of sherds	Like LV ware C1	Like PL glazed C1	Like SO ware C1	As in Figure 5.89				
					Area A	Area B	Area C	Area D	Other
CH ware C1	10	7	0	0	2	1	0	0	0
CH glazed C1	5	0	3	0	2	0	0	0	0
CH scratch C1	5	1	0	0	0	0	3	0	1
CC ware C1	15	4	6	0	5	0	0	0	0
DP ware C1	10	4	5	0	0	1	0	0	0
HW ware C1	10	6	0	0	2	2	0	0	0
HW glazed C1	3	3	0	0	0	0	0	0	0
KM ware C1	10	0	5	0	2	0	0	3	0
PL painted C1	5	2	3	0	0	0	0	0	0
PS ware C1	7	1	2	0	4	0	0	0	0
PX ware C1	5	1	0	0	0	2	0	2	0
SC glazed C1	5	3	1	0	0	0	0	0	1
SO ware C2	14	0	0	8	0	0	0	6	0
ST glazed C1	15	2	10	0	3	0	0	0	0
WB ware C1	20	15	4	0	0	0	0	0	1
WB glazed C1	10	4	5	0	1	0	0	0	0
WH ware C1	10	4	0	0	1	4	1	0	0
WH glazed C1	10	2	5	0	0	3	0	0	0
WH scratch C1	10	10	0	0	0	0	0	0	0
WN ware C1	10	5	4	0	1	0	0	0	0
WT ware C1	5	2	1	0	0	2	0	0	0

Table 5.15 Standardized canonical discriminant function coefficients for second coarse wares analysis (separating LV ware C1, PL glazed C1 and SO ware C1)

Element	Function 1	Function 2
Nickel	-0.03509	0.80688
Iron	0.85371	0.97668
Magnesium	0.26958	-1.33458
Aluminium	-0.93422	-0.37749

Table 5.16 Percentages of coarse wares that can be matched with the separated groups in the second discriminant analysis

Site and ware codes	% of sherds 'like LV'	% of sherds 'like PL'	% of sherds 'like SO'	% other sherds
CH ware C1	70%	0%	0%	30%
CH glazed C1	0%	60%	0%	40%
CH scratch C1	20%	0%	0%	80%
CC ware C1	27%	40%	0%	33%
DP ware C1	40%	50%	0%	10%
HW ware C1	60%	0%	0%	40%
HW glazed C1	100%	0%	0%	0%
KM ware C1	0%	50%	0%	50%
PL painted C1	40%	605	0%	0%
PS ware C1	14%	28%	0%	58%
PX ware C1	20%	0%	0%	80%
SC glazed C1	60%	20%	0%	20%
SO ware C2	0%	0%	57%	43%
ST glazed C1	13%	67%	0%	19%
WB ware C1	75%	20%	0%	5%
WB glazed C1	40%	50%	0%	10%
WH ware C1	40%	0%	0%	60%
WH glazed C1	20%	50%	0%	30%
WH scratch C1	100%	0%	0%	0%
WN ware C1	50%	40%	0%	10%
WT ware C1	40%	20%	0%	40%

Table 5.17 Classification of fine ware sherds based on the results of the first discriminant analysis and the principal components analysis on the fine & coarse wares data set

Site and ware codes	Total no. of sherds	Like LV ware F1	Like SO ware F1	Possibly Group Y	Possibly Group Z	Other
CH ware F1	7	0	0	3	2	2
CH ware F4	3	1	0	2	0	0
CC ware F4	15	1	0	0	14	0
HW ware F1	2	0	0	0	2	0
HW ware F4	7	0	0	0	7	0
PL ware F1	5	4	1	0	0	0
PL ware F3	6	3	0	1	0	2
PL ware F4	7	2	0	0	5	0
SC ware F1	15	11	0	3	1	0
SC ware F3	4	2	0	1	1	0
SC ware F4	15	1	0	0	14	0
SL ware F1	15	14	0	0	0	1
SL ware F4	10	6	0	0	0	4
SO ware F1	9	7	1	1	0	0
SO ware F3	20	0	0	20	0	0
ST ware F1	5	4	0	0	1	0
WB ware F1	2	2	0	0	0	0
WB ware F4	8	0	0	0	2	6
WG ware F1	10	7	0	1	2	0
WG ware F4	2	0	0	0	2	0
WH ware F4	10	0	0	0	8	2

Table 5.18 Standardized canonical discriminant function coefficients for second fine wares analysis (separating LV ware F1, SO ware F1 & CF ware F4)

Element	Function 1	Function 2
Iron	0.50251	0.24128
Magnesium	0.89667	0.09249
Aluminium	-0.66975	0.84189

n.b. Nickel was not entered into this analysis

Table 5.19 Classification of fine ware sherds based on the results of the second discriminant analysis on the fine wares data

Site and ware codes	Total no. of sherds	Like LV ware F1	Like SO ware F1	Like CC ware F4 (Group Z)	Possibly Group Y	Other groups	Outliers
CH ware F1	7	0	4				
CH ware F4	3	3					
CC ware F4	-15	-1		-14			
HW ware F1	2			2			
HW ware F4	7			7			
PL ware F1	5	3	1				1
PL ware F3	6	3			1	2	
PL ware F4	7	2		5			
SC ware F1	15	9	2	1			3
SC ware F3	4	2		1			1
SC ware F4	15	1		14			
SL ware F1	15	10					5
SL ware F4	10	6				4	
SO ware F1	9	4	1		4		
SO ware F3	20	12			8		
ST ware F1	5	4		1			
WB ware F1	2	2					
WB ware F4	8	2				5	1
WG ware F1	10	8		2			
WG ware F4	2			2			
WH ware F4	10			10			
Totals	166(177)	72(73)	4	49(63)	15	9	13

Minus values for the Corfe ware F4 group -used as a 'dummy' kiln group in the analysis

Table 5.20 The maximum number of sherds that can be matched to named groups in both discriminant analyses using the fine wares data

Site and ware codes	Total no. of sherds	Like LV ware F1	Like SO ware F1	Group Z	Group Y
CH ware F1	7	0	0	2	2
CH ware F4	3	1	0	0	0
CC ware F4	15	1	0	14	0
HW ware F1	2	0	0	2	0
HW ware F4	7	0	0	7	0
PL ware F1	5	3	1	0	0
PL ware F3	6	3	0	0	1
PL ware F4	7	2	0	5	0
SC ware F1	15	9	0	1	0
SC ware F3	4	2	0	1	0
SC ware F4	15	1	0	14	0
SL ware F1	15	10	0	0	0
SL ware F4	10	6	0	0	0
SO ware F1	9	4	1	0	0
SO ware F3	20	2	0	0	8
ST ware F1	5	4	0	1	0
WB ware F1	2	2	0	0	0
WB ware F4	8	0	0	0	0
WG ware F1	10	7	0	2	0
WG ware F4	2	0	0	2	0
WH ware F4	10	0	0	8	0
Totals	177	57	2	59	11

TABLE 6·1

The date of ware S1 at sites where the relevant information is available

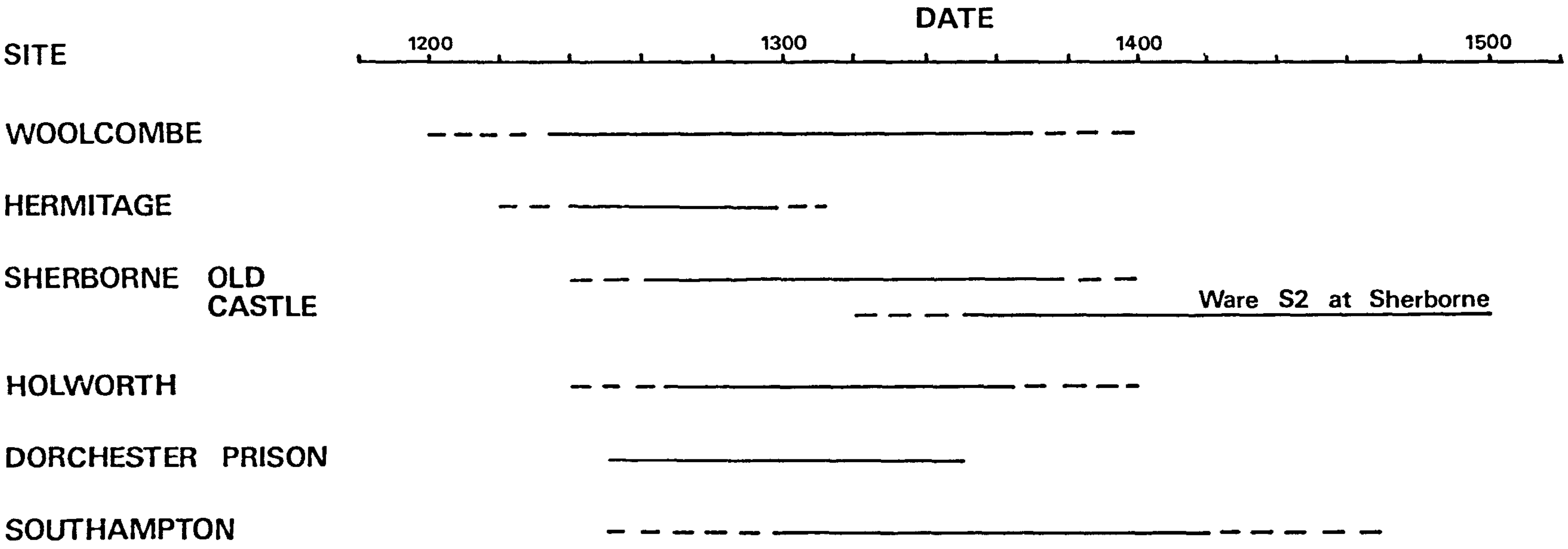


TABLE 6·2

The occurrence of ware S4 C2, as regards date, at sites where the relevant information is available

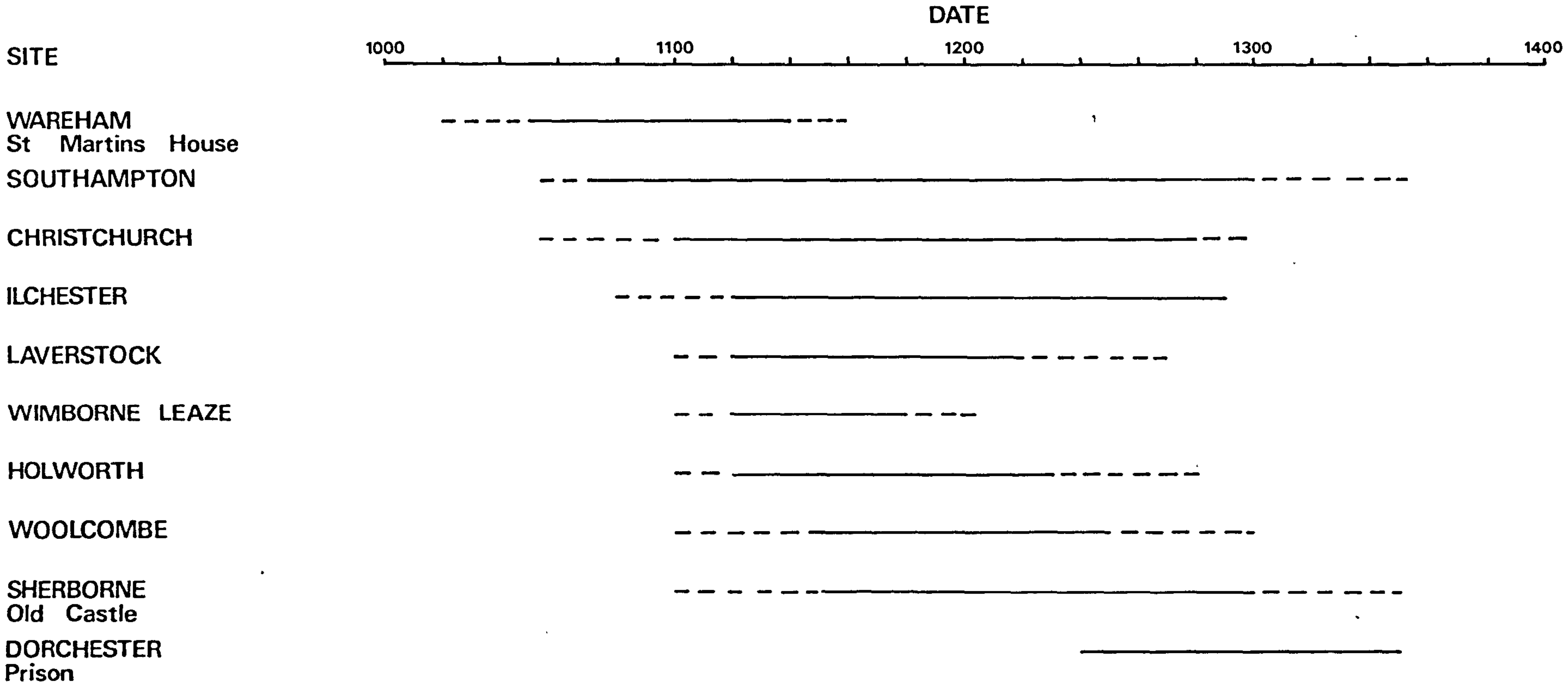


TABLE 6·3

The occurrence of ware C1, as regards date, at sites where the relevant information is available

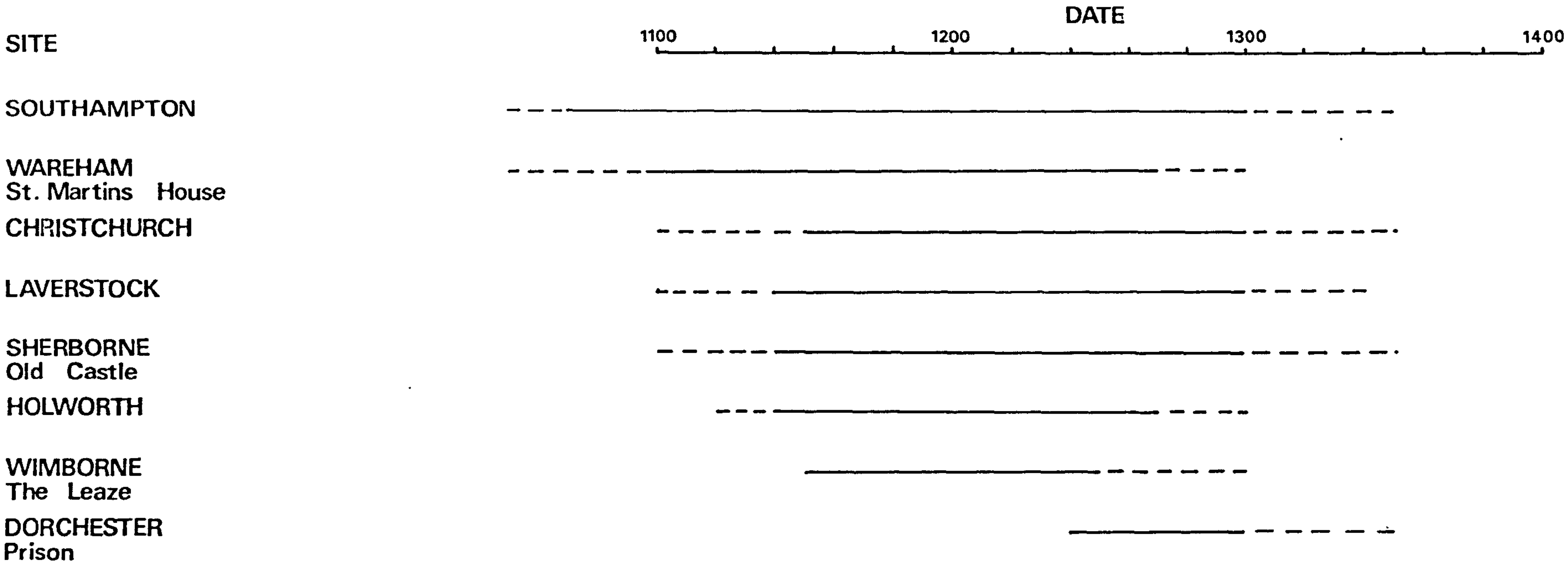


Table 6.4 Sandy wares as percentages of the total 'site assemblage' (as defined in Chapter 2). Data for Figure 6.1

Site	Ware S1	Ware S2	Ware S3	Ware S4/C2
Christchurch	0%	0%	0%	4%
Compton Valence	40%	0%	0%	60%
Corfe Castle	11%	1%	0%	0%
Dorchester Prison	50%	Present	0%	18%
Holworth	52%	Present	0%	1%
Kington Magna	0%	0%	0%	78%
Lodge Farm	0%	61%	0%	3%
Milton Abbas	0%	48%	0%	17%
Poole	0%	0%	0%	0%
Portland, St. Andrews	33%	11%	4%	24%
Poxwell	50%	0%	14%	10%
Salisbury	0%	0%	0%	Present
Shaftesbury	12%	0%	0%	10%
Sherborne Old Castle	12%	Present	0%	37%
Southampton	8%	0%	Present	Present
Wareham, St. Martins	1%	0%	0%	7%
West Grimstead	0%	0%	0%	0%
Whitcombe	36%	0%	24%	3%
Wimborne (the Leaze)	7%	0%	0%	0%
Winterborne Houghton	16%	0%	0%	44%
Woolcombe	64%	0%	0%	35%
Yondover	100%	0%	0%	0%

Table 6.5 Sandy wares as percentages of the total 'site assemblage' (as defined in Chapter 2). Data for Figure 6.2

Site	Ware S1	Ware C1	Ware C2/S4
Christchurch	0%	92%	4%
Compton Valence	40%	0%	60%
Corfe Castle	11%	42%	0%
Dorchester Prison	50%	26%	18%
Holworth	52%	41%	1%
Kington Magna	0%	22%	78%
Lodge Farm	0%	35%	3%
Milton Abbas	0%	33%	17%
Poole	0%	96%	0%
Portland, St. Andrews	33%	25%	24%
Poxwell	50%	26%	10%
Salisbury	0%	Present	Present
Shaftesbury	12%	71%	10%
Sherborne Old Castle	12%	30%	37%
Southampton	8%	Present	Present
Wareham, St. Martins	1%	89%	7%
West Grimstead	0%	48%	0%
Whitcombe	36%	36%	3%
Wimborne (the Leaze)	7%	90%	0%
Winterborne Houghton	16%	41%	43%
Woolcombe	64%	0%	35%
Yondover	100%	0%	0%

Table 6.6 Percentage of glazed wares in assemblages (figures with '+' suffix indicate minimum value)

Site Assemblage	Percentage Glazed	Percentage Fine Wares	Natural Region	Rural (R) or Urban (U)
Compton Valence	0%	0%	2	R
Poxwell	0%	0%	3	R
Whitcombe	0%	0%	2	R
Winterborne Houghton	0%	0%	2	R
Yondover	0%	0%	5	R
Lodge Farm	1%+	1%	2	R
Woolcombe	1%+	1%	2	R
Milton Abbas	2%+	2%	2	U
Christchurch	4%	Present	1	U
Kington Magna	4%	0%	4	R
Holworth	5%+	5%	3	R
Dorchester Prison	6%+	6%	2	U
Portland, St. Andrews	8%	2%	3	R
Wimborne, Leaze	9%	3%	1	U
Salisbury, Brown St. etc	10%*	10%*	8	U
Wareham	15%	3%	1	U
Sherborne	19%+	19%	4	U
Poole	38%	6%	1	U
Corfe Castle	47%	5%	3	U
West Grimstead	47%	47%	1	R
Shaftesbury	85%**	7%**	4	U

