Characterisation Studies of Prehistoric and Early Roman Pottery from Melton, East Yorkshire (OSA04 EX03)

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Excavations on the line of the road widening at Melton, East Yorkshire, undertaken by On-Site Archaeology Ltd revealed a sequence of human activity starting in the early Bronze Age and continuing with the occasional hiatus to the present day.

In order to characterise the pottery associated with this activity a series of samples were taken from visually-identified fabric groups and studied using thin sections and chemical composition analysis. In order to establish a local reference point samples were also taken of fired clay artefacts – daub, the superstructure of a corn-drying kiln and loom weights – and these indicated that two types of local clay were exploited. The first has a fine-textured groundmass and is derived from Jurassic mudstones, which are present on site under a capping of clays, sands and gravels of Quaternary age. The second has a sandy texture and is probably derived from a lacustrine deposit laid down by Lake Humber when the Humber's mouth was impeded by ice and boulder clay.

This report deals with the prehistoric and early Roman pottery fabrics, since during the 2nd century the earlier system of pottery production and supply broke down and was replaced by a Romanised system of wheelthrown reduced grey and oxidised wares.

Methodology

Each sample was assigned a reference number and an offcut was taken for thin section. The samples are listed in Appendix 1. The thin sections were produced by Steve Caldwell at the University of Manchester and were stained using Dickson's method (Dickson 1965). The staining distinguishes dolomite (unstained) and two types of calcite, ferroan (stained blue) and non-ferroan (stained pink). However, some sparry calcite takes up very little of the pink stain and in this report these fragments are described as sparry dolomite or calcite. The identification of dolomite is limited to those grains which show both no staining and a rhombic habit.

A second offcut was removed at the same time and all outer surfaces were mechanically removed. Where there was visual evidence for contamination either through concretions in laminae or discolouration the affected area was removed. The resulting block was then crushed to a fine powder and analysed using Inductively-Coupled Plasma Spectroscopy at Royal Holloway College, London, under the supervision of Dr J N Walsh. A range of major elements was measured and their frequencies by weight expressed as percent oxides (App 2). A series of minor and trace elements was measured and their frequency expressed as parts per million (App 3). To counteract the dilution effect of silica (which was not measured, but estimated by subtracting the total measured oxides from 100%) the data were normalised to aluminium.

Visually-defined Fabric Groups

The samples were taken from groups defined by the dominant inclusion type and their supposed age. In several instances the thin section and chemical analysis has revealed that visual identification was misleading and samples have been re-identified and the database amended. In other cases, the thin section and chemical data can be used to subdivide the fabric groups. In these cases, a fabric number has been assigned, such as IASHEL Fabric 1.

A small number of fabrics identified by eye could not be examined in thin section or using chemical composition analysis because of their small size or the limited number of sherds available for study. In total these account for six separate groups and three groups where the sherd could not be assigned to a single group. The following codes are concerned: EBALST; IAORG; IASAND; IASILTY; IAX; MBAGROG. These account for at most 39 different vessels of which only one, IASAND, is represented by more than 5 vessels.

Petrological Characteristics

The same, or very similar, rock and mineral inclusion types occur in many of the samples and rather than repeat descriptions these are described here and then referred to in the individual fabric descriptions.

"Grog"

Grog is defined as pre-fired clay which is added as temper to a potting clay. It can be recognised in the hand specimen if it differs in colour, texture or inclusion types from the groundmass and grog, so defined, is certainly present in some Roman greywares from Melton.

However, a distinctive feature of some of the Bronze Age and Iron Age pottery from Melton is the presence of what in the hand specimen looks very much like grog. However, in thin section these fragments are always of the same texture as the groundmass although they usually differ in colour, either being lighter or darker than the groundmass.

These fragments are here termed "grog" as a shorthand term but probably they were not pre-heated but owe their difference in colour to the fact that the parent clay had a high organic content, leading some fragments to be opaque black and others to being black with an oxidized margin. It is less easy to interpret instances where the fragments are slightly lighter in colour than the groundmass but perhaps this is due to the use of dry crumbs of oxidized clay as tempering.