* Figures estimated

** Figures of dubious quality

TABLE 6·7

The date of Glazed Ware C1 at some sites in the study region

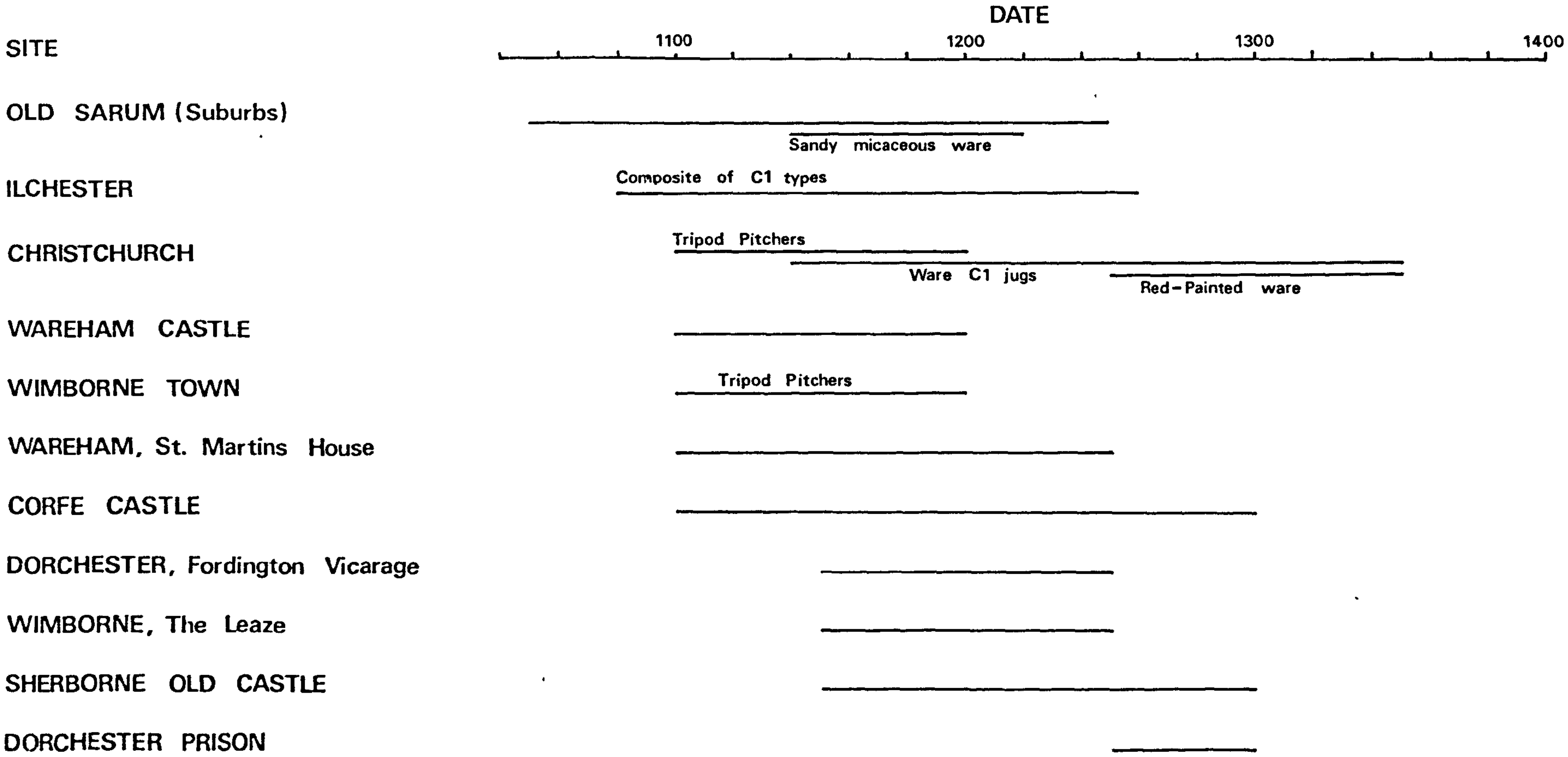


TABLE 6·8

The date of Glazed Ware S1 at some of the sites in the study region

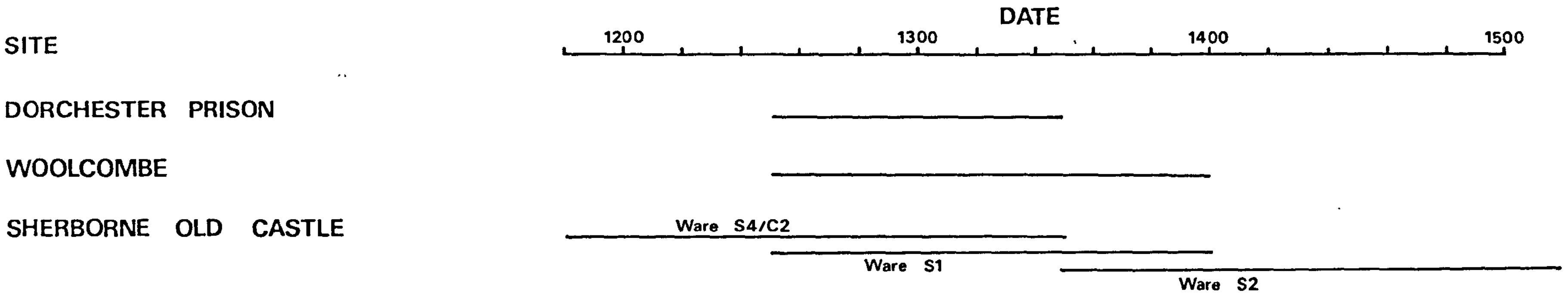


TABLE 6·9

The date of ware F1 at some sites in the study region

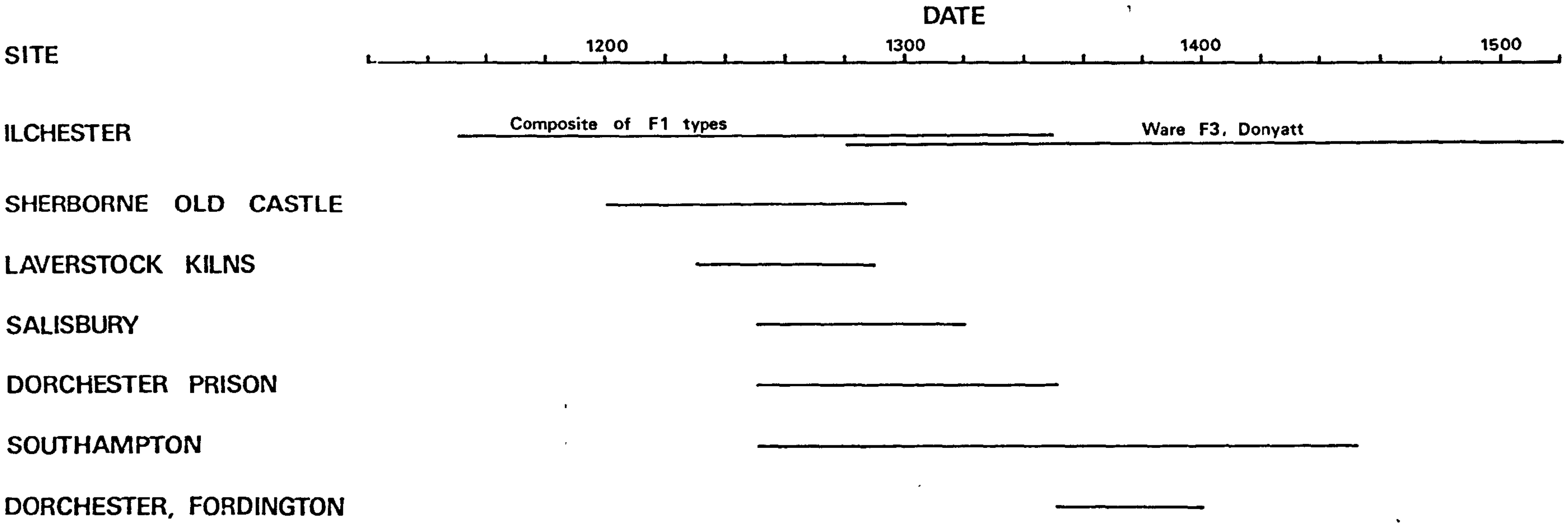


TABLE 6·10

The date of ware F4 at some sites in the study region

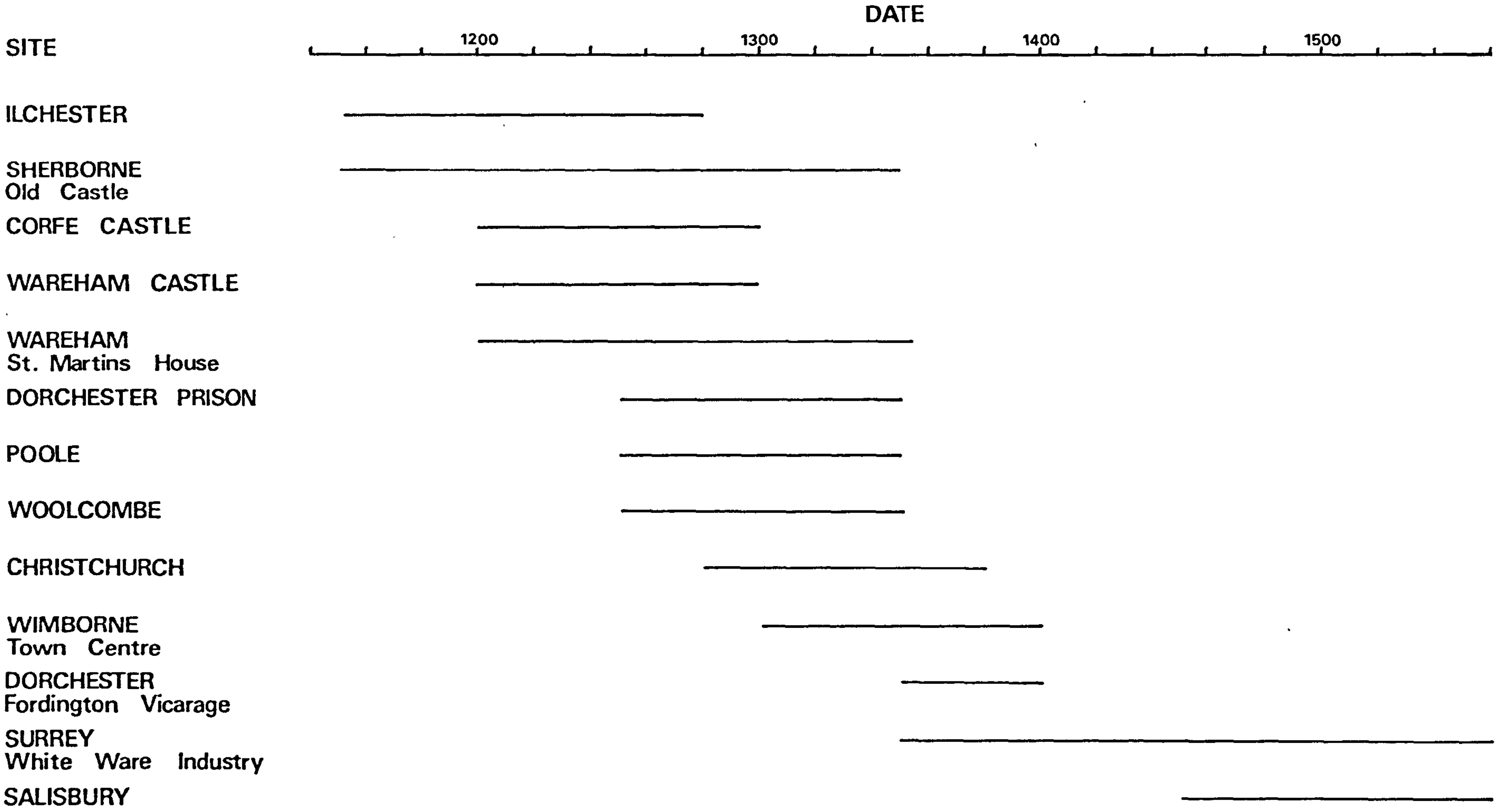


Table 6.11 Chemically identified ware C1 types as a percentage of
a) The ware C1 assemblage from each site
b) the total ceramic assemblage from each site
(Data for Figure 6.5)

	Percentage of the ware C1 assemblage identified as				Percentage of the total site assemblage identified as			
Site Assemblage	Like LV	Like PL	Like SO	Other	Like LV	Like PL	Like SO	Other
Christchurch	30%	20%	0%	50%	28%	18%	0%	46%
Corfe Castle	27%	40%	0%	33%	11%	17%	0%	14%
Dorchester Prison	40%	50%	0%	10%	10%	13%	0%	3%
Holworth	69%	0%	0%	31%	28%	0%	0%	13%
Kington Magna	0%	50%	30%	20%	0%	11%	7%	4%
Poole	40%	60%	0%	0%	38%	58%	0%	0%
Portland, St. Andrews	14%	28%	0%	58%	4%	7%	0%	15%
Poxwell	20%	0%	40%	40%	5%	0%	10%	10%
Shaftesbury	13%	67%	0%	20%	9%	48%	0%	14%
Sherborne Old Castle	60%	20%	0%	20%	18%	6%	0%	6%
Southampton	0%	0%	100%	0%	0%	0%	Pres	0%
Wareham, St. Martins House	53%	17%	0%	30%	47%	15%	0%	27%
Whitcombe	40%	20%	0%	40%	36%	18%	0%	36%
Wimborne, the Leaze	63%	30%	0%	7%	57%	27%	0%	6%
Winterborne Houghton	50%	40%	0%	10%	21%	16%	0%	4%

Table 6.12 Chemically identified fine ware types and other glazed material as proportions of site glazed ware assemblages

P = 'Present', or <25% of glazed ware assemblage at site
C = 'Common', or 25%-50% of glazed ware assemblage at site
D = 'Dominant', or >50% of glazed ware assemblage at site
Blank spaces = type not known or not recorded

	Chemically identified fine ware groups				Glazed ware C1	Glazed ware S1
Site Assemblage	Laverstock	S'hampton	Group Z	Group Y		
Christchurch	P		P	P	D	
Corfe Castle	P		P		D	
Holworth			D			P
Poole	P	P	P	P	D	
Shaftesbury	P		P		D	P
Sherborne Old Castle	P		C		P	P
Southampton	P	P		C		P
Salisbury	D				P	
Wareham, St. Martins			P		D	
Wimborne, the Leaze	P				D	
West Grimstead	D		P			

Appendix 1

Gazetteer of documentary and other evidence for medieval and post-medieval ceramic production in Dorset

Abbreviation used in gazetteer: DRO for Dorset records office.

PARISH	**Grid reference**
Numbers used as identifiers in Figure 1	where a location is known

1. Affpuddle

Mills (1971, 9) mentions a resident of the parish by the name of William Croker.

2. Alderholt

The following information is all taken from Algar *et al* (1987).

In 1337 the tenants of the village of Alderholt paid 14s "for the digging of clay to make pots", and in 1503 seven people were fined for taking clay "to make and burn pots from Alderholt common"

These are the first two known references to pottery production in this parish, which was later to become a major centre of the Verwood and District Potteries. In the mid-seventeenth century eighteen potters are mentioned in the clay rentals (DRO), but by 1847 to 1858 only five potters were left in Alderholt.

However from the late sixteenth century onwards there is a wealth of information concerning pottery production in Alderholt and this has led to the identification of twelve actual kiln sites. The locations of these sites are as follows; the numbering system being that used by Algar *et al* (1987).

Crendell	1	SU089130
	2	SU089131
	3	SU087133
	4	SU084133
Daggons	5	SU093126
	6	SU101126

	7	SU098125
Alderholt	8	SU123132
	9	SU125134
	10	SU124133
	11	SU125132
Daggons	12	SU102127

The mound of kiln site three (Crendell) was excavated in 1975 by Salisbury Museum Archaeological Research Group. The ceramics found dated the last phase of production to the late eighteenth century (Algar *et al*1987, 23).

3. Broadwey

Mills (1977, 202) gives 'Crock Hole' as a field name in the parish. This is interpreted as being derived from a hollow in the field where pot sherds were found.

4. Coombe Keynes

Mills (1977, 120) refers to a field in the parish before 1750 with the name 'Cleag Sceard' or 'Clay Sherd'. At the same period there are three other references to a field with the 'crok' name element. These are 'Crokewell Hey' 1435, 'Croukulhey' 1446 and 'Crokelhay' 1493. Mills interprets these as meaning enclosures with a well or stream where pots have been found.

5. Corscombe ST540065

Hutchins (1863, 92) mentions the place name of 'Crockers Moor' -a small farm about one mile from Corscombe. It is now called Crockham Moor Farm.

6. Cranborne ST046167

Mills (1971, 76) mentions a resident of the parish of Cranborne by the name of Willelmo Poterne. In 1682 one James Thorne recorded a will in Cranborne, in which he described himself as a potter (DRO). The place names Crockerton Hill (ST046167) and nearby Potton Hill are also suggestive of ceramic production. Probably associated with the former is the name Crokkerneway e, found in the 'Ministers accounts' (Mills 1980), this means 'way to the pottery'. Stevenson (1815, 450) refers to "a pottery for coarse earthen ware at Cranborne"

7. Dorchester

Mills (1977, 362) mentions a field by the name of Crockers Cross, which belonged to John Crokker of Dorchester in 1401. Mayo (1908, 142) mentions this same individual who leased property in Dorchester and lived in Frampton. Mayo also records a John Potter who granted "burgage with curtilage" in Dorchester to one John Wynhard (1908, 280).

8. East Chelborough

Mills (1971, 67) mentions a resident of the parish by the name of Johanne Crocker.

9. East Holme SY898860

In 1665 a case concerning a sixty year old potter from East Holme named Thomas Dober appears in a Dorset law suit (Pope n.d. vol. 2, 192). This is additional to previously identified references to the Dobers and Dovers at East Holme, as outlined by Terry (1987, 39). The following information is taken from his paper. It is known that a William Dover was a potter in East Holme in 1701 as in this year it is recorded that he hired an apprentice, Thomas Dover, from the poor house at Wareham (DRO P63/OV9). This is the earliest direct reference to a family of potters named Dover in East Holme, however the earlier Thomas Dober could well be of the same family. A resident of the parish with the name Thomas Dover appears as far back as 1642 in the Protestation Returns (Fry 1912) and one could suggest that this may actually be the same individual described as 'Thomas Dober' in 1665.

The East Holme tithe map (DRO T/EHO) 1841, shows a field which is still today known as 'Potter's Field' although no mention of ownership by a Dover family is made here. However a stream running through the village is known as 'Dover's Stream' and this may well be a relic from a time when the Dover family used this stream as a source for pottery making in 'Potter's Field' (Terry, 1987, 39).

Fieldwalking exercises were carried out between 1974 and 1975 by John Beavis and the late Donald Young, in two newly ploughed fields; 'Button's Cowlease' and 'Potter's Field' at Stoborough in East Holme parish. Both produced large numbers of sherds and wasters, the former in two main concentrations and the latter in one. All the pottery was of post-medieval date, with a probable date for its production being between the seventeenth and nineteenth centuries. To follow up this work magnetometer surveys were carried out in the two fields in 1985 by John Terry. One main area of magnetic enhancement was identified in each field, suggesting the

possible sites of kilns or waster heaps (Terry, 1987).
Popes translations of Dorset law suits (n.d., vol. 4, 214) mention a dispute between two farmers, George Pitt and John Banks over; "mines. quarries, marl pits and clay pits in the manor of Stowborough alias Stoborough and Laughton Wallis and boundaries of the two manors". This case, dated 1699, may relate to ceramic manufacture in the parish of East Holme, however the clay diggings could just as likely be a part of the pipe-clay extractive industry which was so important to Wareham and Poole in the seventeenth and eighteenth centuries (Page, vol. 2, 363-4). A number of references to this industry can be found in Popes translations including one case of 1697-8 involving 1800 tons of clay; "dug, cut and carried from the pits at Wareham on the waterside...". This clay was; "put in cellars and conveyed to London and elsewhere" (Pope n.d., vol.11, 225-6).

10. East Stoke

Mills (1977, 152) identifies a place name of1662 in this parish as 'Crocker's Tenement'.

11. Edmondsham SU084113

Thomas Lawrence was a potter at Gotham Farm from 1700 until his death in 1737. His son Lawrence succeeded him. During the last quarter of the seventeenth century Lewis Kerley was also potting at Edmondsham, either at Gotham Farm, or at a second unlocated site (Algar *et al*1987, 29).

12. Fifehead Magdelen

Hutchins (1870, 58), mentions 'crockerford' as a place name in this parish, now lost.

13. Fifehead Neville

Mills (1980, 99), gives 'Crockerne's Land' as a field name in the parish in 1662. It is associated with one John Crockerne.

14. Frampton

Mills (1971, 88) mentions a resident of the parish by the name of Nicholas de Crockwaye.

15. Halstock

Mills (1971, 41) mentions a resident of the parish by the name of Willelme le Crokker. This is probably the same individual known as Willelmo Crokkere in the 1327 Lay Subsidy Roll (Rumble 1980, 62).

16. Haydon

The Dorset Lay Subsidy Rolls of 1327 (Rumble 1980, 28) and 1332 (Mills 1971, 32) mention a resident of the parish by the name of Waltero Potage.

17. Hazelbury Bryan

Fagersten (1933, 54), mentions a field in the parish called "Crockern Stoke" in the early fourteenth century. This can be interpreted as 'a house where pots were made' or as 'potter's place'.

18. Hermitage ST656067

In 1957 and 1958 a nine acre field north of Hartley Manor Farm in Hermitage parish was ploughed for the first time. During this process wasters, kiln furniture and black soil appeared in several places. After the material was identified as being derived from a medieval kiln or kilns, a short excavation was carried out in 1959, (Field, 1966). Excavation below the patches of black soil revealed a clay mound, about 1 metre across, under which was the body of a kiln. Inside the kiln were sherds, fragments of roofing tiles, fire bars and a pottery griddle. The kiln oven measured approximately 1.5 metres long, by 1 metre wide and it appeared to have had two phases of construction. The products of the kiln dated its period of use as being between 1250 and 1300, with the possibility of the initial date being somewhat earlier. No traces of other kilns were found and, although sixteenth century sherds had previously been discovered towards the eastern end of the same field, no post-medieval wasters came to light during excavation.

Documentary evidence does however exist for a possible later period of ceramic production in this parish. Popes translations of Dorset lawsuits (Pope n.d., vol. 1, 249). contain a case of 1635 involving four potters from Holnest, named John and Mesusaleth Miller, and Beere Pollard and Thomas Dober. The dispute is over closes of land in Hermitage parish. Whether this land was where ceramic manufacture occurred, or whether it was for fuel-gathering, clay-digging or agricultural purposes is not known.

19. Holnest

The records of the consitory court for 1617 state that Thomas Vincent, a potter at Holnest, was granted fuel gathering rights. Furthermore in Popes translations of Dorset suits of law (Pope n.d., vol. 1, 249), four potters from Holnest are mentioned in the year 1635; Beere Pollard, aged 26, Thomas Dober, aged 55 and John and Mesusaleth Miller, both aged 40. In 1677 another case is recorded (Pope n.d., vol. 5, 298) involving potters from Holnest. It concerns a debt they owed for £20. The names are Thomas Dober and his son John Dober, and John Miller and his son William Miller.

20. Holt

Heavy sherd concentrations at three places suggest that pottery production was carried out in this parish from the seventeenth century onwards (Algar *et al,* 1987, 28).

1. SU031066
2. SU026062
3. SU027063

21. Horton

A great deal of information concerning post-medieval pottery production in Horton parish has been compiled by members of the Verwood and District Potteries Trust (Algar *et al* 1987, 26-28). References suggest that the industry probably started around the end of the sixteenth century and continued up until the early eighteenth century in the village itself, and up until the mid nineteenth century at the Verwood end of the parish. Five kiln sites have so far been identified in the parish, these are located at:

1. SU032075
2. SU030071
3. SU080085
4. SU076085
5. SU078083

During 1976 a small excavation was carried out at Horton Site 1. A trench three metres square revealed a primary waste dump containing fragments of about 700 vessels in over thirty forms, all of probable seventeenth century date. The only traces of the kiln itself were a few pieces of partially fused brick, however its actual location cannot be more than a few metres away from the excavation (Algar *et al* 1987, 26).

The ceramics from this site will be discussed in a forthcoming paper (Copland-Griffiths, this volume).

22. Leigh

Mills (1971, 35) mentions a resident of the parish by the name of Willelmo Croker. Fagersten (1933, 224), gives as a field name in the parish "Crocker's Knap" before1750.

23. Loders

Mills (1971, 26) mentions a resident of the parish by the name of Willelmo Crokker.

24. Lydlinch

Hutchins (1870, 191), refers to the place name 'crockern stoke' in Lydlinch parish.

25. Lyme Regis SY342953

The following is all taken from Drapers 1982 paper. Kiln furniture and large quantities of eighteenth century wasters have been found on Hole Common at the extreme north end of Lyme parish. The site is near the Penn Inn on the original Bridport to Axminster road. Documentary references record the marriage of one John Mitchell, a potter in 1742 (Lyme Parish Registers) and also the marriage of a potter named Joshua Case of Whitchurch Canonicorum in 1762. Draper suggests that these men may be potters from this site (Draper 1982, 137).

26. Maiden Newton SY614958

Mills (1971, 87) mentions the existence of one Roberto Crockwaye in Maiden Newton parish. This is the only personal reference to possible ceramic production so far discovered for this parish, however much more information exists in the form of place and field names.

Fagersten (1933, 233), records 'Crockway Farm' as being a place where pots have been found in the past. Furthermore, Pulman (1875, 64). mentions 'Crimmercrock Lane' as passing through this parish. The1836 Tithe Map For Maiden Newton (DCRO T/MAI) shows five fields with the 'Crockway' name element, these being: 'Crockway Hill', 'Crockway Bottom', 'Crockway Great Field', 'Crockway Marsh', and 'Crockway Bottom Mead'. Recent fieldwork after ploughing on 'Crockway Great Field' produced some pottery, but the amount was not suggestive of anything more than normal manuring activities. A rotavated area in 'Crockway Bottom Mead' also produced some pottery, however the number of sherds was again very small and they can probably be attributed to the disturbance of medieval house platforms at the top of the field.

27. Osmington

Mills (1977, 216) records a 1318 field name in this parish as 'Crocklynch'. This can be interpreted as meaning 'a ridge or bank where potsherds were found'

28. Pamphill

Mills (1971, 96) mentions a resident of the parish by the name of Rogero Poter.

29. Piddlehinton

Rumble (1980, 16) mentions an individual known as Eua de Crockway in this parish. This name may represent an ex-resident of Crockway in Maiden Newton parish. Mills (1971, 13) refers to a person of the same surname who's forname is not known.

30. Poole, borough of (formerly Kinson parish)

Austen (1852) states the following. 'About midway [between Bournemouth and Sandbanks] there was formerly a pottery for the manufacture of common earthenware.' This was probably located in the part of the borough that was formerly the parish of Kinson. Many brick kilns were operative in this area in the nineteenth century and it is possible that vessel manufacture existed alongside this industry. The large South Western Pottery factory was also producing wares in the nineteenth century at Parkstone, however this would have been a much larger concern than that described by Austen.

31. Portesham

The Dorset Lay Subsidy Rolls of 1327 (Rumble 1980, 116) and 1332 (Mills 1971, 93) both mention a resident of the parish by the name of Willelmo le Crokker.

32. Puddletown

Mills (1977, 325)) gives as a field name in the parish 'Potter's Mead'. Also, in1372 there was a field known as 'Crukescumba' which can be interpreted as meaning 'crocker's valley' (Mills, 1977, 326).

33. Pulham

Mills (1971, 67) mentions a resident of the parish by the name of Johanne Crocker.

34. Sydling St. Nicholas

Rumble (1980, 55) and Mills (1971, 24) mention a resident of the parish by the name of Edwardo Potage.

35. Turner's Puddle

Mills (1977, 298) gives as field names in the parish 'Crockrys' and 'Crokkesclose' with the dates 1442 and 1445 repectively. In 1442 one John Crocker is recorded as being associated with these fields.

36. Tyneham

Mills (1971, 89) mentions a resident of Egliston in this parish by the name of Henrico le Croker.

37. Verwood

Verwood became the centre of a rural pottery industry which had its origins in the fourteenth century, but which was most active in this particular parish in the eighteenth and nineteenth centuries. Pottery associated names exist in the parish, however, from the thirteenth century onwards (Mills 1980, 257). Members of the Verwood and District Potteries Trust have located twelve kiln sites in the parish to date (Young 1979, Algar *et al*1987), grid references for which can be seen below. Kilns 1 and 2 were probably in operation by the 1660,s, and others may have existed at this date as well. These early sites are in East Worth, rather than Verwood proper which is about one mile to the south. The larger, later industry can be seen as "little more than a southward extension of the activity at East Worth" (Algar *et al* 1987, 31). The last kiln ceased operating in 1952.

Kiln 8 is located at Pottern farm. This place-name is of medieval origin (Mills 1980, 257) and is the only suggestion of pre seventeenth century ceramic manufacture in this particular parish. Substantial earthworks are present here, probably relating to post-medieval pottery production, however some remains of medieval activity may also be present

Location of kiln sites in Verwood Parish.

1. SU087103
2. SU083097
3. SU086091
4. SU095088
5. SU094087
6. SU093087
7. SU086083
8. SU091077
9. SU079083
10. SU083086
11. SU077086
12. SU082079

38. West Compton SY564944

Good (1940, 96), mentions the name "Crocker's Farm" in this parish. The farm still exists but no earlier references to the name can be found.

39. West Stour

Rumble (1980, 69)mentions a resident of the parish by the name of Thomas Pottere.

40. Wimborne Minster

Mills (1980, 192), gives a 1552 place name in this parish as 'Crockerne Fyldys'. This he interprets as meaning a field where pots were made.

41. Winfrith Newburgh

Mills (1977, 180) gives 'Crocker's Hay' as a field name in this parish.

42. Winterborne Kingston

Mills (1971, 9) mentions a resident of the parish by the name of Thoma Potel. Furthermore Mills (1977, 386) gives 'Crocker's' as a field name in the parish before 1750. This field was owned by a Henry Crocker in 1664 and so this may be the source of the name. By the time that the 1847 tithe map was compiled (DROT/WBK) the owner's name was no longer Crocker.

43. Wool

Mills (1971, 8) mentions a resident of the parish by the name of Rogero Crocker.

44. Wootton Glanville

Rumble (1980, 77) mentions two residents of this parish with the name Willelmo Crokkere and one called Johanne Crokkere.

Appendix 2

Neutron Activation Analysis study of kiln site sherds

The various sources of potential error in the analytical data were discussed in Chapter 3. Some attempts were made to identify the deviations of the measured values from absolute, through comparisons with data derived from other laboratories. These were summarised in Tables 3.2 and 3.3, where the indications were that, for most of the elements studied, the results of the analyses used here were 'as good' as those used in other similar pieces of work.

A further comparison between values measured by AAS at the Dorset Institute, and values measured by NAA at the University of Bradford, was made, with the latter work being supervised by Arnold Aspinall. Thirty powdered ceramic samples, ten from Hermitage sherds and twenty from Laverstock sherds were irradiated and transported to Bradford for decay-counting. Due to personnel difficulties only the long half-life elements were counted at Bradford, and this resulted in measurements for only two elements from the ten studied at the Dorset Institute, being duplicated at Bradford. Concentrations for many more trace elements were also produced, and these were also of interest as further useful discriminators were possible in this group. In fact, none of these elements proved better than iron and magnesium at separating the two kiln groups, and the two wares from Laverstock, and so this data was ultimately not of great use.

The data for the NAA study can be seen in Table A2.1, with the comparison between the data for Cr and Fe being visible in Table A2.2.

Table A2.2 illustrates a number of points. Firstly, the Cr data, derived by AAS, is rather inaccurate, resulting from the very low concentrations that this element was present in. NAA is more sensitive than AAS for most elements, and the NAA data for Cr must therefore be viewed as the most valuable of the two, particularly as a large portion of the AAS Cr data is only described to one significant figure.

Iron was present in concentrations that enabled good measurements to be made using both methods. However, it is evident that there are again large discrepancies between the two sets of figures. The error seems to increase with increasing concentration, and this perhaps,indicates that the internal calibration curve calculation of the AAS may have not been properly set up. In AAS concentration-dependent errors are caused by a number of factors. all of which result in a non-linear response once the measured concentration exceeds a 'best' region. The iron measurements on the Hermitage sherds were made at quite high sample concentrations, and this could explain the poor quality of the final results. In later analyses for Iron, which includes those on the samples from the settlement sites as well as a re-run of the kiln material, the solutions were further diluted and such problems did not arise again.

Table A2.1 Concentrations in sherds determined by NAA

	Concentration, in ug/ml, or ppm												
Sherd	Fe	Sb	Sc	Co	Rb	Cs	Ce	Eu	Tb	Hf	Ta	Pa	Cr
HM21	53781.37	1.81	18.2	24.89	176.7	12.25	78.51	1.34	0.76	6.49	1.1	12.72	1.7.21
HM22	56343.82	0.54	17.2	71.91	108.6	14.55	126.1	1.53	0.77	7.81	1.15	12.05	120.1
HM23	53415.34	1.94	18.56	28.17	199.2	14.7	90.65	1.77	0.77	7.36	1.15	11.62	115
HM26	41393.08	1.37	13.98	17	105.2	8.79	74.01	1.32	0.68	7.02	0.64	9.54	87.28
HM27	50741.75	0.38	17.47	20.47	151.2	11.26	89.25	1.83	0.78	7.8	0.98	12	128
HM28	57021.54	1.97	19.55	23.51	231.1	13.25	85.44	1.66	0.87	8.98	0.95	11.83	123.2
HM31	58545.95	0.87	16.11	25.47	155.8	10.74	86.35	1.72	0.79	8.04	1.04	12.21	108.2
HM32	50015.73	0.36	16.7	18.27	128.5	11.98	84.73	1.36	0.59	7.64	1.04	13.17	112.9
HM36	52341.81	0.79	15.14	23.28	166.7	10.78	72.16	1.34	0.08	7.26	0.85	10.03	127
HM37	47270.23	1.49	14.26	29.27	114.9	10.67	75.68	1.24	0.37	7.7	0.62	9.36	105.8
LV1	13784.66	0.55	15.48	4.73	96.52	8.24	83.64	1.73	0.74	6.34	0.91	9.86	94.16
LV2	16607.29	0.56	15.5	5.01	74.15	10.06	70.58	1.76	0.75	6.74	1.12	10.3	96.38
LV3	13674.74	0.52	16.21	5.35	74.74	8.59	76.73	1.68	0.83	6.85	0.83	10.3	93.3
LV4	14246.85	0.59	16.68	4.85	88.84	9.15	77.46	1.86	0.89	5.67	0.82	9.81	96.94
LV5	16115.08	0.39	16.33	4.71	99.03	6.97	73.23	1.53	0.81	6.73	1.08	10.03	103.4
LV6	17617.17	0.53	16.12	4.43	112.3	8.24	71.52	1.26	0.55	7.51	1.06	10.7	117.7
LV7	21210.3	0.437	17.5	4.65	95.58	8.18	61.29	1.3	0.44	6.33	1.48	11.12	121
LV8	19782.09	0.35	15.88	3.73	74.7	8.99	75.56	1.32	0.54	6.63	1.34	10.08	107.5
LV9	24327.79	0.28	21.39	7.65	55.38	9.19	64.92	1.64	0.79	3.74	1.15	11.15	114.9
LV10	39239.45	0.52	17.25	34.42	148.2	7.31	74.12	1.57	0.94	3.33	0.68	11.07	99.86
LV21	14256.17	0.59	15.42	4.16	90.51	8.12	99.28	1.52	0.69	5.93	1.2	9.68	71.88
LV24	15012.15	0.69	14.59	3.76	70.97	7.37	68.41	1.18	0.63	5.68	1.3	8.51	61.9
LV27	22606.65	1.28	21.28	5.82	117.1	9.69	87.91	1.62	0.73	7.1	1.63	12.45	147.1
LV30	20260.87	0.86	16.83	4.02	108.8	8.35	67.09	1.29	0.68	6.85	1.36	9.95	105.1
LV33	14711.83	0.32	16.02	4.88	98.11	9.78	63.58	1.32	0.58	7.13	1.46	9.23	118.5
LV36	27855.97	1.22	20.64	13.04	74.77	10.74	62.43	1.44	0.6	4.68	0.7	11.47	116.7
LV39	14527.24	0.13	13.72	7.91	33.64	6.65	57.61	1.81	0.83	4.25	0.86	8.79	80.3
LV42	17596.18	0.3	14.18	6.46	45.26	6.1	58.99	1.66	0.73	3.65	0.91	9.03	87.68
LV45	17022.6	0.45	14.14	4.86	87.39	9.03	71.71	1.19	0.7	5.96	1.11	9.5	106
LV48	21077.91	0.63	14.68	5.27	113.1	7.7	64.68	1.34	0.69	7.09	1.49	9.96	113.8

Table A2.2 A comparison of Chromium and Iron concentrations, calculated through AAS and NAA

	AAS, Dorset Institute		NAA, University of Bradford	
Samples	%Fe	%Cr	%Fe	%Cr
HM21	4.963	0.013	5.378	0.0107
HM22	4.185	0.018	5.634	0.012
HM23	4.787	0.015	5.342	0.015
HM26	4.317	0.015	4.14	0.0087
HM27	4.307	0.014	5.141	0.0128
HM28	4.093	0.015	5.702	0.0123
HM31	4.41	0.015	5.855	0.0108
HM32	4.39	0.014	5.002	0.0113
HM36	4.72	0.013	5.234	0.0127
HM37	4.733	0.012	4.727	0.0106
LV1	1.51	0.011	1.379	0.0094
LV2	1.65	0.009	1.661	0.0096
LV3	1.32	0.008	1.367	0.0093
LV4	1.5	0.01	1.425	0.0097
LV5	1.51	0.01	1.612	0.0103
LV6	1.97	0.009	1.762	0.0118
LV7	1.56	0.009	2.121	0.0121
LV8	1.79	0.011	1.978	0.0107
LV9	1.9	0.011	2.433	0.0114
LV10	4.31	0.01	3.924	0.0099
LV21	1.453	0.009	1.426	0.0072
LV24	1.723	0.011	1.501	0.0062
LV27	1.82	0.009	2.26	0.0147
LV30	2.247	0.013	2.026	0.0105
LV33	1.337	0.012	1.471	0.0118
LV36	2.327	0.011	2.786	0.0117
LV39	1.387	0.01	1.453	0.008
LV42	1.55	0.011	1.76	0.0088
LV45	1.9	0.01	1.902	0.0106
LV48	1.777	0.01	2.11	0.0113

Appendix 3 Ten element concentrations in the samples from the kiln sites

Sample code	From Sherd...	%Mg	%Ca	%Fe	%Ni	%Mn	%Cu	%Al	%Ti	%Cr	%K
LY1	LYK1 1	0.401	0.5	1.51	0.01	0.005	0.016	8.31	0.625	0.011	1.3
LY2	2	0.406	0.58	1.65	0.01	0.004	0.016	7.99	0.569	0.009	1.1
LY3	3	0.379	0.54	1.32	0.012	0.004	0.012	7.02	0.493	0.008	0.725
LY4	4	0.418	0.65	1.5	0.009	0.006	0.009	8.25	0.56	0.01	0.825
LY5	5	0.386	0.9	1.51	0.011	0.004	0.02	7.44	0.422	0.91	1.3
LY6	6	0.41	1.02	1.97	0.009	0.006	0.018	8.09	0.433	0.009	1.35
LY7	7	0.424	0.044	1.56	0.012	0.005	0.021	6.64	0.408	0.013	1.125
LY8	8	0.486	0.59	1.79	0.01	0.005	0.016	6.97	0.435	0.011	1.275
LY9	9	0.271	1.01	1.9	0.011	0.004	0.013	7.56	0.358	0.011	0.25
LY10	10	1.199	4.36	4.31	0.01	0.051	0.013	8.45	0.434	0.91	2.5
LY11	11	0.458	0.73	1.74	0.008	0.004	0.012	7.5	0.55	0.009	1.25
LY12	12	0.516	4.42	1.79	0.008	0.012	0.013	8.21	0.601	0.011	1.1
LY13	13	0.543	0.84	1.93	0.01	0.005	0.013	7.7	0.603	0.009	1.35
LY14	14	0.548	0.89	2.32	0.01	0.006	0.015	8.82	0.615	0.013	1.15
LY15	15	0.459	0.7	2.1	0.011	0.006	0.015	7.31	0.594	0.012	1.25
LY16	16	0.462	0.92	1.75	0.007	0.006	0.011	7.42	0.445	0.011	0.3
LY17	17	0.253	1.17	2.14	0.008	0.005	0.014	9.48	0.349	0.01	0.15
LY18	18	0.32	1.18	2.38	0.02	0.003	0.015	8.98	0.389	0.011	0.15
LY19	19	0.269	0.89	1.51	0.02	0.004	0.014	8.56	0.563	0.01	0.15
LY20	20	0.276	0.82	1.96	0.018	0.003	0.012	7.69	0.475	0.01	0.85
LY21	LYK6 1	0.39	0.73	1.453	0.007	0.006	0.01	7.627	0.52	0.01	1.36
LY22	1	0.38	0.71	1.363	0.006	0.006	0.008	7.99	0.43	0.009	1.25
LY23	1	0.405	3.73	1.687	0.006	0.012	0.013	8.453	0.49	0.009	1.09
LY24	2	0.317	3.72	1.723	0.005	0.011	0.012	7.593	0.51	0.01	1.17
LY25	2	0.336	0.62	1.6	0.004	0.007	0.012	8.537	0.4	0.013	1.21
LY26	2	0.325	0.79	1.7	0.005	0.007	0.012	8.823	0.47	0.012	1.909
LY27	3	0.409	0.53	1.82	0.007	0.006	0.01	9.047	0.48	0.009	1.27
LY28	3	0.401	0.63	1.84	0.005	0.006	0.011	8.347	0.46	0.01	1.34
LY29	3	0.408	0.7	1.88	0.008	0.006	0.01	8.533	0.53	0.009	1.02
LY30	4	0.389	0.55	2.247	0.006	0.006	0.012	8.767	0.44	0.008	1.11
LY31	4	0.371	0.89	1.99	0.006	0.005	0.009	8.253	0.42	0.013	0.56
LY32	4	0.373	0.9	2.047	0.005	0.006	0.01	8.14	0.39	0.013	0.51
LY33	5	0.37	1.48	1.337	0.006	0.006	0.013	7.813	0.39	0.012	0.39
LY34	5	0.357	1.3	1.37	0.007	0.006	0.019	7.393	0.37	0.012	0.35
LY35	5	0.362	1.49	1.273	0.009	0.006	0.014	7.64	0.14	0.011	0.3
LY36	6	0.315	3.73	2.327	0.013	0.009	0.015	8.887	0.39	0.011	0.34
LY37	6	0.307	0.74	2.2	0.015	0.006	0.014	8.51	0.47	0.013	1.32
LY38	6	0.316	0.8	2.167	0.017	0.006	0.014	8.62	0.49	0.012	1.32
LY39	7	0.17	0.9	1.387	0.016	0.006	0.013	8.697	0.38	0.011	0.95
LY40	7	0.175	1.98	1.34	0.012	0.007	0.013	6.947	0.45	0.011	1.05