All of the "grog" fragments have a fine-textured groundmass but it is possible that there are two groups; those derived from clay/mudstone with variable iron content and those derived from clay/mudstone with a high organic content. However, it is difficult to determine the original organic content if the fabric has been fired in an oxidizing environment for a sufficiently long period of time (as is the case with the local fired clay, FCLAY Fabric 2, which has this “grog”-tempered texture but in which the parent clay was clearly variable in its iron content).

Quartz

Quartz is the most common inclusion in the prehistoric Melton thin sections. Experience suggests that detailed analysis of size, shape, inclusions, strain and so on is extremely time-consuming, even to record a sample of, say, 50 to 100 grains and therefore a more subjecting approach was adopted in which certain distinctive types were sought and noted.

In order of their geological age, these types start with grains derived from Carboniferous sandstones. These grains typically are either unstrained monocrystalline or are polycrystalline with sutured grain boundaries or mosaic texture. The diagnostic feature is that the grains have one or more straight edges, indicating that they derive from a sandstone with overgrowth. There is rarely any sign of the original grain boundary.

The next distinctive type consists of rounded grains between c.0.2mm and 1.0mm across which have a very high sphericity. These are likely to be “millet seed” grains derived from Permo-Triassic desert sands. Such sands exist below the Quaternary deposits of the Vale of York and Humber wetlands but are surprisingly rare in later deposits in those areas but do occur in quantity in superficial sands in Nottinghamshire and, from there, occur in Trent Valley sands and aeolian deposits derived from them. A small proportion of these Permo-Triassic sands consists of chert, presumably re-worked from Carboniferous deposits, and the rarity of chert grains is also a good indication that little of the prehistoric Melton pottery originated from sites south of the Humber.

The next distinctive type consists of silt-sized angular grains. These are abundant in clays of Middle Lias age; in Quaternary lacustrine deposits and in Holocene estuarine clays from the Humber wetlands to either side of the Humber. The lacustrine deposits have a coarser grain size than the other two groups and several of the prehistoric Melton fabrics appear to be derived from such clays (IAERR Fabric 1; IAGSQ Fabric 2; IALST Fabric 2; LOOL Fabric 3) although in each case an aeolian origin cannot be excluded. Holocene Estuarine clays do not seem to have been used to any great extent in contrast to the medieval period where they are the main source of potting clay used on either side of the Humber Gap.

Middle Jurassic sands, derived from the Kellaways sands and the Kellaways Rock, probably account for a high proportion of the quartz grains of subangular shape and varying between c.0.1mm and 0.3mm across. However, these grains do not have any clear diagnostic features to distinguish them for certain from grains derived from the finer Middle and Upper Carboniferous sandstones of West and South Yorkshire or present as erratics in Quaternary deposits. Nevertheless, where they occur to the exclusion of other types, a Middle Jurassic origin is likely. Such sands occur in several fabrics, often as a sparse scatter of grains. They are present, for example, in EBAGROG; IAERR Fabrics 1 and 3; IAFLINT; IAGSQ Fabric 2; IALST Fabric 2; IAOOL; IASH Fabrics 1 and 2; IASLAG; IASST; and LOOL Fabrics 1, 2 and 4. Such grains could easily have been redeposited by the wind.

The final distinctive quartz type in these fabrics is rounded but has a low sphericity, often having embayments. These grains are derived from Upper Jurassic to Lower Cretaceous deposits which outcrop immediately below the chalk in both Yorkshire and, especially Lincolnshire (e.g. the Spilsby Sandstone, 1992, 67-70). They also occur, as reworked grains, in the Marlstone which forms the basal chalk around the Yorkshire wolds (1992, 76-77). Such grains, which in the hand specimen are water polished and very distinctive, occur as a minor element of the quartzose sand found in the local fired clay (FCLAY Fabric 1) and there is little evidence for a Lincolnshire Wolds origin for any of these fabrics. These grains have been noted not only in IAGSQ, in which they are the most distinctive inclusion type, but as sparse inclusions in IAERR Fabric 2; IALST Fabric 2; IASLAG; IASST and LOOL Fabric 3.

Flint

Most of the flint fragments present in these thin sections are unstained and angular. They might have been produced through the use of flint knapping waste; or, more likely, of frost-shattered or ice-crushed flint. The angularity of most of the fragments allows a detrital source to be discounted, however. A few examples of well-rounded flint are present and these are likely to be from alluvial gravels, such as those on the foreshore of the Humber estuary (for example, at North Ferriby, a mile from the Melton site) or in earlier Quaternary gravels. Angular flint is a remarkably small fraction of the quartzose sand found in local fired clay (FCLAY Fabric 1).

Chalk

Given the proximity of the Upper Cretaceous chalk Wolds to the Melton site, there is remarkably little presence of chalk in the thin sections. In many instances, even where other calcareous inclusions survive, chalk seems to be preferentially leached, leaving well-rounded voids. This is probably a function of the softness of the rock and the structure, composed mostly of fragments of coccolith. Spherical microfossils, perhaps intact coccolithophores, are usually present in small quantities and can sometimes be abundant. In most cases the rock is light grey in plane-polarised light but it can be a light brown or darker brown colour. These examples might come from the red chalk, which outcrops at the base of the chalk. Rounded chalk fragments are a minor element in the quartzose sand found in local fired clay (FCLAY Fabric 1).

Shell and Shelly limestone

Bivalve shell is a relatively common inclusion in the prehistoric Melton pottery thin sections. However, in almost every instance it can be demonstrated that these are fossil shells (i.e.

they no longer have any organic, content) and most have a ferroan calcite cement adhering to the shell surfaces or filling bore holes in the shell. This ferroan calcite certainly confirms a fossil origin but does not actually prove that the shell came from a limestone, since it is quite common to find a coating of calcite on fossil shell incorporated into a mudstone or marl. Thus, it is possible for the shell fragments to have been present in the potting clay.

Where shell is less than 50% of the rock it has been classified as shell or shelly limestone but where shell is less than 50% of the rock it has been classified as limestone.

Most of the shell fragments are composed of non-ferroan calcite and have a nacreous structure (i.e. oyster-like). This can usually be seen easily at x20 magnification.

Another distinctive shell type is punctate brachiopod but no examples of loose punctate brachiopod were noted in any of the thin sections, although it is present in some of the limestone fragments (see below).

Gastropod shell was only observed in some of the oolitic limestone fragments (see below).

Oolitic limestone

Inclusions of this rock are particularly characteristic of IAOOL. The clasts are between 0.3mm and 1.0mm across and consist of ooliths, sparry non-ferroan calcite, gastropod and shell fragments. All have a brown, sometimes dark brown, micrite coating. The matrix consists either of non-ferroan sparry calcite or ferroan sparry calcite. Some of the sparry calcite clasts show traces of an original echinoid shell structure. The limestone has been fractured and the veins filled with ferroan and non-ferroan sparry calcite.

Fossiliferous limestones

Inclusions of fossiliferous limestone are characteristic of IALST and occur as a minor part of other rock suites in other fabrics.

That in IALST Fabric 1 has a light brown non-ferroan micrite groundmass, partially replaced by coarser-grained ferroan calcite and contains rounded, non-ferroan brown micrite-coated pellets which are formed around bivalve shell fragments, punctate brachiopod fragments, echinoid spines, and ostracods. Rare ferroan calcite gastropod shell is present and the bivalve shell is thin-walled.

IALST Fabric 2 contains some limestone fragments of similar character to those in IALST Fabric 1 but in some sections almost all the limestone fragments have been replaced by sparry dolomite, although this replacement has not completely destroyed the fossil content.

That in IAERR Fabric 3 has a sparry matrix with only slight pink staining and contains one shell fragment 1.0mm long and other unidentified fossil fragments partially replaced and coated by light brown micrite. It is very likely to be the same limestone as occurs in IALST Fabric 1

The limestone in LOOL is similar to that in IALST Fabric 1 but the pellets have been wholely or partially replaced by opaque iron ore. One fragment is cut by a vein of dolomite.