Appendix 3 continued

Sample code	From Sherd...	%Mg	%Ca	%Fe	%Ni	%Mn	%Cu	%Al	%Ti	%Cr	%K
LY41	7	0.162	3.73	1.373	0.013	0.007	0.012	6.823	0.53	0.013	1.27
LY42	8	0.18	3.73	1.55	0.008	0.006	0.011	7.323	0.41	0.012	1.19
LY43	8	0.165	3.73	1.467	0.01	0.006	0.011	7.07	0.44	0.013	1.15
LY44	8	0.171	0.82	1.547	0.008	0.007	0.01	7.367	0.49	0.01	1.09
LY45	9	0.376	0.77	1.9	0.008	0.006	0.053	8.003	0.45	0.01	1.09
LY46	9	0.376	0.78	1.8	0.006	0.007	0.012	7.633	0.45	0.01	0.99
LY47	9	0.379	0.69	1.997	0.011	0.008	0.013	7.837	0.59	0.01	1.35
LY48	10	0.325	0.94	1.777	0.01	0.011	0.012	6.503	0.6	0.009	1.38
LY49	10	0.311	1.08	1.867	0.007	0.01	0.018	6.247	0.56	0.009	1.34
LY50	10	0.335	0.61	1.94	0.008	0.006	0.01	6.283	0.52	0.006	1.34
LY51	11	0.342	0.08	1.72	0.009	0.005	0.011	7.637	0.5	0.009	1.21
LY52	11	0.306	0.62	1.797	0.007	0.006	0.015	8.647	0.49	0.01	1.34
LY53	11	0.333	1.44	2.34	0.009	0.006	0.013	8.56	0.49	0.011	1.35
LY54	12	0.378	2.19	1.68	0.01	0.006	0.014	7.603	0.53	0.012	1.09
LY55	12	0.347	3.73	1.617	0.011	0.008	0.017	7.183	0.47	0.011	1.23
LY56	12	0.368	0.72	1.817	0.012	0.007	0.007	7.84	0.54	0.001	1.29
LY57	13	0.392	0.74	1.367	0.008	0.006	0.01	7.443	0.46	0.01	1.25
LY58	13	0.397	0.75	1.343	0.009	0.006	0.01	7.457	0.5	0.001	1.23
LY59	13	0.394	0.66	1.357	0.008	0.012	0.016	7.243	0.58	0.01	1.49
LY60	14	0.379	0.64	1.71	0.012	0.007	0.011	7.963	0.6	0.01	1.73
LY61	14	0.377	0.63	1.62	0.01	0.007	0.011	7.81	0.64	0.009	1.63
LY62	14	0.379	0.71	1.65	0.008	0.01	0.013	7.903	0.5	0.011	1.46
LY63	15	0.355	0.83	2.037	0.004	0.01	0.016	7.47	0.53	0.011	1.25
LY64	15	0.377	0.81	1.587	0.007	0.008	0.013	8.037	0.55	0.01	1.44
LY65	15	0.345	1.68	1.87	0.005	0.009	0.018	7.91	0.4	0.01	0.32
LY66	16	0.391	1.8	2.157	0.005	0.021	0.017	8.3	0.36	0.011	0.3
LY67	16	0.392	1.57	2.033	0.006	0.011	0.017	8.317	0.46	0.011	0.32
LY68	16	0.395	1.25	2.017	0.008	0.008	0.015	8.407	0.37	0.009	0.41
LY69	17	0.506	1.06	1.95	0.009	0.004	0.018	8.36	0.42	0.01	0.43
LY70	17	0.51	1.49	2.183	0.009	0.008	0.015	8.737	0.37	0.011	0.43
LY71	17	0.511	0.71	1.947	0.007	0.006	0.015	8.863	0.53	0.012	1.44
LY72	18	0.405	0.82	2.053	0.01	0.005	0.012	7.88	0.6	0.014	1.34
LY73	18	0.437	0.52	1.947	0.01	0.005	0.014	7.86	0.54	0.012	1.29
LY74	18	0.449	0.76	1.897	0.009	0.006	0.015	7.957	0.53	0.013	1.43
LY75	19	0.141	0.82	1.59	0.011	0.006	0.013	7.253	0.53	0.001	1.29
LY76	19	0.129	0.66	1.53	0.01	0.005	0.014	6.93	0.47	0.014	1.34
LY77	19	0.168	1.5	1.727	0.01	0.004	0.014	8.02	0.44	0.013	0.49
LY78	20	0.224	1.19	1.697	0.014	0.007	0.015	7.51	0.369	0.013	0.56
LY79	20	0.209	1.56	1.82	0.014	0.006	0.046	8.01	0.35	0.011	0.49
LY80	20	0.205	1.21	1.743	0.017	0.004	0.011	7.463	0.36	0.011	0.62

Appendix 3 continued

Sample code	From Sherd...	%Mg	%Ca	%Fe	%Ni	%Mn	%Cu	%Al	%Ti	%Cr	%K
HM1	1	0.534	0.86	6.75	0.017	0.053	0.016	7.533	0.52	0.014	1.275
HM2	1	0.618	0.74	5.343	0.013	0.017	0.01	7.073	0.56	0.012	1.325
HM3	1	0.418	0.79	5.883	0.011	0.018	0.011	7.71	0.5	0.011	1.425
HM4	2	0.864	0.73	4.623	0.009	0.018	0.011	8.683	0.57	0.013	1.8
HM5	2	0.874	0.73	4.63	0.012	0.038	0.011	8.387	0.54	0.014	1.55
HM6	2	0.409	0.56	4.207	0.012	0.023	0.01	7.993	0.51	0.014	1.25
HM7	3	0.816	1.89	4.31	0.017	0.019	0.011	7.487	0.51	0.01	1.9
HM8	3	0.91	1.94	4.37	0.01	0.02	0.013	7.497	0.53	0.012	1.85
HM9	3	0.891	2	4.69	0.017	0.02	0.013	7.743	0.53	0.011	1.85
HM10	4	0.877	0.86	4.81	0.018	0.034	0.013	9.473	0.61	0.012	1.9
HM11	4	0.824	0.82	4.89	0.018	0.047	0.013	8.657	0.64	0.013	1.45
HM12	4	0.94	0.78	4.917	0.015	0.022	0.018	9.423	0.59	0.014	1.9
HM13	5	0.867	4.26	4.35	0.019	0.018	0.017	8.35	0.51	0.014	1.725
HM14	5	0.841	4.42	4.317	0.025	0.029	0.013	8.53	0.51	0.014	1.925
HM15	5	0.843	4.26	4.653	0.024	0.018	0.019	8.933	0.52	0.015	1.8
HM16	6	0.665	0.81	4.21	0.017	0.034	0.013	6.68	0.47	0.015	1.375
HM17	6	0.695	0.86	4.44	0.011	0.023	0.013	7.127	0.53	0.014	1.275
HM18	6	0.536	0.65	4.017	0.019	0.025	0.013	8.38	0.41	0.015	1.275
HM19	7	0.789	0.96	4.363	0.014	0.019	0.012	5.597	0.44	0.016	1.6
HM20	7	0.79	0.91	4.683	0.011	0.029	0.013	8.607	0.48	0.015	1.7
HM21	7	0.739	1.03	4.963	0.01	0.02	0.015	8.65	0.54	0.016	1.7
HM22	8	0.759	0.84	4.185	0.018	0.017	0.016	8.177	0.49	0.014	1.475
HM23	8	0.591	0.75	4.787	0.013	0.018	0.014	8.477	0.5	0.014	1.45
HM24	8	0.782	0.84	4.41	0.017	0.017	0.015	8.897	0.54	0.014	1.85
HM25	9	0.814	0.72	4.227	0.018	0.02	0.014	7.863	0.55	0.014	1.525
HM26	9	0.823	0.76	4.317	0.015	0.017	0.014	8.477	0.53	0.013	1.45
HM27	9	0.798	0.74	4.307	0.018	0.019	0.014	8.897	0.47	0.014	1.4
HM28	10	0.778	0.73	4.093	0.012	0.031	0.014	7.27	0.44	0.015	1.55
HM29	10	0.778	0.76	3.903	0.015	0.024	0.016	7.443	0.42	0.016	1.9
HM30	10	0.773	0.75	3.777	0.021	0.013	0.015	7.4	0.44	0.016	1.8
HM31	11	0.589	0.77	4.41	0.013	0.029	0.007	7.713	0.5	0.013	1.475
HM32	11	0.614	0.79	4.39	0.01	0.019	0.008	7.733	0.52	0.014	1.55
HM33	11	0.647	0.81	4.423	0.008	0.013	0.009	7.837	0.44	0.015	1.325
HM34	12	0.815	1.01	4.487	0.016	0.024	0.012	7.893	0.52	0.015	1.775
HM35	12	0.851	1.07	4.58	0.017	0.035	0.019	7.907	0.58	0.014	1.55
HM36	12	0.856	1.05	4.72	0.016	0.025	0.007	8.253	0.5	0.017	1.825
HM37	13	0.857	1.25	4.733	0.013	0.042	0.01	8.8	0.52	0.014	1.45
HM38	13	0.799	1.16	4.71	0.015	0.078	0.012	8.813	0.55	0.014	1.55
HM39	13	0.815	1.17	4.73	0.018	0.202	0.011	8.67	0.53	0.015	1.7
HM40	14	0.86	0.84	4.6	0.019	0.032	0.01	8.323	0.52	0.015	1.775

Appendix 3 continued

Sample code	From Sherd...	%Mg	%Ca	%Fe	%Ni	%Mn	%Cu	%Al	%Ti	%Cr	%K
HM41	14	0.835	0.84	4.547	0.02	0.035	0.008	8.167	0.52	0.015	1.5
HM42	14	0.851	0.9	4.413	0.016	0.035	0.009	8.233	0.53	0.015	1.65
HM43	15	0.599	0.82	4.37	0.01	0.041	0.007	7.663	0.42	0.014	1.35
HM44	15	0.499	0.2	4.25	0.011	0.016	0.007	7.443	0.45	0.014	1.325
HM45	15	0.409	0.69	4.567	0.014	0.018	0.009	7.493	0.4	0.013	1.175
HM46	16	0.761	1.09	4.003	0.016	0.023	0.008	6.173	0.35	0.013	1.325
HM47	16	0.78	1.14	4.043	0.024	0.033	0.01	6.467	0.4	0.014	1.575
HM48	16	0.805	0.263	4.24	0.024	0.021	0.013	6.693	0.39	0.012	1.55
HM49	17	0.698	0.66	4.243	0.014	0.013	0.011	7.22	0.42	0.013	1.375
HM50	17	0.757	0.62	4.237	0.012	0.032	0.012	6.903	0.43	0.012	1.375
HM51	17	0.758	0.65	4.323	0.014	0.018	0.012	7.25	0.42	0.013	1.325
HM52	18	0.351	0.59	5.603	0.013	0.061	0.01	6.407	0.35	0.012	1.125
HM53	18	0.382	0.6	6.19	0.014	0.024	0.012	5.797	0.36	0.012	0.7
HM54	18	0.407	0.61	6.373	0.013	0.032	0.008	5.437	0.34	0.011	0.7
HM55	19	0.603	1.28	4.097	0.013	0.018	0.008	5.833	0.36	0.012	1.3
HM56	19	0.567	0.94	4.1	0.016	0.019	0.006	6.15	0.4	0.012	1.375
HM57	19	0.595	1.19	4.057	0.014	0.019	0.01	5.71	0.39	0.012	1.25
HM58	20	0.774	1.01	4.127	0.017	0.027	0.013	6.083	0.4	0.012	1.575
HM59	20	0.777	1	4.07	0.019	0.022	0.012	6.277	0.4	0.012	1.475
HM60	20	0.818	1.02	4.267	0.017	0.037	0.012	6.557	0.44	0.012	1.775
HM61	21	0.723	1.43	4.58	0.012	0.031	0.008	8.6	0.43	0.013	1.84
HM62	22	0.844	0.78	4.83	0.017	0.025	0.008	8.47	0.55	0.018	1.46
HM63	23	0.832	0.73	4.28	0.018	0.014	0.01	9.07	0.47	0.015	1.8
HM64	24	0.605	0.59	4.22	0.01	0.021	0.01	8.06	0.39	0.014	1.46
HM65	25	0.812	0.67	4.19	0.016	0.016	0.01	7.37	0.39	0.014	1.54
HM66	26	0.462	0.85	3.97	0.011	0.012	0.009	7.35	0.44	0.015	1.25
HM67	27	0.679	0.71	4.73	0.011	0.013	0.009	8	0.48	0.014	1.63
HM68	28	0.838	2.62	4.35	0.01	0.03	0.011	7.97	0.4	0.015	1.63
HM69	29	0.822	0.71	4.29	0.015	0.018	0.009	8.11	0.45	0.014	1.84
HM70	30	0.863	0.74	5.04	0.012	0.018	0.01	8.77	0.21	0.015	1.63
HM71	31	0.593	0.84	4.86	0.013	0.056	0.011	7.19	0.43	0.015	1.46
HM72	32	0.689	0.77	4.28	0.013	0.022	0.012	7.28	0.41	0.014	1.43
HM73	33	0.829	1.01	4.33	0.011	0.022	0.01	8.02	0.41	0.013	1.71
HM74	34	0.536	0.73	4.18	0.015	0.056	0.008	7.23	0.32	0.014	1.32
HM75	35	0.684	1.05	4.22	0.008	0.014	0.01	7.8	0.39	0.014	1.46
HM76	36	0.686	0.87	4.01	0.017	0.014	0.009	6.14	0.39	0.013	1.38
HM77	37	0.698	0.86	3.76	0.023	0.023	0.008	5.65	0.37	0.012	1.51
HM78	38	0.715	1.46	3.74	0.017	0.014	0.009	5.2	0.34	0.013	1.54
HM79	39	0.685	0.68	3.91	0.02	0.009	0.01	5.25	0.39	0.013	1.21
HM80	40	0.439	0.4	4.17	0.011	0.035	0.011	6.18	0.34	0.014	1.09

Appendix 4

Examples of three types of plots used for the identification of the degree of 'normality' in frequency distributions

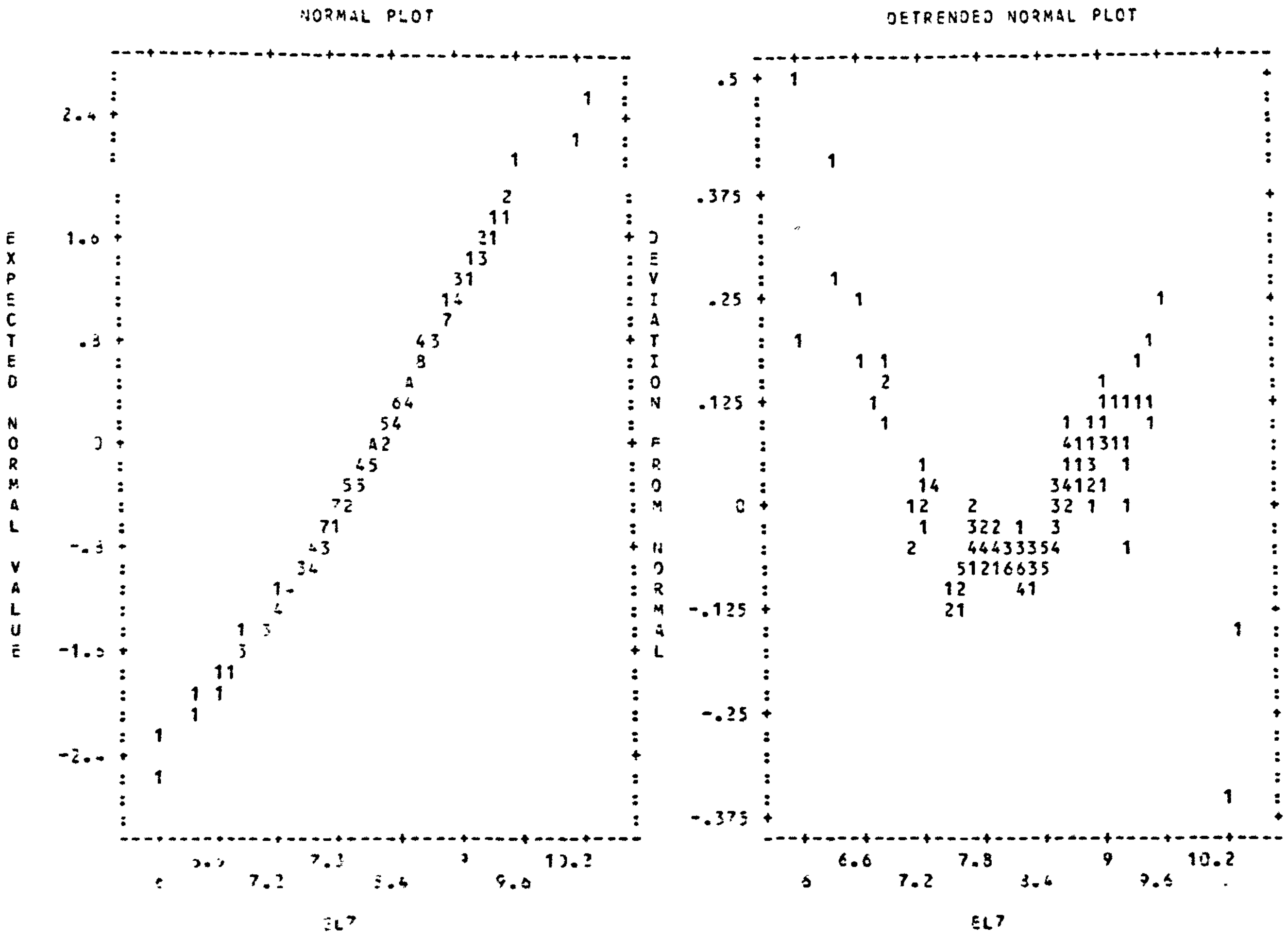
All three plots are derived from the Aluminium concentrations for the Hermitage sherds. The stem-leaf plot is a form of vertical histogram, with the concentrations divided up into intervals. The shape of this curve is not that far removed from normal. This is evident again in the other plots, with the straight line in the normal plot and the random values above and below zero in the detrended normal plot, again indicating near-normality

```
Stem-and-leaf display for variable .. EL7

    58 . 9
    60 . 1
    62 . 34
    64 . 8
    66 . 04
    68 . 2240
    70 . 0336
    72 . 00227914
    74 . 770224479
    76 . 02334556723456
    78 . 01455689904459
    80 . 00245568222477
    82 . 000112226672344 5578
    84 . 0344457790022334568
    86 . 02225566780056
    88 . 0456790015
    90 . 00123485
    92 . 3389046
    94 . 713
    96 . 1
    98 .
     0 .
     2 . 11

- - - - - - - - - - - - - - - - - - - - - - - - - -
```

Appendix 4 Normal plot and detrended normal plot for Aluminium concentrations in the Hermitage kiln data.



Appendix 5 Group membership table for the discriminant analysis on the sandy wares data

Sample/ Sherd No.	Actual Group	Highest Group	Probability P(D/G)	P(G/D)	2nd Highest Group	Probability P(G/D)
Hermitage ware S1 wasters						
HM1	7	7	0.0018	1	8	0
HM2	7	7	0.5953	1	8	0
HM3	7	7	0.3212	1	8	0
HM4	7	7	0.5007	0.999	8	0.001
HM5	7	7	0.5215	0.9997	8	0.0003
HM6	7	7	0.0111	0.6785	8	0.3215
HM7	7	7	0.9124	0.9991	8	0.0009
HM8	7	7	0.0848	0.9968	8	0.0032
HM9	7	7	0.3478	1	8	0
HM10	7	7	0.2786	1	8	0
HM11	7	7	0.3676	1	8	0
HM12	7	7	0.2859	1	8	0
HM13	7	7	0.7916	0.9999	8	0.0001
HM14	7	7	0.1731	1	8	0
HM15	7	7	0.0891	1	8	0
HM16	7	7	0.8638	0.9904	8	0.0096
HM17	7	7	0.6341	0.9864	8	0.0136
HM18	7	7	0.0681	0.9895	8	0.0105
HM19	7	7	0.0737	0.9949	8	0.0051
HM20	7	7	0.9036	0.9993	8	0.0007
HM21	7	7	0.864	0.9997	8	0.0003
HM22	7	7	0.6911	0.9982	8	0.0018
HM23	7	7	0.4375	0.9987	8	0.0013
HM24	7	7	0.5734	0.9996	8	0.0004
HM25	7	7	0.9801	0.9991	8	0.0009
HM26	7	7	0.994	0.9989	8	0.0011
HM27	7	7	0.9835	0.999	8	0.001
HM28	7	7	0.4678	0.9675	8	0.0325
HM29	7	7	0.6846	0.9679	8	0.0321
HM30	7	7	0.6437	0.9918	8	0.0082
HM31	7	7	0.5236	0.9824	8	0.0176
HM32	7	7	0.6055	0.9543	8	0.0457
HM33	7	7	0.5914	0.9459	8	0.0541
HM34	7	7	0.8812	0.9996	8	0.0004
HM35	7	7	0.6694	0.9999	8	0.0001
HM36	7	7	0.5722	0.9999	8	0.0001
HM37	7	7	0.6886	0.9999	8	0.0001
HM38	7	7	0.7418	0.9999	8	0.0001
HM39	7	7	0.4937	1	8	0
HM40	7	7	0.5699	1	8	0
HM41	7	7	0.5852	1	8	0
HM42	7	7	0.8922	0.9996	8	0.0004
HM43	7	7	0.5446	0.9395	8	0.0605
HM44	7	7	0.1745	0.7884	8	0.2116
HM45	7	7	0.1859	0.9836	8	0.0164
HM46	7	7	0.4462	0.977	8	0.023
HM47	7	7	0.9484	0.9993	8	0.0007
HM48	7	7	0.8092	0.9998	8	0.0002

Appendix 5 contd

Sample/ Sherd No.	Actual Group	Highest Group	Probability		2nd Highest Group	Probability
			P(D/G)	P(G/D)		P(G/D)
HM49	7	7	0.8211	0.986	8	0.014
HM50	7	7	0.4136	0.9808	8	0.0192
HM51	7	7	0.7945	0.9952	8	0.0048
HM52	7	7	0.576	0.9998	8	0.0002
HM53	7	7	0.2401	1	8	0
HM54	7	7	0.1067	1	8	0
HM55	7	7	0.3301	0.8229	8	0.1771
HM56	7	7	0.4863	0.9193	8	0.0807
HM57	7	7	0.3536	0.8231	8	0.1769
HM58	7	7	0.484	0.9931	8	0.0069
HM59	7	7	0.7759	0.9958	8	0.0042
HM60	7	7	0.5049	0.9984	8	0.0016
HM61	7	7	0.9426	0.9982	8	0.0018
HM62	7	8	0.473	1	7	0
HM63	7	7	0.5719	0.9997	8	0.0003
HM64	7	7	0.3502	0.884	8	0.116
HM65	7	7	0.8524	0.9971	8	0.0029
HM66	7	7	0.0806	0.6895	8	0.3105
HM67	7	7	0.8853	0.998	8	0.002
HM68	7	7	0.4318	0.9938	8	0.0062
HM69	7	7	0.9785	0.9984	8	0.0016
HM70	7	7	0.3418	1	8	0
HM71	7	7	0.9896	0.9987	8	0.0013
HM72	7	7	0.7853	0.9828	8	0.0172
HM73	7	7	0.5947	0.9948	8	0.0052
HM74	7	7	0.2224	0.9342	8	0.0658
HM75	7	7	0.4231	0.8771	8	0.1229
HM76	7	7	0.6622	0.9682	8	0.0318
HM77	7	7	0.7723	0.9828	8	0.0172
HM78	7	7	0.2126	0.8446	8	0.1554
HM79	7	7	0.6232	0.9727	8	0.0273
HM80	7	8	0.1786	0.5587	7	0.4413
Woolcombe ware S1 sherds						
WF1	UNGRPD	8	0.2997	0.7162	7	0.2838
WF2	UNGRPD	8	0.0868	0.5107	7	0.4893
WF3	UNGRPD	7	0.0368	0.9917	8	0.0083
WF4	UNGRPD	8	0.3723	0.8057	7	0.1943
WF5	UNGRPD	7	0.5798	0.9919	8	0.0081
WF6	UNGRPD	7	0.0254	0.638	8	0.362
WF7	UNGRPD	8	0.5635	0.9795	7	0.0205
WF8	UNGRPD	7	0.6663	0.971	8	0.029
WF9	UNGRPD	7	0.2181	0.6767	8	0.3233
WF10	UNGRPD	7	0.8825	0.9984	8	0.0016
WF11	UNGRPD	7	0.0748	0.7173	8	0.2827
WF12	UNGRPD	7	0.4562	0.9871	8	0.0129
WF13	UNGRPD	8	0.1512	0.913	7	0.087
WF14	UNGRPD	8	0.2077	0.9637	7	0.0363
WF15	UNGRPD	7	0.2481	0.7338	8	0.2662
WF16	UNGRPD	7	0.5147	0.9133	8	0.0867
WF17	UNGRPD	8	0.4317	0.8622	7	0.1378
WF18	UNGRPD	8	0.5704	0.9588	7	0.0412

Appendix 5 contd

Sample/ Sherd No.	Actual Group	Highest Group	Probability		2nd Highest Group	Probability
			P[D/G]	P[G/D]		P[G/D]
WF19	UNGRPD	8	0.2439	0.6098	7	0.3902
WF20	UNGRPD	7	0.3853	0.8403	8	0.1597
WF21	UNGRPD	8	0.3226	0.7505	7	0.2495
WF22	UNGRPD	8	0.4576	0.9729	7	0.0271
WF23	UNGRPD	7	0.2738	0.6714	8	0.3286
WF24	UNGRPD	8	0.2978	0.7193	7	0.2807
WF25	UNGRPD	8	0.3906	0.9101	7	0.0899
WF26	UNGRPD	7	0.3567	0.8044	8	0.1956
WF27	UNGRPD	7	0.6459	0.9582	8	0.0418
WF28	UNGRPD	8	0.7858	0.9873	7	0.0127
WF29	UNGRPD	8	0.1676	0.5201	7	0.4799
WF30	UNGRPD	7	0.323	0.7596	8	0.2404
WF31	UNGRPD	8	0.5055	0.939	7	0.061
WF32	UNGRPD	8	0.882	0.9915	7	0.0085
WF33	UNGRPD	8	0.272	0.6878	7	0.3122
WF34	UNGRPD	8	0.9785	0.9969	7	0.0031
WF35	UNGRPD	7	0.622	0.9907	8	0.0093
WF36	UNGRPD	8	0.6269	0.9691	7	0.0309
WF37	UNGRPD	9	0.2941	1	8	0
WF38	UNGRPD	7	0.9365	0.9996	8	0.0004
WF39	UNGRPD	7	0.2888	0.7366	8	0.2634
WF40	UNGRPD	7	0.5927	0.9956	8	0.0044
Woolcombe ware S4/C2 sherds						
WF41	UNGRPD	7	0.9104	0.9964	8	0.0036
WF42	UNGRPD	8	0.7177	0.9903	7	0.0097
WF43	UNGRPD	8	0.1399	0.8047	7	0.1953
WF44	UNGRPD	7	0.3898	0.9998	8	0.0002
WF45	UNGRPD	7	0.3189	0.8708	8	0.1292
WF46	UNGRPD	8	0.0573	0.5035	7	0.4965
WF47	UNGRPD	7	0.2074	0.5744	8	0.4256
WF48	UNGRPD	8	0.1334	0.9647	7	0.0353
WF49	UNGRPD	7	0.143	0.6464	8	0.3536
WF50	UNGRPD	8	0.0761	0.7799	7	0.2201
WF51	UNGRPD	8	0.0455	0.9917	7	0.007
WF52	UNGRPD	8	0.0107	0.9538	9	0.0422
WF53	UNGRPD	8	0.0801	0.9843	7	0.0155
WF54	UNGRPD	8	0.0742	0.9875	7	0.0123
WF55	UNGRPD	8	0.3853	0.9843	7	0.0157
WF56	UNGRPD	8	0.0256	0.9805	9	0.0181
WF57	UNGRPD	9	0.0006	0.6812	8	0.3071
WF58	UNGRPD	7	0.0154	0.9211	8	0.0789
WF59	UNGRPD	8	0.1488	0.8956	7	0.1044
WF60	UNGRPD	8	0.2236	0.946	7	0.036
WF61	UNGRPD	7	0.0883	0.73	8	0.27
WF62	UNGRPD	8	0.0936	0.8965	7	0.1035
WF63	UNGRPD	8	0.7955	0.9989	7	0.0011
WF64	UNGRPD	8	0.3844	0.998	7	0.002
WF65	UNGRPD	7	0.1254	0.6049	8	0.3951
WF66	UNGRPD	7	0.2222	0.8624	8	0.1376
WF67	UNGRPD	8	0.27864	0.8967	7	0.1033
WF68	UNGRPD	7	0.1777	0.6932	8	0.3068

Appendix 5 contd

Sample/ Sherd No.	Actual Group	Highest Group	Probability P(D/G)	P(G/D)	2nd Highest Group	Probability P(G/D)
WF69	UNGRPD	8	0.4872	0.9985	7	0.0015
WF70	UNGRPD	7	0.2134	0.539	8	0.461
WF71	UNGRPD	8	0.028	0.9446	9	0.0554
WF72	UNGRPD	7	0.3122	0.9043	8	0.0957
WF73	UNGRPD	7	0.8069	0.9864	8	0.0136
WF74	UNGRPD	7	0.5683	0.9393	8	0.0607
WF75	UNGRPD	7	0.2508	0.9353	8	0.0647
WF76	UNGRPD	8	0.0851	0.8126	7	0.1874
WF77	UNGRPD	8	0.0988	0.579	7	0.421
WF78	UNGRPD	7	0.8256	0.9998	8	0.0002
WF79	UNGRPD	8	0.1198	0.9141	7	0.0859
WF80	UNGRPD	8	0.0668	0.5524	7	0.4476
Portland, St. Andrews ware S1 sherds						
PS1	UNGRPD	7	0.6559	0.9931	8	0.0069
PS2	UNGRPD	8	0.5266	0.9211	7	0.0789
PS3	UNGRPD	8	0.5022	0.9997	7	0.0003
PS4	UNGRPD	7	0.3643	0.9545	8	0.0455
PS5	UNGRPD	8	0.1568	0.5262	7	0.4738
PS6	UNGRPD	8	0.8679	0.9917	7	0.0083
PS7	UNGRPD	7	0.144	0.6112	8	0.3888
PS8	UNGRPD	7	0.5656	0.9917	8	0.0083
PS9	UNGRPD	8	0.1157	0.5532	7	0.4468
PS10	UNGRPD	8	0.4438	0.903	7	0.097
Sherbome Old Castle ware S1 sherds						
SC41	UNGRPD	8	0.4196	0.8505	7	0.1495
SC42	UNGRPD	8	0.2555	0.6309	7	0.3691
SC44	UNGRPD	8	0.2283	0.5772	7	0.4228
SC46	UNGRPD	8	0.0335	0.6392	7	0.3608
SC52	UNGRPD	8	0.4166	0.9399	7	0.0601
SC56	UNGRPD	8	0.5615	0.9345	7	0.0655
SC70	UNGRPD	7	0.702	0.9721	8	0.0279
SC71	UNGRPD	7	0.1735	0.9925	8	0.0075
SC72	UNGRPD	8	0.4889	1	7	0
SC73	UNGRPD	7	0.4553	0.9523	8	0.0477
SC74	UNGRPD	7	0.6053	0.9609	8	0.0391
SC79	UNGRPD	8	0.9853	0.9989	7	0.0011
SC80	UNGRPD	8	0.4002	0.8588	7	0.1412
Sherbome Old Castle ware S2 sherds						
SC43	UNGRPD	8	0.2813	0.6917	7	0.3083
SC45	UNGRPD	7	0.2253	0.8954	8	0.1046
SC47	UNGRPD	8	0.4425	0.9438	7	0.0562
SC48	UNGRPD	7	0.2513	0.6241	8	0.3759
SC49	UNGRPD	8	0.2101	0.7017	7	0.2983
SC50	UNGRPD	7	0.4346	0.8691	8	0.1309
SC51	UNGRPD	8	0.7868	0.9852	7	0.0148
SC53	UNGRPD	8	0.1075	0.7049	7	0.2951
SC54	UNGRPD	8	0.369	0.8417	7	0.1583
SC55	UNGRPD	7	0.823	0.9998	8	0.0002
SC57	UNGRPD	7	0.504	0.9979	8	0.0021
SC58	UNGRPD	8	0.1738	0.767	7	0.233
SC59	UNGRPD	8	0.1383	0.8078	7	0.1922

Appendix 5 contd

Sample/	Actual	Highest	Probability		2nd Highest	Probability
Sherd No.	Group	Group	P(D/G)	P(G/D)	Group	P(G/D)
SC60	UNGRPD	7	0.0685	0.8367	8	0.1633
SC61	UNGRPD	8	0.173	0.9212	7	0.0788
SC62	UNGRPD	8	0.1539	0.5966	7	0.4034
SC63	UNGRPD	7	0.3365	0.8089	8	0.1911
SC64	UNGRPD	7	0.8136	0.9856	8	0.0144
SC65	UNGRPD	8	0.4922	0.9886	7	0.0114
SC66	UNGRPD	8	0.2336	0.8091	7	0.1909
SC67	UNGRPD	7	0.2124	0.6912	8	0.3088
SC68	UNGRPD	8	0.0906	0.7461	7	0.2539
SC69	UNGRPD	8	0.2922	0.8569	7	0.1431
SC75	UNGRPD	7	0.3048	0.7351	8	0.2649
SC76	UNGRPD	7	0.3734	0.9183	8	0.0817
SC77	UNGRPD	7	0.6778	0.9659	8	0.0341
SC78	UNGRPD	7	0.5204	0.9297	8	0.0703
Sherborne Old Castle ware S4/C2						
SC81	8	8	0.4426	0.9996	7	0.0004
SC82	8	8	0.8165	0.9986	7	0.0014
SC83	8	8	0.7723	0.9998	7	0.0002
SC84	8	9	0.0002	0.8248	8	0.143
SC85	8	8	0.388	0.9998	7	0.0002
SC86	8	8	0.2276	1	7	0
SC87	8	8	0.4288	0.9995	7	0.0005
SC88	8	8	0.715	0.9975	7	0.0025
SC89	8	8	0.3424	0.9997	7	0.0003
SC90	8	8	0.6624	0.9991	7	0.0009
SC91	8	8	0.5453	0.9998	7	0.0002
SC92	8	8	0.3738	0.9981	7	0.0019
SC93	8	8	0.7812	0.9979	7	0.0021
SC94	8	7	0.0397	0.9965	8	0.0035
SC95	8	8	0.4888	0.9	7	0.1
SC96	8	8	0.4801	0.9998	7	0.0002
SC97	8	8	0.6406	0.9997	7	0.0003
SC98	8	8	0.5095	0.9989	7	0.0011
SC99	8	8	0.4173	0.9998	7	0.0002
SC100	8	8	0.4924	0.9985	7	0.0015
Dorchester Prison ware S1						
DP1	UNGPD	9	0	1	7	0
DP2	UNGPD	7	0.2481	0.8093	8	0.1907
DP3	UNGPD	7	0.2784	1	8	0
DP4	UNGPD	7	0	1	8	0
DP5	UNGPD	7	0.2673	0.9509	8	0.0491
DP6	UNGPD	7	0.6548	0.9701	8	0.0299
DP7	UNGPD	8	0.4222	0.985	7	0.015
DP8	UNGPD	8	0.539	0.9305	7	0.0695
DP9	UNGPD	8	0.2973	0.9924	7	0.0076
DP10	UNGPD	8	0.0839	0.9187	7	0.0813
DP11	UNGPD	8	0.1621	0.9556	7	0.0444
DP12	UNGPD	7	0.759	0.989	8	0.011
DP13	UNGPD	8	0.1529	0.6511	7	0.3489
DP14	UNGPD	7	0.0512	0.8152	8	0.1848
DP15	UNGPD	8	0.7272	0.9981	7	0.0019

Appendix 5 contd

Sample/ Sherd No.	Actual Group	Highest Group	Probability P(D/G)	P(G/D)	2nd Highest Group	Probability P(G/D)
DP16	UNGPD	8	0.2644	0.9822	7	0.0178
DP17	UNGPD	8	0.9794	0.997	7	0.003
DP18	UNGPD	8	0.7899	0.9852	7	0.0148
DP19	UNGPD	8	0.4495	0.9972	7	0.0028
DP20	UNGPD	7	0.2843	1	8	0
Holworth ware S1						
HW1	UNGRPD	8	0.1921	0.9993	7	0.0005
HW2	UNGRPD	8	0.3121	0.9814	7	0.0186
HW3	UNGRPD	8	0.1557	0.6584	7	0.3416
HW4	UNGRPD	8	0.857	0.9916	7	0.0084
HW5	UNGRPD	8	0.74	0.9985	7	0.0015
HW6	UNGRPD	8	0.2688	0.6741	7	0.3259
HW7	UNGRPD	8	0.5033	0.9874	7	0.0126
HW8	UNGRPD	8	0.0802	0.5623	7	0.4377
HW9	UNGRPD	8	0.9713	0.9993	7	0.0007
HW10	UNGRPD	8	0.1601	0.7774	7	0.2226
HW11	UNGRPD	7	0.2386	0.814	8	0.186
HW12	UNGRPD	9	0.8384	1	8	0
HW13	UNGRPD	8	0.8028	0.9949	7	0.0051
HW14	UNGRPD	7	0.4427	0.8914	8	0.1086
HW15	UNGRPD	8	0.8362	0.9962	7	0.0038
HW16	UNGRPD	8	0.81	0.9938	7	0.0062
HW17	UNGRPD	8	0.5259	0.9707	7	0.0293
HW18	UNGRPD	7	0.9348	0.9944	8	0.0056
HW19	UNGRPD	8	0.3136	0.927	7	0.073
HW20	UNGRPD	8	0.211	0.7171	7	0.2829
Foxwell ware S1						
PX1	UNGRPD	7	0.2912	0.7546	8	0.2454
PX2	UNGRPD	7	0.0262	0.7423	8	0.2577
PX3	UNGRPD	7	0.3485	0.7823	8	0.2177
PX4	UNGRPD	7	0.5623	0.9351	8	0.0649
PX5	UNGRPD	8	0.4074	0.8691	7	0.1309
PX6	UNGRPD	7	0.3334	0.8843	8	0.1157
PX7	UNGRPD	7	0.0083	1	8	0
PX8	UNGRPD	8	0.7079	0.9813	7	0.0187
PX9	UNGRPD	8	0.0082	0.8448	9	0.1542
PX10	UNGRPD	7	0.3856	0.8215	8	0.1785
Whitcombe ware S1						
WT1	UNGRPD	7	0.4958	0.911	8	0.089
WT2	UNGRPD	8	0.4106	0.9371	7	0.0629
WT3	UNGRPD	8	0.8339	0.9998	7	0.0002
WT4	UNGRPD	7	0.2098	0.5314	8	0.4686
WT5	UNGRPD	7	0.4976	0.9564	8	0.0436
WT6	UNGRPD	7	0.3979	0.954	8	0.046
WT7	UNGRPD	8	0.3197	0.8686	7	0.1314
WT8	UNGRPD	7	0.5691	0.9381	8	0.0619
WT9	UNGRPD	7	0.1989	0.6724	8	0.3276
WT10	UNGRPD	8	0.5356	0.9346	7	0.0654
Vondover ware S1						
YO1	UNGRPD	8	0.0269	0.9377	9	0.0623
YO2	UNGRPD	7	0.3345	0.7863	8	0.2137