Sandstone

Several difference sandstone types occur in the thin sections.

Those in IAERR Fabrics 1 and 3 and IASST Fabric 1 consist of well-sorted interlocking grains with dark brown or opaque cement filling sparse pores. The individual grains range from c.0.2mm to c.0.4mm across and there is evidence for overgrowth, sometimes leaving euhedral pores but sometimes forming an orthoquartzite. Given the association of these rock fragments with glacial erratics of NE English, Scottish or Scandinavian origin there are several possibilities for the identity of this rock. They might be of Lower Carboniferous age and either from the Pennines or northeast England or southeast Scotland or they might be of Jurassic age and either local (Kellaways sand) or from one of the calcareous grits from the North Yorkshire Moors.

Calcareous sandstone

Calcareous sandstone occurs in IALST Fabric 1. It contains well-sorted angular quartz c.0.1mm across and has a ferroan calcite matrix. This is likely to be the Kellaways Rock (1992).

A calcareous sandstone in IAGSQ Fabric 3 is clearly of Upper Jurassic/Lower Cretaceous/Upper Cretaceous origin. Possible candidates include the Lower and Upper Spilsby Sandstone and the Carstone (1992, 67-70 and 76-7). If the former, then the fabric is an import from Lincolnshire but well-rounded flint fragments are a common inclusion and these suggest a Humber estuary source, in which case the rock is probably the Carstone.

Erratics

Acid igneous rock

This is characteristic of IAERR Fabric 2 and consists mainly of quartz and microcline feldspar grains c.1.0mm across with minor dark brown biotite. A single fragment was also identified in an early Bronze Age fabric (EBAERR). Granitic erratics from the southwest of Scotland and Shap in the Lake District occur in boulder clays and fluvio-glacial sands in the Vale of York, the Tees Valley and are present, but rarer, in boulder clays to the east of the Wolds.

Basic igneous rock

This is characteristic of IAERR Fabric 1 and occurs as a minor element in several other fabric groups. No attempt to distinguish the various rock types present in this group has been made but they vary from those with a glassy matrix, which can vary from a light grey to almost opaque in colour, and can have more or less euhedral phenocrysts, to crystalline rocks with grains up to 0.5mm across. None of the fragments show any sign of rounding but they occur, rarely, in the quartzose sand used in local fired clay (FCLAY Fabric 1) and are therefore at least potentially naturally occurring inclusions both in tills and fluvio-glacial and later sands.

Fabric Analysis

Each thin section was examined and the inclusion types present were noted. The thin sections were then grouped together on the basis, first, of the presence/absence of inclusion types and, second, on the texture, as reflected in the size range and frequency of the total clastic fraction and the relative proportion of different inclusion types. The inclusion types present in each fabric group are listed below together with details of the frequency and size range of the specific inclusion type and any diagnostic characteristics not covered by the general description of inclusion types give above.

EBAERR Early Bronze Age Erratic-tempered ware (EBAERR)

A single sample of this fabric was thin-sectioned. It contains the following inclusion types:

- Basic igneous rock. Moderate fragments up to 0.5mm across.
- Quartz. Sparse angular fragments up to 0.5mm across.
- Flint. Sparse angular fragments.
- "Grog". Sparse subangular fragments up to 0.5mm across. Some contain a higher quantity of dark brown rounded grains than the groundmass.
- Acid igneous rock. A single angular fragment 0.5mm across containing quartz and microcline feldspar.

The groundmass consists of optically-anisotropic baked clay minerals, sparse rounded dark brown grains up to 0.05mm across and sparse angular quartz up to 0.05mm across.

Interpretation: Probably a boulder clay derived from Jurassic mudstones

EBAGROG Early Bronze Age Grog-tempered ware (EBAGROG)

A single sample of this fabric was thin-sectioned. It contains the following inclusion types:

- Basic igneous rock. A single fragment 0.4mm across
- Quartz. Sparse subangular fragments up to 0.2mm across.
- "Grog". Sparse subangular fragments up to 0.5mm across.