Appendix 5 contd

Sample/ Sherd No.	Actual Group	Highest Group	Probability P(D/G)	P(G/D)	2nd Highest Group	Probability P(G/D)
YO3	UNGRPD	7	0.4005	0.9695	8	0.0305
YO4	UNGRPD	7	0.2251	0.8643	8	0.1357
YO5	UNGRPD	8	0.2564	0.7548	7	0.2452
YO6	UNGRPD	7	0.0276	0.6476	8	0.3524
YO7	UNGRPD	7	0.7851	0.9818	8	0.0182
YO8	UNGRPD	8	0.3633	0.9998	7	0.0002
YO9	UNGRPD	9	0.0485	0.9843	8	0.0157
YO10	UNGRPD	9	0.1228	0.9988	8	0.0012
YO11	UNGRPD	9	0.0338	0.9616	8	0.0384
YO12	UNGRPD	9	0.0117	0.7393	8	0.2607
YO13	UNGRPD	7	0.4102	1	8	0
YO14	UNGRPD	7	0.3452	1	8	0
YO15	UNGRPD	7	0.3381	0.9975	8	0.0025
YO16	UNGRPD	7	0.7546	0.9998	8	0.0002
YO17	UNGRPD	8	0.3348	0.7608	7	0.2392
YO18	UNGRPD	7	0.57	0.985	8	0.015
YO19	UNGRPD	7	0	1	8	0
YO20	UNGRPD	7	0.1691	0.7689	8	0.2311
Compton Valence						
CY1	UNGRPD	7	0.5253	0.9211	8	0.0789
CY2	UNGRPD	8	0.1171	0.509	7	0.491
CY3	UNGRPD	7	0	0.9999	8	0.0001
CY4	UNGRPD	8	0.2157	0.705	7	0.295
CY5	UNGRPD	8	0.1471	0.9067	7	0.0933
CY6	UNGRPD	8	0.4173	0.947	7	0.053
CY7	UNGRPD	8	0.3723	0.9485	7	0.0515
CY8	UNGRPD	7	0.7228	0.9729	8	0.0271
CY9	UNGRPD	8	0.0906	0.7141	7	0.2859
CY10	UNGRPD	8	0.2413	0.811	7	0.189
CY11	UNGRPD	8	0.4746	0.8973	7	0.1027
CY12	UNGRPD	7	0.5376	0.9999	8	0.0001
CY13	UNGRPD	7	0.4129	0.9998	8	0.0002
CY14	UNGRPD	8	0.2676	0.9855	7	0.0145
CY15	UNGRPD	8	0.5747	0.9489	7	0.0511
CY16	UNGRPD	7	0.5099	0.9565	8	0.0435
CY17	UNGRPD	7	0.7115	0.9711	8	0.0289
CY18	UNGRPD	7	0.2032	0.791	8	0.209
CY19	UNGRPD	7	0.216	0.8675	8	0.1325
CY20	UNGRPD	8	0.5477	0.9438	7	0.0562
Milton Abbas ware S2						
MA1	UNGRPD	8	0.85	0.9996	7	0.0004
MA2	UNGRPD	8	0.1111	0.9986	9	0.0009
MA3	UNGRPD	8	0.0161	0.8286	9	0.1713
MA4	UNGRPD	8	0.368	1	7	0
MA5	UNGRPD	8	0.8076	0.9998	7	0.0002
MA6	UNGRPD	8	0.3395	1	7	0
MA7	UNGRPD	7	0.31	0.8926	8	0.1074
MA8	UNGRPD	8	0.228	0.8185	7	0.1815
MA9	UNGRPD	8	0.3115	1	7	0
MA10	UNGRPD	8	0.0829	0.9992	9	0.0008
MA11	UNGRPD	8	0.2621	1	9	0

Appendix 5 contd

Sample/ Sherd No:	Actual Group	Highest Group	Probability P(D/G)	P(G/D)	2nd Highest Group	Probability P(G/D)
MA12	UNGRPD	8	0.0135	0.8181	9	0.1819
MA13	UNGRPD	8	0.2931	0.9796	7	0.0204
MA14	UNGRPD	8	0.6997	0.9969	7	0.0031
MA15	UNGRPD	8	0.1456	0.9867	7	0.0133
MA16	UNGRPD	8	0.6036	0.9999	7	0.0001
MA17	UNGRPD	8	0.2498	0.9956	7	0.0044
MA18	UNGRPD	8	0.9364	0.995	7	0.005
MA19	UNGRPD	8	0.8488	0.9882	7	0.0118
MA20	UNGRPD	8	0.3898	0.979	7	0.021
Lodge Farm ware S2						
LF1	UNGRPD	7	0.9738	0.9978	8	0.0022
LF2	UNGRPD	9	0.001	0.9911	8	0.0084
LF3	UNGRPD	7	0.0042	0.7614	8	0.2386
LF4	UNGRPD	7	0.9359	0.9945	8	0.0055
LF5	UNGRPD	7	0.7801	0.9989	8	0.0011
LF6	UNGRPD	7	0.0259	0.9255	8	0.0745
LF7	UNGRPD	7	0.0001	0.9897	8	0.0097
LF8	UNGRPD	9	0.4473	1	8	0
LF9	UNGRPD	7	0.0031	0.7377	8	0.2621
LF10	UNGRPD	9	0.0036	0.9972	8	0.0027
Southampton ware S1						
SO21	UNGRPD	8	0.3986	0.9267	7	0.0733
SO22	UNGRPD	7	0.1243	0.7713	8	0.2287
SO23	UNGRPD	8	0.2595	0.9101	7	0.0899
SO24	UNGRPD	8	0.3094	0.7455	7	0.2545
SO25	UNGRPD	8	0.9467	0.9966	7	0.0034
Southampton ware S3 wasters						
SO31	UNGRPD	7	0.2696	0.9682	8	0.0318
SO32	UNGRPD	8	0.4308	0.907	7	0.093
SO33	UNGRPD	8	0.0868	0.5155	7	0.4845
SO34	UNGRPD	8	0.1145	0.6007	7	0.3993
SO35	UNGRPD	8	0.5341	0.947	7	0.053
Kington Magna ware S4/C2						
KM11	UNGRPD	8	0.0626	0.962	7	0.0379
KM12	UNGRPD	8	0.4011	1	7	0
KM13	UNGRPD	8	0.4227	1	7	0
KM14	UNGRPD	8	0.4309	0.9999	7	0.0001
KM15	UNGRPD	8	0.6592	0.9948	7	0.0052
KM16	UNGRPD	8	0.9583	0.998	7	0.002
KM17	UNGRPD	8	0.6749	0.9998	7	0.0002
KM18	UNGRPD	8	0.9274	0.9968	7	0.0032
KM19	UNGRPD	8	0.7043	0.9999	7	0.0001
KM20	UNGRPD	8	0.2299	1	7	0
KM21	UNGRPD	8	0.5073	0.9927	7	0.0073
KM22	UNGRPD	8	0.8021	0.9998	7	0.0002
KM23	UNGRPD	8	0.5077	0.9999	7	0.0001
KM24	UNGRPD	8	0.5668	0.9998	7	0.0002
KM25	UNGRPD	8	0.5524	0.9996	7	0.0004
KM26	UNGRPD	8	0.8239	0.9971	7	0.0029
KM27	UNGRPD	9	0.1209	0.9989	8	0.0011
KM28	UNGRPD	7	0.5763	0.982	8	0.018

Appendix 5 contd

Sample/ Sherd No.	Actual Group	Highest Group	Probability		2nd Highest Group	Probability
			P(D/G)	P(G/D)		P(G/D)
KM29	UNGRPD	8	0.7277	0.9998	7	0.0002
KM30	UNGRPD	8	0.4554	0.9382	7	0.0618
Winterborne Houghton ware S1						
WN1	UNGRPD	8	0.4092	0.9999	7	0.0001
WN2	UNGRPD	8	0.5241	0.9463	7	0.0537
WN3	UNGRPD	8	0.1189	0.9997	9	0.0003
WN4	UNGRPD	8	0.3563	0.9972	7	0.0028
WN5	UNGRPD	7	0.041	0.6065	8	0.3935
WN6	UNGRPD	9	0.7947	1	8	0
WN7	UNGRPD	7	0.7118	0.972	8	0.028
WN8	UNGRPD	8	0.7754	0.9805	7	0.0195
WN9	UNGRPD	8	0.6209	0.9868	7	0.0132
WN10	UNGRPD	9	0.7563	1	8	0
Shaftesbury ware S1						
ST1	UNGRPD	8	0.7296	0.9986	7	0.0014
ST2	UNGRPD	7	0.4848	0.9981	8	0.0019
ST3	UNGRPD	8	0.0311	0.7115	7	0.2885
ST4	UNGRPD	7	0.7003	0.9695	8	0.0305
ST5	UNGRPD	7	0.7986	0.9906	8	0.0094
ST6	UNGRPD	7	0.5998	0.9465	8	0.0535
ST7	UNGRPD	7	0.2525	0.7081	8	0.2919
ST8	UNGRPD	7	0.0702	0.5218	8	0.4782
ST9	UNGRPD	9	0.0074	0.7922	8	0.2077
ST10	UNGRPD	7	0.2023	0.7969	8	0.2031
Shaftesbury ware S4/C2						
ST31	UNGRPD	8	0.2706	0.9998	7	0.0002
ST32	UNGRPD	8	0.6486	0.9999	7	0.0001
ST33	UNGRPD	8	0.5089	1	7	0
ST34	UNGRPD	8	0.8051	0.9998	7	0.0002
ST35	UNGRPD	8	0.0262	0.6984	7	0.3016
Laverstock ware C1						
LY9	9	9	0.5772	1	8	0
LY17	9	9	0.9265	1	8	0
LY18	9	9	0.0725	1	8	0
LY19	9	9	0.3267	1	8	0
LY20	9	9	0.6208	1	8	0
LY36	9	9	0.4071	1	8	0
LY37	9	9	0.457	1	8	0
LY38	9	9	0.3512	1	8	0
LY39	9	9	0.1861	1	8	0
LY40	9	9	0.5543	1	8	0
LY41	9	9	0.6358	1	8	0
LY42	9	9	0.4374	1	8	0
LY43	9	9	0.5108	1	8	0
LY44	9	9	0.2854	1	8	0
LY75	9	9	0.5697	1	8	0
LY76	9	9	0.6192	1	8	0
LY77	9	9	0.8742	1	8	0
LY78	9	9	0.9903	1	8	0
LY79	9	9	0.9343	1	8	0
LY80	9	9	0.9983	1	8	0

Appendix 6 Four element concentrations in all samples studied

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
CH1	1	0.067	2.188	0.204	8.551
CH2	1	0.024	3.013	0.324	5.827
CH3	1	0.012	1.87	0.199	7.921
CH4	1	0.029	2.102	0.106	8.467
CH5	1	0.046	2.262	0.267	8.906
CH6	2	0.016	1.874	0.449	9.191
CH7	2	0.016	2.152	0.34	7.61
CH8	2	0.011	2.987	0.307	8.872
CH9	2	0.023	1.759	0.545	10.292
CH10	2	0.02	1.915	0.476	9.133
CH11	2	0.026	3.355	0.448	9.299
CH12	2	0.011	1.817	0.127	10.384
CH13	2	0.016	1.447	0.135	6.669
CH14	2	0.024	2.453	0.313	8.064
CH15	2	0.021	2.07	0.242	9.776
CH16	2	0.018	3.27	0.409	9.607
CH17	2	0.012	1.846	0.168	11.943
CH18	2	0.023	3.32	0.345	8.35
CH19	2	0.013	1.923	0.478	7.033
CH20	2	0.029	2.42	0.276	6.764
CH21	1	0.015	1.889	0.167	8.417
CH22	1	0.04	2.04	0.427	8.35
CH23	1	0.015	2.66	0.346	6.936
CH24	1	0.017	1.72	0.328	8.575
CH25	1	0.01	2.012	0.199	7.545
CH26	1	0.013	1.588	0.19	6.3
CH27	1	0.02	1.68	0.271	7.22
CH28	1	0.012	1.91	0.312	8.15
CH29	1	0.016	2.104	0.219	7.775
CH30	1	0.015	2.984	0.276	7.409

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
CY1	1	0.01	4.344	0.596	7.405
CY2	1	0.013	3.85	0.55	4.064
CY3	1	0.034	4.021	0.552	8.101
CY4	1	0.012	3.956	0.467	6.262
CY5	1	0.01	3.81	0.452	7.279
CY6	1	0.012	3.837	0.371	5 35
CY7	1	0.009	3.719	0.49	7.056
CY8	1	0.013	4.107	0.733	7.731
CY9	3	0.01	4.12	0.405	7.064
CY10	1	0.01	3.842	0.519	7.186
CY11	1	0.01	3.665	0.575	6.719
CY12	1	0.015	4.954	0.687	8.543
CY131	1	0.021	4.365	0.753	8.148
CY14	1	0.011	3.68	0.348	5.941
CY15	1	0.008	3.7	0.567	6.325
CY16	1	0.017	3.905	0.679	7.17
CY17	3	0.011	4.22	0.719	8.045
CY18	2	0.017	3.834	0.568	6.542
CY19	2	0.015	3.881	0.628	7.646
CY20	1	0.013	3.429	0.565	6.123
CC1	2	0.017	0.61	0.206	10.15
CC2	2	0.007	2.505	0.174	9.9
CC3	2	0.008	1.06	0.127	8.4
CC4	2	0.007	0.73	0.212	8.885
CC5	2	0.006	1.416	0.177	8.959
CC6	2	0.005	0.719	0.165	7.83
CC7	2	0.005	1.336	0.175	10.172
CC8	2	0.005	1.779	0.133	9.316
CC9	2	0.008	1.18	0.205	10.964
CC10	2	0.005	1.21	0.237	12.1
CC11	2	0.004	0.966	0.132	8.516
CC12	2	0.004	1.013	0.167	7.816
CC13	2	0.004	1.59	0.143	9.918
CC14	2	0.002	1.116	0.123	9.177
CC15	2	0.006	1.174	0.21	10.612
CC16	1	0.013	1.519	0.363	8.301
CC17	1	0.014	1.42	0.304	7.84
CC18	1	0.013	1.377	0.272	7.265
CC19	1	0.012	1.155	0.351	7.979
CC20	1	0.01	2.31	0.242	6.961
CC21	1	0.023	1.477	0.339	8.383
CC22	1	0.008	2.236	0.129	9.447
CC23	2	0.02	1.838	0.424	9.121
CC24	1	0.013	2.44	0.238	7.889
CC25	1	0.009	1.511	0.327	7.809
CC26	1	0.012	1.414	0.447	8.248
CC27	1	0.017	1.682	0.4	8.333
CC28	1	0.015	2.013	0.23	6.791
CC29	1	0.014	1.697	0.236	6.761
CC30	1	0.02	1.574	0.272	6.187

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
DP1	1	0.44	2.493	0.638	5.503
DP2	2	0.027	2.875	0.816	6.143
DP3	2	0.015	5.314	0.758	8.246
DP4	2	0.021	5.042	1.417	8.924
DP5	1	0.016	3.923	0.75	5.675
DP6	1	0.022	3.662	0.747	5.459
DP7	1	0.011	3.147	0.597	5.632
DP8	1	0.013	3.396	0.603	6.275
DP9	2	0.01	2.93	0.76	5.855
DP10	1	0.01	3.358	0.776	5.794
DP11	1	0.011	3.13	0.806	6.032
DP12	2	0.014	4.086	0.806	7.631
DP13	2	0.012	3.533	0.752	6.386
DP14	1	0.013	3.828	0.777	5.543
DP15	1	0.014	2.567	0.74	5.462
DP16	1	0.011	3.087	0.75	5.684
DP17	1	0.017	2.651	0.642	4.949
DP18	1	0.013	3.103	0.624	6.238
DP19	1	0.012	2.839	0.699	5.104
DP20	2	0.018	4.51	1.065	9.65
DP21	2	0.018	1.653	0.447	8.421
DP22	2	0.025	1.97	5.82	10.492
DP23	2	0.017	2.739	0.515	9.065
DP24	2	0.017	1.703	0.34	7.243
DP25	2	0.026	2.003	0.594	10.605
DP26	1	0.013	2.381	0.283	9.275
DP27	2	0.022	1.866	0.543	9.809
DP28	2	0.015	1.929	0.435	7.944
DP29	1	0.02	2.401	0.298	8.73
DP30	1	0.016	2.295	0.397	8.779

Sitelware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
HW1	1	0.008	3.23	0.365	6.62
HW2	3	0.008	3.47	0.633	5.572
HW3	2	0.009	4.28	0.387	6.6
HW4	3	0.008	3.49	0.508	6.374
HW5	2	0.007	3.308	471	6.646
HW6	1	0.008	4.058	0.556	6.613
HW7	2	0.007	3.793	0.391	6.563
HW8	2	0.006	4.02	0.695	6.85
HW9	2	0.007	3.075	0.56	6.222
HW10	2	0.008	3.798	0.675	6.355
HW11	2	0.013	3.865	0.659	8.003
HW12	2	0.01	1.825	0.297	8.456
HW13	2	0.006	3.436	0.571	6.256
HW14	2	0.008	4.327	0.643	7.494
HW15	2	0.007	3.39	0.546	5.842
HW16	2	0.006	3.59	0.475	6.775
HW17	2	0.008	3.79	0.442	6.576
HW18	2	0.013	4.31	0.753	8.167
HW19	2	0.008	4.052	0.378	6.524
HW20	1	0.008	3.914	0.63	6.49
HW21	1	0.009	2.163	0.225	9.69
HW22	1	0.011	2.29	0.235	8.982
HW23	1	0.02	2.7	0.265	11.436
HW24	1	0.01	2.035	0.163	8.738
HW25	1	0.015	1.87	0.21	8.687
HW26	1	0.015	1.945	0.256	8.543
HW27	1	0.012	2.272	0.238	9.228
HW28	1	0.011	2.135	0.228	7.646
HW29	3	0.011	2.631	0.311	8.181
HW30	1	0.014	2.254	0.109	7.256
HW31	2	0.005	1.656	0.253	10.321
HW32	2	0.005	1.436	0.156	10.388
HW33	2	0.004	1.746	0.15	11.551
HW34	2	0.005	1.58	0.181	12.263
HW35	2	0.006	1.562	0.108	9.628
HW36	2	0.006	0.868	0.057	9.579
HW37	2	0.006	1.475	0.1	8.072
HW38	2	0.006	1.761	0.204	10.629
HW39	2	0.007	1.874	0.188	12.089
HW40	2	0.015	1.761	0.236	8.652
HW41	2	0.01	1.649	0.173	8.09
HW42	2	0.015	1.7	0.229	8.425

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
KM1	3	0.008	3.64	0.757	7.173
KM2	2	0.009	2.362	0.35	7.09
KM3	2	0.01	1.822	0.312	8.428
KM4	2	0.009	3.027	0.699	6.305
KM5	2	0.01	2.049	0.419	7.877
KM6	2	0.01	1.888	0.371	7.655
KM7	2	0.013	2.191	0.553	10.01
KM8	2	0.011	2.242	0.534	9.165
KM9	2	0.011	2.663	0.692	6.591
KM10	2	0.011	3.145	0.339	8.278
KM11	1	0.017	3.09	0.547	7.076
KM12	1	0.007	2.419	0.565	5.829
KM13	1	0.009	2.419	0.529	5.633
KM14	1	0.011	2.523	0.518	5.974
KM15	1	0.01	3.278	0.509	6.53
KM16	1	0.008	2.933	0.687	6.93
KM17	1	0.012	2.64	0.535	5.734
KM18	1	0.013	2.839	0.632	6.187
KM19	1	0.006	2.81	0.535	6.302
KM20	1	0.008	2.275	0.512	5.641
KM21	1	0.011	3.099	0.591	7.254
KM22	1	0.009	2.64	0.611	6.559
KM23	1	0.009	2.594	0.556	6.617
KM24	1	0.01	2.832	0.463	5.77
KM25	1	0.009	2.825	0.553	6.973
KM26	1	0.006	3.055	0.714	7.261
KM27	1	0.009	2.188	0.476	9.262
KM28	1	0.016	4.442	0.507	6.301
KM29	1	0.011	2.621	0.571	6.091
KM30	1	0.008	3.68	0.603	6.247
LF1	1	0.017	4.26	0.75	7.551
LF2	1	0.018	3.231	0.403	8.698
LF3	1	0.015	3.974	47	8.342
LF4	1	0.016	4.155	0.765	7.455
LF5	1	0.019	4.138	0.801	8.164
LF6	2	0.014	4.267	0.47	8.168
LF7	1	0.021	4.101	0.486	9.153
LF8	1	0.016	2.01	0.364	8.233
LF9	2	0.016	3.891	0.475	8.242
LF10	2	0.017	3.065	0.405	8.8