The groundmass consists of optically-anisotropic baked clay minerals, sparse rounded dark brown grains up to 0.05mm across and sparse angular quartz up to 0.05mm across.

Interpretation: the groundmass has a similar texture to that of EBAERR and could therefore either also be a boulder clay (as the single grain of basic igneous rock might hint) or a contaminated weathered Jurassic mudstone.

IACALC Calcite-tempered ware (IACALC)

Eight sections of calcite-tempered wares were thin-sectioned. One of these came from a Roman deposit but might have been a residual Iron Age vessel and the remainder come from Iron Age contexts. The sections can be grouped into three fabrics although all contain similar sparry calcite inclusions.

Fabric 1

Four thin sections were classed as Fabric 1. They contain the following inclusion types:

- Sparry calcite. Abundant angular fragments of sparry calcite (unstained or with a faint pink stain from Dickson's method) up to 3.0mm across. A few fragments include light brown chalk which indicate that the calcite fills veins within a shattered chalk.
- Chalk. Rare rounded fragments of light brown colour up to 1.0mm across
- Quartz. Sparse subangular and rounded grains up to 0.3mm across.

The groundmass consists of dark brown and opaque black optically anisotropic baked clay minerals with sparse angular quartz and rare muscovite up to 0.1mm long.

Interpretation: The calcite has formed as veins within the chalk and the difference in rounding between the chalk and calcite may be simply due to the difference in grain size between the two materials. The colour of the chalk suggests that the source is the Red Chalk which outcrops at the base of the Chalk and is exposed at the foot of the Chalk scarp. The groundmass could be either of Upper Jurassic or Lower Cretaceous clay (the Speeton clay).

Fabric 2

One thin section was classed as Fabric 2. The following inclusion types were noted:

- Sparry Calcite. As Fabric 1
- Glauconite. Moderate rounded fragments of altered glauconite up to 0.3mm across.

The groundmass is similar to that of Fabric 1.

Interpretation: this fabric is definitely produced from the Speeton Clay, probably also the source of Fabric 1 which lacks the diagnostic altered glauconite grains.

Fabric 3

Three thin sections were classed as Fabric 3. The following inclusions were noted:

- Sparry calcite. Abundant fragments as in Fabrics 1 and 2
- Chalk. Sparse fragments as in Fabrics 1 and 2

The groundmass consists of dark brown optically anisotropic baked clay minerals, sparse angular quartz and sparse to moderate non-ferroan calcite microfossils with ferroan calcite infill of their tests, c.0.1mm across.

Interpretation: this fabric is almost identical in appearance to Fabric 1 apart from the presence of the microfossils. No microfossils have been noted in any samples of Bronze Age, Roman or early Anglo-Saxon calcite tempered wares from West Heslerton, all of which were almost certainly produced in the Vale of Pickering (Vince forthcoming). This fabric is therefore either produced from an unusual clay in the Vale of Pickering or may indicate that the samples were produced elsewhere.

IAERR Erratic-Tempered ware (IAERR)

Eighteen samples of this fabric group were thin-sectioned. The thin sections could be grouped into four sub-fabrics which are described separately below. However, only one of these, Fabric 1, is common.

Fabric 1

Eleven samples of this sub-fabric were thin-sectioned. The following inclusion types were noted:

- Basic igneous rock. Moderate angular fragments up to 2.0mm across. These vary in lithology from fine-grained, cryptocrystalline material, sometimes with feldspar phenocrysts to coarse-grained rocks.
- Sandstone. Sparse to moderate angular fragments showing some signs of metamorphism (formation of mosaic quartz around original grain boundaries and straining of original grains).
- Quartz. Abundant angular grains up to 0.2mm across and sparse grains, some with one or more flat faces.

The groundmass consists of optically anisotropic baked clay minerals, moderate angular quartz, and sparse muscovite up to 0.1mm across.

Interpretation: the silty groundmass is similar to those found in pro-glacial and immediately post-glacial lacustrine clays. The character of the inclusions suggests a source to the east of the Wolds.