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
MA1	1	0.013	2.737	0.516	5.114
MA2	1	0.02	2.405	0.487	5.357
MA3	1	0.013	2.601	0.345	6.135
MA4	2	0.012	2.445	0.455	4.93
MA5	2	0.008	2.943	0.488	5.208
MA6	1	0.013	2.163	0.514	4.327
MA7	1	0.016	3.773	0.684	7.595
MA8	1	0.011	3.74	0.539	7.207
MA9	2	0.007	2.694	0.433	5.964
MA10	2	0.005	2.758	0.288	5.566
MA11	1	0.009	2.516	0.447	5.676
MA12	2	0.008	2.485	0.332	6.438
MA13	1	0.01	3.21	0.721	5.796
MA14	1	0.008	2.999	0.706	6.517
MA15	1	0.007	3.253	0.745	6.027
MA16	1	0.008	2.713	0.589	5.357
MA17	1	0.006	3.274	0.673	5.808
MA18	1	0.005	3.367	0.611	7.252
MA19	2	0.006	3.463	0.601	7.275
MA20	2	0.009	3.31	0.69	6.034

Sitelware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
PL1	2	0.006	1.786	0.384	7.945
PL2	2	0.009	1.699	0.436	8.157
PL3	2	0.007	0.658	0.172	8.072
PL4	2	0.008	2.017	0.154	11.729
PL5	2	0.01	2.751	0.357	8.706
PL6	2	0.007	1.499	0.273	7.822
PL7	2	0.009	1.688	0.394	7.439
PL8	2	0.01	1.597	0.447	8.253
PL9	2	0.01	2.633	0.451	7.99
PL10	2	0.015	1.64	0.443	9.523
PL11	2	0.008	2.032	0.415	8.746
PL12	2	0.01	1.771	0.171	6.892
PL13	2	0.009	1.884	0.184	7.107
PL14	2	0.009	0.1905	0.383	7.962
PL15	2	0.008	1.828	0.405	8.347
PL16	2	0.007	1.589	0.299	7.897
PL17	2	0.009	1.748	0.354	7.793
PL18	2	0.009	1.637	0.375	8.024
PL19	2	0.007	2.006	0.406	8.124
PL20	2	0.009	1.955	0.422	7.826
PL21	2	0.009	4.623	1.529	7.787
PL22	2	0.007	1.239	0.16	12.185
PL23	2	0.007	4.115	1.039	6.635
PL24	2	0.008	2.477	0.63	8.354
PL25	2	0.006	1.795	0.555	8.883
PL26	2	0.005	1.594	0.251	8.632
PL27	2	0.005	2.515	0.495	8.335
PL28	2	0.016	3.52	0.482	8.681
PL29	2	0.01	2.606	0.399	8.475
PL30	2	0.007	2.518	0.273	8.299
PL31	2	0.006	1.992	0.276	7.624
PL32	2	0.008	2.56	0.347	8.444
PL33	2	0.009	1.205	0.264	12.201
PL34	2	0.001	0.29	0.064	2.802
PL35	2	0.004	2.087	0.282	8.945

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
PS1	2	0.022	3.71	0.85	5.95
PS2	1	0.009	3.675	0.585	6.51
PS3	2	0.01	2.745	0.605	4.73
PS4	1	0.016	3.925	0.795	6.31
PS5	1	0.016	3.335	0.785	6.185
PS6	1	0.008	3.075	0.725	7.44
PS7	1	0.01	3.85	0.725	6.76
PS8	1	0.019	4.115	0.65	7.045
PS9	3	0.011	3.585	0.735	6.43
PS10	2	0.013	3.33	0.655	6.965
PS11	1	0.029	1.935	0.535	9.77
PS12	1	0.016	2.25	0.29	7.335
PS13	1	0.012	2.715	0.335	6.95
PS14	1	0.012	2.315	0.27	7.66
PS15	1	0.015	2.16	0.495	8.325
PS16	1	0.013	2.34	0.315	7.2
PS17	1	0.015	1.99	0.46	8.125
PX1	1	0.016	3.7	0.659	6.79
PX2	2	0.011	3.641	0.889	6.515
PX3	1	0.017	3.541	0.746	6.539
PX4	1	0.015	4.057	0.648	6.35
PX5	1	0.018	2.901	0.803	6.061
PX6	1	0.019	3.555	0.773	5.638
PX7	1	0.025	5.565	0.645	7.787
PX8	1	0.018	2.681	0.725	6.182
PX9	1	0.017	2.826	0.385	6.455
PX10	2	0.016	2.66	0.722	6.872
PX11	1	0.015	3.146	0.877	6.663
PX12	1	0.019	3.625	0.875	8.1
PX13	1	0.018	1.347	0.357	8.685
PX14	1	0.014	3.333	0.254	8.737
PX15	1	0.014	2.425	0.156	5.384

Site/ware code or sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
SL1	2	0.006	2.063	0.366	5.34
SL2	2	0.005	2.151	0.281	5.93
SL3	2	0.006	1.797	0.426	6.842
SL4	2	0.006	1.485	0.286	6.587
SL5	2	0.007	1.777	0.356	7.224
SL6	2	0.005	1.68	0.381	7.291
SL7	2	0.004	1.966	0.418	7.588
SL8	2	0.006	1.514	0.413	6.798
SL9	2	0.004	1.994	0.491	7.318
SL10	2	0.005	2.178	0.378	7.456
SL11	2	0.007	1.627	0.411	9.273
SL12	2	0.006	1.478	0.363	8.634
SL13	2	0.01	2.056	0.248	9.216
SL14	2	0.008	1.573	0.168	7.821
SL15	2	0.009	1.596	0.202	8.977
SL16	2	0.009	1.39	0.428	6.899
SL17	2	0.009	1.424	0.372	6.113
SL18	2	0.007	1.408	0.403	6.546
SL19	2	0.01	1.762	0.157	9.024
SL20	2	0.006	1.411	0.355	5.776
SL21	2	0.01	1.966	0.39	6.527
SL22	2	0.012	2.125	0.204	7.664
SL23	2	0.007	1.319	0.367	7.574
SL24	2	0.009	1.919	0.514	8.163
SL25	2	0.008	1.19	0.296	6.475

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
ST1	2	0.005	3.408	0.493	5.24
ST2	2	0.013	4.55	0.762	6.927
ST3	1	0.008	3.75	0.754	6.002
ST4	1	0.012	4.118	0.744	7.926
ST5	2	0.014	4.285	0.69	7.82
ST6	4	0.016	3.929	0.701	6.614
ST7	2	0.014	3.657	0.744	6.617
ST8	2	0.01	3.813	0.73	6.26
ST9	4	0.013	2.54	0.532	8.81
ST10	4	0.009	4.122	0.687	6.737
ST11	2	0.007	1.873	0.402	9.476
ST12	2	0.014	1.826	0.193	7.305
ST13	2	0.012	1.427	0.364	5.894
ST14	2	0.011	1.513	0.363	6.249
ST15	2	0.015	2.443	0.572	9.697
ST16	2	0.009	1.593	0.232	7.285
ST17	2	0.016	2.242	0.422	8.112
ST18	2	0.015	1.817	0.495	9.03
ST19	3	0.009	1.648	0.399	8.167
ST20	2	0.913	2.01	0.371	7.875
ST21	2	0.014	2.169	0.239	6.933
ST22	2	0.014	2.32	0.478	8.28
ST23	2	0.013	2.122	0.592	10.584
ST24	2	0.015	2.315	0.603	0.13
ST25	2	0.015	1.681	0.45	7.345
ST26	2	0.005	1.851	0.33	6.03
ST27	2	0.01	1.989	0.52	9 138
ST28	2	0.008	1.857	0.539	7.839
ST29	2	0.009	1.45	0.247	0.139
ST30	2	0.006	2.019	0.533	8.097
ST31	1	0.004	2.862	0.689	6.123
ST32	1	0.006	2.672	0.576	6.446
ST33	1	0.008	2.379	0.608	6.264
ST34	1	0.007	2.689	0.652	6.551
ST35	1	0.007	3 847	0.737	6.018

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
SC1	2	0.016	1.749	0.399	8.238
SC2	2	0.005	1.45	0.115	8.138
SC3	2	0.011	1.5	0.409	7.526
SC4	2	0.011	1.7	0.324	7.956
SC5	2	0.015	1.899	0.381	7.978
SC6	2	0.016	2.15	0.474	9.496
SC7	2	0.015	2.851	0.514	10.205
SC8	2	0.007	0.99	0.125	9.037
SC9	2	0.008	1.1	0.224	9.303
SC10	2	0.005	0.8	0.167	10.34
SC11	2	0.016	1.751	0.372	10.476
SC12	2	0.007	0.751	0.061	7.548
SC13	2	0.006	3.6	0.511	5.16
SC14	2	0.005	2.099	0.529	9.031
SC15	2	0.007	1.501	0.314	8.22
SC16	2	0.009	3.55	0.446	7.666
SC17	2	0.011	2.549	0.393	9.109
SC18	2	0.014	0.7	0.075	7.516
SC19	2	0.007	1.65	0.312	7.43
SC20	2	0.012	2.25	0.413	7.958
SC21	2	0.01	4.55	1.764	7.761
SC22	2	0.01	1.301	0.089	8.691
SC23	2	0.019	1.251	0.443	8.27
SC24	2	0.008	1.2	0.121	9.998
SC25	2	0.008	1.25	0.16	9.611
SC26	2	0.016	2.85	0.475	5.906
SC27	2	0.017	1.7	0.158	11.664
SC28	2	0.006	1.601	0.416	7.631
SC29	2	0.015	2.548	0.447	9.048
SC30	2	0.018	2.2	0.432	9.774
SC31	2	0.014	1.36	0.222	9.943
SC32	2	0.009	3.7	0.504	8.056
SC33	2	0.006	1.501	0.13	9.83
SC34	2	0.009	1.551	0.281	9.983
SC35	2	0.011	1.3	0.138	10.661
SC36	2	0.006	1.151	0.191	9.086
SC37	2	0.008	1.15	0.174	9.99
SC38	2	0.005	0.7	0.338	10.226
SC39	2	0.007	1.65	0.337	7.603
SC40	2	0.013	2.05	0.467	8.688
SC41	4	0.011	3.7	0.575	6.3
SC42	4	0.013	3.749	0.595	6.204
SC43	2	0.012	3.65	0.654	6.544
SC44	2	0.013	3.652	0.664	6.586
SC45	2	0.016	3.8	0.663	7.781
SC46	2	0.009	3.55	0.849	6.681
SC47	2	0.009	3.349	735	6.947
SC48	2	0.011	4	0.602	6.68
SC49	2	0.01	3.549	0.765	7.147
SC50	2	0.013	3.75	0.785	7.7

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
SC51	1	0.012	3.101	0.666	6.166
SC52	1	0.009	3.55	0.645	6.206
SC53	1	0.009	3.7	0.734	6.438
SC54	2	0.009	3.651	0.665	6.909
SC55	2	0.018	4.452	0.839	7.937
SC56	2	0.01	3.749	0.5	5.998
SC57	2	0.012	4.402	0.848	7.831
SC58	2	0.008	3.799	0.676	6.47
SC59	2	0.008	3.555	0.784	6.984
SC60	2	0.009	4.101	0.744	6.302
SC61	2	0.008	3.75	0.616	5.46
SC62	2	0.01	3.652	0.754	6.989
SC63	1	0.012	4.048	0.639	6.434
SC64	1	0.016	4.15	0.687	6.972
SC65	2	0.009	3.401	0.596	5.36
SC66	2	0.011	3.702	0.639	5.641
SC67	2	0.01	3.9	0.719	7.043
SC68	2	0.009	3.75	0.7	5.956
SC69	2	0.008	3.949	0.549	5.742
SC70	1	0.012	4.048	0.789	8.139
SC71	1	0.009	4.7	0.697	6.414
SC72	1	0.007	2.865	0.39	4.594
SC73	1	0.012	4.395	0.599	5.943
SC74	1	0.014	3.998	0.72	7.847
SC75	2	0.013	3.971	0.615	6.204
SC76	2	0.011	4.124	0.711	6.906
SC77	1	0.015	4.031	0.71	6.954
SC78	1	0.016	3.918	0.668	6.882
SC79	1	0.012	2.915	0.548	5.427
SC80	5	0.009	3.78	0.59	6.401
SC81	1	0.007	2.987	0.509	7.272
SC82	1	0.007	3.133	0.558	72154
SC83	1	0.006	2.915	0.53	6.554
SC84	1	0.028	2.643	0.569	7.576
SC85	1	0.007	2.806	0.544	7.495
SC86	1	0.005	2.323	0.656	5.944
SC87	1	0.009	2.845	0.554	7.285
SC88	1	0.01	2.994	0.647	5.626
SC89	1	0.005	3.058	0.579	5.247
SC90	1	0.007	3.048	0.552	7.337
SC91	1	0.007	2.794	0.613	5.552
SC92	1	0.008	3.164	0.608	5.043
SC93	1	0.011	3.17	0.522	4.552
SC94	1	0.01	4.971	0.625	4.932
SC95	1	0.007	3.949	0.508	6.717
SC96	1	0.007	2.73	0.673	5.853
SC97	1	0.007	2.925	0.532	6.97
SC98	1	0.009	2.98	0.626	5.179
SC99	1	0.007	2.754	0.664	5.646
SC100	1	0.01	2.955	0.561	7.169

Sitelware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
SO1	2	0.012	3.497	0.41	8.806
SO2	2	0.01	3.521	0.42	8.605
SO3	2	0.009	3.35	0.415	8.004
SO4	2	0.013	3.511	0.45	8.957
SO5	2	0.013	3.494	0.479	8.973
SO6	2	0.014	3.371	0.436	8.521
SO7	2	0.02	3.56	0.51	9.938
SO8	2	0.021	2.672	0.395	9.341
SO9	2	0.017	2.779	0.489	9.381
SO10	2	0.015	3.216	0.326	8.308
SO11	2	0.018	2.652	0.34	7.759
SO12	2	0.017	2.194	0.324	8.004
SO12	2	0.018	3.042	0.363	7.654
SO14	2	0.019	3.595	0.387	7.646
SO15	2	0.018	3.147	0.367	7.638
SO16	2	0.019	2.938	0.349	7.589
SO17	2	0.015	3.267	0.343	8.128
SO18	2	0.01	2.02	0.216	5.139
SO19	2	0.017	3.032	0.33	7.961
SO20	2	0.01	3.139	0.27	7.368
SO21	2	0.012	3.522	0.605	5.307
SO22	2	0.011	3.934	0.732	6.25
SO23	2	0.009	3.513	0.707	6.347
SO24	2	0.015	3.407	0.685	6.026
SO25	2	0.013	3.013	0.548	5.777
SO26	2	0.01	2.427	0.404	7.651
SO27	2	0.011	2.502	0.465	9.491
SO28	2	0.012	2.216	0.454	9.032
SO29	2	0.013	1.816	0.428	8.661
SO30	2	0.01	1.849	0.442	9.095
SO31	2	0.01	4.298	0.743	6.874
SO32	2	0.01	3.465	0.69	6.687
SO33	2	0.01	3.704	0.766	6.703
SO34	2	0.009	3.766	0.73	6.697
SO35	2	0.01	3 379	0.684	6.636
SO36	2	0.011	2.712	0.593	7.976
SO37	2	0.006	2.716	0.629	7.998
SO38	2	0.011	3.394	0.589	10.162
SO39	2	0.011	2.522	0.624	7.62
SO40	2	0.011	2.408	0.552	9.355
SO41	2	0.017	3.041	0.499	9.206
SO42	2	0.01	2.24	0.66	8
SO43	2	0.013	2.503	0.607	7.331
SO44	2	0.011	2.443	0.637	7.313
SO45	2	0.012	2.386	0.543	9.644
SO46	2	0.015	2.497	0.626	7.366
SO47	2	0.012	2.532	0.675	7.633
SO48	2	0.008	2.577	0.721	8.316
SO49	2	0.009	2.346	0.639	7.277
SO50	2	0.01	2.588	0.593	6.956
SO51	2	0.01	2.571	0.711	8.18

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
SO52	1	0.012	3.69	0.591	6.397
SO53	1	0.011	3.115	0.695	6.329
SO54	1	0.012	2.808	0.656	6.091
SO55	1	0.019	3.314	0.596	5.024
SO56	1	0.02	3.292	0.556	4.861
SO57	1	0.009	3.397	0.839	6.199
SO58	1	0.011	3.779	0.696	5.824
SO59	1	0.008	3.264	0.603	5.603
SO60	1	0.008	3.611	0.73	5.705
SO61	1	0.009	3.561	0.572	5.03
SO62	1	0.009	2.274	0.387	3.961
SO63	1	0.009	3.096	0.429	5.274
SO64	1	0.009	2.805	0.665	6.485
SO65	1	0.009	3.034	0.508	6.874
SO66	1	0.009	3.422	0.355	6.489
SO67	1	0.008	3.097	0.364	5.133
SO68	1	0.009	3.533	0.589	4.985
SO69	1	0.013	4.129	0.733	4.802
SO70	1	0.002	2.722	0.287	5.467
SO71	1	0.003	3.678	0.804	6.523
SO72	1	0.004	2.906	0.571	5.059

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
WH1	1	0.045	1.786	0.3	7.683
WH2	1	0.022	2.129	0.268	7.214
WH3	1	0.02	1.341	0.317	7.388
WH4	1	0.02	1.341	0.317	7.388
WH5	1	0.014	2.346	0.232	7.075
WH6	1	0.021	1.564	0.27	7.337
WH7	1	0.018	2.087	0.226	7.676
WH8	1	0.037	2.255	0.468	8.638
WH9	1	0.015	2.115	0.271	7.198
WH10	1	0.025	1.616	0.403	8.334
WH11	2	0.021	2.091	0.484	9.228
WH12	2	0.013	2.986	0.103	7.945
WH13	2	0.016	1.625	0.338	8.396
WH14	2	0.007	1.812	0.094	8.036
WH15	2	0.019	2.271	0.478	9.113
WH16	2	0.009	0.724	0.189	8.733
WH17	2	0.009	0.743	0.188	8.842
WH18	2	0.017	3.984	0.319	7.767
WH19	2	0.014	1.57	0.393	8.774
WH20	2	0.016	2.854	0.105	8.523
WH21	1	0.009	2.061	0.138	7.777
WH22	1	0.01	1.884	0.143	7.21
WH23	1	0.011	1.76	0.122	7.41
WH24	1	0.008	1.853	0.18	8.157
WH25	1	0.009	1.875	0.177	7.704
WH26	1	0.01	1.814	0.175	8.002
WH27	1	0.012	1.841	0.163	7.884
WH28	1	0.012	1.874	0.169	7.848
WH29	1	0.006	1.894	0.13	7.816
WH30	1	0.011	2.07	0.153	7.889
WG1	2	0.005	1.836	0.273	7.045
WG2	2	0.007	2.518	0.496	8.099
WG3	3	0.005	2.166	0.532	7.734
WG4	2	0.007	2.041	0.372	7.244
WG5	2	0.007	3.247	0.457	7.368
WG6	2	0.009	2.015	0.346	7.761
WG7	2	0.006	1.977	0.19	7.002
WG8	2	0.007	1.583	0.269	10.271
WG9	2	0.006	1.662	0.289	11.045
WG10	3	0.005	2.225	0.426	7.195
WG11	2	0.005	2.128	0.473	8.244
WG12	2	0.005	2.311	0.483	7.719
WG13	2	0.004	1.274	0.128	8.459
WG14	2	0.006	1.441	0.257	9.513
WG15	2	0.007	1.605	0.377	8.68

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
WT1	1	0.016	3.758	0.747	6.747
WT2	1	0.012	3.38	0.662	5.698
WT3	1	0.014	2.591	0.537	4.92
WT4	1	0.014	3.725	0.637	6.274
WT5	1	0.017	3.832	0.713	7.471
WT6	2	0.017	3.75	0.74	7.955
WT7	2	0.018	3.144	0.645	6.23
WT8	1	0.018	4.008	0.595	5.704
WT9	1	0.018	3.452	0.692	6.923
WT10	1	0.013	3.26	0.661	6.809
WT11	1	0.019	1.694	0.404	8.071
WT12	1	0.017	2.079	0.406	8.96
WT13	2	0.017	2.59	0.201	8.082
WT14	1	0.019	1.806	0.151	7.646
WT15	1	0.018	1.831	0.545	7.231

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
WB1	2	0.01	2.438	0.25	9.741
WB2	2	0.008	1.809	0.424	10.68
WB3	2	0.01	1.743	0.486	7.715
WB4	2	0.009	1.218	0.244	10.039
WB5	2	0.01	2.534	0.267	9.781
WB6	2	0.01	1.785	0.259	10.546
WB7	2	0.01	2.106	0.399	8.807
WB8	2	0.006	1.437	0.258	12.566
WB9	2	0.011	4.235	0.765	9.356
WB10	2	0.007	2.588	0.3	10.578
WB11	2	0.025	2.571	0.571	10.722
WB12	2	0.012	2.122	0.434	10.249
WB13	2	0.017	1.62	0.419	9.592
WB14	2	0.006	1.835	0.226	6.509
WB15	2	0.019	2.082	0.479	8.014
WB16	2	0.012	1.861	0.284	8.012
WB17	2	0.015	1.798	0.354	6.666
WB18	2	0.018	1.741	0.453	9.064
WB19	2	0.01	1.705	0.304	7.539
WB20	2	0.015	1.756	0.235	7.186
WB21	1	0.012	2.109	0.276	8.768
WB22	1	0.021	2.332	0.423	8.927
WB23	1	0.016	2.295	0.305	8.2
WB24	1	0.012	1.787	0.28	8.211
WB25	1	0.013	1.564	0.181	9.557
WB26	1	0.016	2.211	0.374	9.132
WB27	1	0.015	1.933	0.405	8.248
WB28	1	0.013	1.585	0.285	9.05
WB29	1	0.011	1.472	0.272	8.941
WB30	1	0.013	1.234	0.198	7.696
WB31	1	0.02	2.616	0.442	9.408
WB32	1	0.013	1.54	0.303	7.626
WB33	1	0.011	2.109	0.345	8.923
WB34	1	0.011	1.826	0.216	8.199
WB35	1	0.011	1.526	0.256	8.634
WB36	1	0.012	1.531	0.392	9.638
WB37	1	0.01	1.439	0.141	6.841
WB38	1	0.016	1.762	0.247	8.55
WB39	1	0.012	1.394	0.255	7.414
WB40	1	0.012	2.404	0.384	9.797

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
WN1	1	0.008	2.846	0.424	5.924
WN2	1	0.005	3.832	0.546	7.825
WN3	1	0.008	2.625	0.316	5.02
WN4	1	0.008	3.397	0.432	6.949
WN5	1	0.008	3.941	0.754	6.441
WN6	1	0.009	2.019	0.375	10.175
WN7	1	0.009	4.612	0.582	7.289
WN8	1	0.008	3.764	0.448	5.729
WN9	1	0.007	3.696	0.501	5.396
WN10	1	0.01	2.059	0.265	8.259
WN11	1	0.009	2.155	0.223	8.09
WN12	1	0.011	1.613	0.309	8.427
WN13	2	0.015	2.166	0.487	9.396
WN14	1	0.009	2.111	0.336	9.759
WN15	1	0.011	1.969	0.247	8.061
WN16	1	0.011	1.922	0.203	7.065
WN17	1	0.012	2.131	0.243	8.36
WN18	1	0.016	1.772	0.266	8.208
WN19	1	0.01	2.456	0.189	10.079
WN20	2	0.012	1.701	0.507	8.924

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
WF1	1	0.01	4.225	0.4	5.45
WF2	1	0.012	4.22	0.385	6.3
WF3	1	0.018	4.54	0.415	7.83
WF4	3	0.012	3.765	0.545	5.875
WF5	1	0.017	4.205	0.655	7.49
WF6	3	0.015	4.02	0.43	7.05
WF7	3	0.008	3.505	0.59	5.9
WF8	3	0.015	4.22	0.615	6.8
WF89	2	0.011	4.13	0.53	7.055
WF10	2	0.012	5.06	0.525	6.13
WF11	1	0.009	4.12	0.675	5.92
WF12	1	0.011	4.725	0.5	7.715
WF13	3	0.008	3.525	0.735	6.315
WF14	1	0.008	3.44	0.705	6.01
WF15	1	0.014	3.69	0.695	7.7
WF16	3	0.012	4.075	0.675	7.485
WF17	1	0.009	3.69	0.615	7.145
WF18	1	0.011	3.725	0.44	5.665
WF19	1	0.016	3.595	0.605	5.73
WF20	1	0.013	4.075	0.615	6.21
WF21	1	0.012	3.505	0.7	6.93
WF22	1	0.01	3.61	0.535	4.89
WF23	1	0.015	3.665	0.69	6.45
WF24	1	0.012	3.73	0.59	6.555
WF25	1	0.011	3.715	0.5	6.49
WF26	3	0.014	3.905	0.635	6.82
WF27	1	0.11	4.38	0.61	7.26
WF28	1	0.007	3.85	0.41	5.15
WF29	2	0.007	4.265	0.54	6.36
WF30	2	0.01	4.06	0.65	7.15
WF31	1	0.008	3.89	0.495	5.6
WF32	3	0.01	3.165	0.625	6.685
WF33	2	0.017	3.51	0.59	5.605
WF34	3	0.009	3.06	0.625	6.685
WF35	3	0.018	4.1	0.675	7.295
WF36	1	0.009	3.745	0.455	6.125
WF37	1	0.009	1.77	0.45	8.9
WF38	2	0.016	4.375	0.85	8.535
WF39	3	0.01	4.2	0.55	7.15
WF40	2	0.014	4.12	0.875	7.73

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
WF41	1	0.013	4.469	0.699	8.134
WF42	1	0.011	6.217	0.57	6.617
WF43	1	0.01	3.968	0.446	7.142
WF44	1	0.016	4.945	0.596	8.062
WF45	1	0.011	4.538	0.472	5.02
WF46	1	0.013	3.617	0.752	5.65
WF47	1	0.009	4.611	0.349	4.731
WF48	1	0.011	3.515	0.486	7.463
WF49	1	0.01	4.336	0.504	4.995
WF50	1	0.014	3.583	0.54	7.422
WF51	1	0.014	3.26	0.395	6.65
WF52	1	0.014	3.249	0.343	6.811
WF53	1	0.011	3.59	0.375	6.9
WF54	1	0.012	3.616	0.32	6.294
WF55	1	0.009	3.793	0.355	6.117
WF56	1	0.011	3.109	0.406	7.472
WF57	1	0.019	3.05	0.458	7.99
WF58	1	0.023	3.701	0.526	6.881
WF59	1	0.012	3.532	0.551	7.589
WF60	1	0.012	3.64	0.415	6.344
WF61	1	0.012	3.91	0.603	8.437
WF62	1	0.01	3.902	0.408	7.232
WF63	1	0.009	3.12	0.499	6.28
WF64	1	0.014	3.125	0.403	5.346
WF65	1	0.014	3.78	592	7.353
WF66	1	0.011	4.228	0.55	7.856
WF67	1	0.01	3.718	0.522	7.256
WF68	1	0.011	4.17	0.507	7.207
WF69	1	0.008	3.177	0.498	7.121
WF70	1	0.01	3.684	0.747	8.11
WF71	1	0.008	2.776	0.301	6.313
WF72	1	0.013	4.239	0.536	7.157
WF73	1	0.01	4.352	0.728	8.695
WF74	1	0.009	4.481	0.573	7.509
WF75	1	0.009	4.763	0.396	7.343
WF76	1	0.014	3.557	0.538	7.361
WF77	1	0.014	3.557	0.542	7.05
WF78	1	0.013	5.119	0.621	7.654
WF79	1	0.01	3.848	0.422	7.199
WF80	1	0.012	3.937	0.501	7.448

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
YO1	1	0.017	2.365	0.305	4.484
YO2	1	0.009	4.185	0.627	7.105
YO3	1	0.012	4.403	0.568	7.869
YO4	1	0.011	4.057	0.634	8.498
YO5	1	0.008	4.338	0.358	6.151
YO6	1	0.015	3.449	0.71	9.177
YO7	1	0.012	4.204	0.741	8.003
YO8	1	0.008	2.995	0.534	4.306
YO9	1	0.015	2.29	0.234	5.313
YO10	1	0.014	2.408	0.209	5.938
YO11	1	0.013	2.484	0.23	5.672
YO12	1	0.014	2.565	0.33	6.35
YO13	1	0.012	5.014	0.82	10.276
YO14	1	0.008	5.355	0.775	10.9
YO15	1	0.01	4.497	0.815	8.652
YO16	1	0.01	5.433	0.524	7.913
YO17	1	0.009	3.86	0.597	6.902
YO18	1	0.014	3.912	0.821	9.234
YO19	1	0.01	4.529	2.215	8.045
YO20	1	0.011	3.969	0.706	6.321

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
AL1	1	0.013	2.295	0.169	8.179
AL2	3	0.019	2.527	0.214	9.172
AL3	3	0.014	2.253	0.171	8.77
AL4	1	0.024	2.179	0.23	9.168
AL5	3	0.013	2.106	0.19	8.444
AL6	3	0.012	2.375	0.215	9.018
AL7	1	0.018	2.301	0.171	9.567
AL8	3	0.014	2.013	0.179	9.095
AL9	3	0.013	2.029	0.176	8.476
AL10	1	0.011	2.845	0.204	8.441
AL11	2	0.011	1.96	0.189	8.557
AL12	3	0.024	1.942	0.179	8.258
AL13	1	0.014	2.335	0.247	8.866
AL14	2	0.015	2.273	0.184	8.724
AL15	2	0.013	2.399	0.202	8.867
HO1	3	0.014	3.91	0.414	8.98
HO2	3	0.015	4.358	0.373	8.01
HO3	3	0.015	3.978	0.375	8.737
HO4	3	0.012	4.108	0.353	8.039
HO5	3	0.014	4.258	0.357	7.373
HO6	3	0.014	4	0.364	8.41
HO7	3	0.021	4.582	0.363	7.803
HO8	3	0.015	4.495	0.388	8.737
HO9	3	0.008	4.23	0.353	7.938
HO10	3	0.013	4.152	0.404	7.524
HO11	3	0.014	4.153	0.399	9.172
HO12	3	0.012	4.246	0.365	8.405
HO13	3	0.013	4.078	0.362	9.633
HO14	3	0.012	4.165	0.366	8.66
HO15	3	0.011	4.539	0.373	9.662
EH1	3	0.009	2.641	0.259	10.241
EH2	3	0.007	1.776	0.352	12.488
EH3	3	0.01	2.034	0.318	12.525
EH4	3	0.01	1.328	0.27	10.815
EH5	3	0.011	3.036	0.214	10.172
EH6	3	0.011	1.409	0.394	12.252
EH7	3	0.01	2.694	0.305	12.193
EH8	3	0.012	3.143	0.29	10.898
EH9	3	0.01	1.49	0.302	12.079
EH10	3	0.009	2.759	0.28	9.392
EH11	3	0.009	2.543	0.247	10.508
EH12	3	0.008	2.16	0.332	13.169
EH13	3	0.01	1.018	0.32	12.802
EH14	3	0.006	2.351	0.16	9.035
EH15	3	0.006	1.899	0.286	11.212

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
LY1	2	0.01	1.51	0.401	8.31
LY2	2	0.01	1.65	0.406	7.99
LY3	2	0.012	1.32	0.379	7.02
LY4	2	0.009	1.5	0.418	8.25
LY5	2	0.011	1.51	0.386	7.44
LY6	2	0.009	1.97	0.41	8.09
LY7	2	0.012	1.56	0.424	6.64
LY8	2	0.01	1.79	0.486	6.97
LY9	1	0.011	1.9	0.271	7.56
LY10	1	0.01	4.31	1.199	8.45
LY11	2	0.008	1.74	0.458	7.5
LY12	2	0.008	1.79	0.516	8.21
LY13	2	0.01	2.32	0.548	8.82
LY14	2	0.01	2.32	0.548	8.82
LY15	2	0.011	2.1	0.459	7.31
LY16	2	0.007	1.75	0.462	7.42
LY17	1	0.008	2.14	0.253	9.48
LY18	1	0.02	2.38	0.32	8.98
LY19	1	0.02	1.51	0.269	8.56
LY20	1	0.018	1.96	0.276	7.69
LY21	2	0.007	1.453	0.39	7.627
LY22	2	0.006	1.363	0.38	7.99
LY23	2	0.006	1.687	0.405	8.453
LY24	2	0.005	1.723	0.317	7.593
LY25	2	0.004	1.6	0.336	8.537
LY26	2	0.005	1.7	0.326	8.823
LY27	2	0.007	1.82	0.409	9.047
LY28	2	0.005	1.84	0.401	8.347
LY29	2	0.006	1.88	0.408	8.533
LY30	2	0.006	2.247	0.389	8.767
LY31	2	0.006	1.99	0.371	8.253
LY32	2	0.005	2.047	0.373	8.14
LY33	3	0.006	1.337	0.37	7.813
LY34	3	0.007	1.37	0.357	7.393
LY35	3	0.009	1.273	0.362	7.64
LY36	1	0.013	2.327	0.315	8.887
LY37	1	0.015	2.2	0.307	8.51
LY38	1	0.017	2.167	0.316	8.62
LY39	1	0.016	1.387	0.17	8.697
LY40	1	0.012	1.34	0.176	6.947

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
LY41	1	0.013	1.373	0.162	6.823
LY42	1	0.008	1.55	0.18	7.323
LY43	1	0.01	1.467	0.165	7.07
LY44	1	0.006	1.547	0.171	7.367
LY45	4	0.008	1.9	0.376	8.003
LY46	4	0.006	1.8	0.376	7.633
LY47	4	0.011	1.997	0.379	7.837
LY48	4	0.01	1.777	0.325	6.503
LY49	4	0.007	1.867	0.311	6.247
LY50	4	0.008	1.94	0.335	6.283
LY51	2	0.009	1.72	0.342	7.637
LY52	2	0.007	1.797	0.306	8.647
LY53	2	0.009	2.34	0.333	8.56
LY54	2	0.01	1.68	0.378	7.603
LY55	2	0.011	1.617	0.347	7.183
LY56	2	0.012	1.817	0.368	7.48
LY57	2	0.008	1.367	0.392	7.443
LY58	2	0.009	1.343	0.397	7.457
LY59	2	0.008	1.357	0.394	7.243
LY60	2	0.012	1.71	0.379	7.963
LY61	2	0.01	1.62	0.377	7.81
LY62	2	0.008	1.65	0.379	7.903
LY63	2	0.004	2.037	0.355	7.47
LY64	2	0.007	1.587	0.377	8.037
LY65	2	0.005	1.97	0.345	7.91
LY66	2	0.005	2.157	0.391	8.3
LY67	2	0.006	2.033	0.392	8.317
LY69	2	0.006	2.017	0.395	8.407
LY69	2	0.008	1.95	0.506	8.36
LY70	2	0.009	2.183	0.51	8.737
LY71	2	0.009	1.947	0.511	8.863
LY72	2	0.007	2.053	0.405	7.88
LY73	2	0.01	1.947	0.437	7.86
LY74	2	0.01	1.897	0.449	7.957
LY75	1	0.009	1.56	0.141	7.253
LY76	1	0.011	1.53	0.129	6.93
LY77	1	0.01	1.727	0.168	8.02
LY78	1	0.014	1.697	0.224	7.51
LY79	1	0.014	1.82	0.209	8.01
LY80	1	0.014	1.743	0.205	7.463

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
HM1	1	0.017	6.75	0.534	7.533
HM2	1	0.013	5.343	0.618	7.873
HM3	1	0.011	5.883	0.418	7.71
HM4	1	0.009	4.623	0.864	8.683
HM5	1	0.012	4.63	0.874	8.387
HM6	1	0.012	4.207	0.409	7.993
HM7	1	0.017	4.31	0.816	7.487
HM8	1	0.01	4.37	0.91	7.497
HM9	1	0.017	4.69	0.891	7.743
HM10	1	0.018	4.81	0.877	9.473
HM11	1	0.018	4.89	0.824	8.657
HM12	1	0.015	4.917	0.94	9.423
HM13	1	0.019	4.35	0.867	8.35
HM14	1	0.025	4.317	0.841	8.53
HM15	1	0.024	4.653	0.843	8.933
HM16	2	0.017	4.21	0.665	6.68
HM17	2	0.011	4.44	0.695	7.127
HM18	2	0.019	4.017	0.636	8.38
HM19	2	0.014	4.363	0.789	5.597
HM20	2	0.011	4.687	0.79	8.607
HM21	2	0.01	4.963	0.739	8.65
HM22	2	0.018	4.185	0.759	8.177
HM23	2	0.013	4.787	0.591	8.477
HM24	2	0.017	4.41	0.782	8.897
HM25	2	0.018	4.227	0.814	7.863
HM26	2	0.015	4.317	0.823	8.477
HM27	2	0.018	4.307	0.798	7.27
HM28	2	0.012	4.097	0.778	7.27
HM29	2	0.015	3.903	0.778	7.443
HM30	2	0.021	3.777	0.773	7.4
HM31	3	0.013	4.41	0.589	7.713
HM32	3	0.01	4.39	0.614	7.733
HM33	3	0.008	4.423	0.647	7.837
HM34	3	0.016	4.467	0.815	7.893
HM35	3	0.017	4.58	0.85	7.907
HM36	3	0.016	4.72	0.856	8.253
HM37	3	0.013	4.733	0.857	8.8
HM38	3	0.015	4.71	0.799	8.813
HM39	3	0.018	4.73	0.815	8.67
HM40	3	0.019	4.6	0.86	8.323

Site/ware code of sample	Form	Nickel concentration	Iron concentration	Magnesium concentration	Aluminium concentration
HM41	3	0.02	4.547	0.835	8.167
HM42	3	0.016	4.413	0.851	8.233
HM43	3	0.01	4.37	0.599	7.663
HM44	3	0.011	4.25	0.499	7.443
HM45	3	0.014	4.567	0.469	7.493
HM46	4	0.016	4.003	0.761	6.173
HM47	4	0.024	4.043	0.78	6.467
HM48	4	0.024	4.24	0.805	6.693
HM49	4	0.014	4.243	0.698	7.22
HM50	4	0.012	4.327	0.757	6.903
HM51	4	0.014	4.323	0.758	7.25
HM52	4	0.013	5.603	0.351	6.407
HM53	4	0.014	6.19	0.382	5.797
HM54	4	0.013	6.373	0.407	5.437
HM55	4	0.013	4.097	0.603	5.833
HM56	4	0.016	4.1	0.567	6.15
HM57	4	0.014	4.057	0.595	5.71
HM58	4	0.017	4.127	0.774	6.083
HM59	4	0.019	4.07	0.777	6.277
HM60	4	0.017	4.267	0.818	6.557
HM61	1	0.012	4.58	0.723	8.6
HM62	1	0.017	4.83	0.844	8.47
HM63	1	0.018	4.28	0.832	9.07
HM64	1	0.01	4.22	0.605	8.06
HM65	1	0.016	4.19	0.812	7.37
HM66	2	0.011	3.97	0.462	7.35
HM67	2	0.011	4.73	0.679	8
HM68	2	0.01	4.35	0.838	7.97
HM69	2	0.015	4.29	0.822	8.11
HM70	2	0.012	5.04	0.863	8.77
HM71	3	0.013	4.86	0.593	7.19
HM72	3	0.013	4.28	0.689	7.28
HM73	3	0.011	4.33	0.829	8.02
HM74	3	0.015	4.18	0.536	7.23
HM75	3	0.008	4.22	0.684	7.8
HM76	4	0.017	4.01	0.686	6.14
HM77	4	0.023	3.76	0.698	5.65
HM78	4	0.017	3.74	0.715	5.2
HM79	4	0.02	3.91	0.685	5.25
HM80	4	0.011	4.17	0.439	6.18