Fabric 2

Three sample of this sub-fabric were thin-sectioned. The following inclusion types were noted:

- Acid igneous rock. Moderate angular fragments of biotite granite up to 2.0mm across.

- Quartz. At least two of lower Cretaceous origin c.0.5mm across.
- Clay pellets. One subangular fragment containing moderate rounded dark brown grains in the groundmass.
- Flint. Sparse angular grains up to 0.5mm across.

The groundmass consists of optically anisotropic baked clay minerals and sparse angular quartz and rare muscovite laths.

Interpretation: A mixture of biotite granite and inclusions of Jurassic and Cretaceous origin. This suite of inclusions suggests a source close to the west or south scarp of the Wolds, which could include the Melton area.

Fabric 3

Two samples of this sub-fabric were thin-sectioned. The following inclusion types were noted:

- Basic igneous rock. Moderate angular fragments of mixed lithology, up to 1.5mm across
- Fossiliferous limestone. A single subangular fragment present in each section.
- Chalk. A single rounded dark brown fragment 0.8mm across.
- Quartz. Sparse subangular grains c.0.2mm across.
- Sandstone. Moderate angular fragments up to 2.0mm across.

The groundmass consists of dark brown to black optically anisotropic baked clay minerals with sparse angular quartz and moderate subangular dark brown grains less than 0.05mm across.

Interpretation: the groundmass suggests that the clay is derived from a Jurassic clay whilst the inclusions many be from two sources: sparse fragments of possible Jurassic and Cretaceous origin and deliberately added angular sandstone and basic igneous rocks. The groundmass is consistent with a local origin.

Fabric 4

Two samples of this sub-fabric were thin-sectioned. The following inclusion types were noted:

- Basic igneous rock. Moderate angular fragments of mixed lithology, up to 2.0mm across.
- Sandstone. Sparse angular fragments up to 1.0mm across.
- Calcite. A single euhedral void c.1.5mm by 1.0mm probably contained sparry calcite.
- Limestone. Sparse rounded voids up to 1.0mm across include “ghosts” of shell and echinoid shell preserved in the brown clay infilling.

- Organics. Carbonised material is present in some of the laminae and has produced a darkened halo to either side.

The groundmass consists of dark brown to black optically anisotropic baked clay minerals with sparse angular quartz and moderate subangular dark brown grains less than 0.05mm across

Interpretation: very similar to IAERR Fabric 3 in groundmass and general character of the inclusions.

IAFLINT Flint-tempered ware (IAFLINT)

Two samples of this fabric group were thin-sectioned. The following inclusion types were noted:

- Flint. Moderate angular, often very angular, grains up to 1.5mm across.
- Quartz. Sparse angular grains up to 0.5mm across. The majority of these grains are between c.0.05mm and c.0.20mm across.
- “Grog”. Moderate angular grains up to 2.0mm across. Varying in carbon content but otherwise similar to the groundmass.

The groundmass consists of optically anisotropic baked clay minerals with few visible inclusions. The core of both samples is black with a sharp boundary with the oxidized margins.

Interpretation: the flint appears to be either fire-cracked or frost-shattered and deliberately added to the groundmass, which is otherwise very similar to the IAGROG fabric.

IAGROG Grog-tempered ware (IAGROG)

Eleven samples of this group were thin-sectioned. All contain “grog” as their main constituent, other inclusions being sparse. These other inclusions have been used to subdivide the group into two major groups (containing basic igneous rock and angular flint respectively) and four fabrics each containing a single sample.

Fabric 1

The distinguishing feature of fabric 1 is the presence of basic igneous rock fragments. The following inclusion types were noted:

- “Grog”. Abundant fragments up to 3.0mm across. Some of these are opaque and either have a very high carbon content or a clay/iron composition.
- Basic igneous rock. Sparse angular fragments.
- Quartz. Sparse subangular grains up to 0.2mm across.

The groundmass consists of optically anisotropic baked clay minerals, subangular dark brown clay/iron fragments up to 0.1mm across and rare muscovite laths up to 0.1mm long.

Interpretation: the groundmass is similar to that of one of the local fired clay fabrics used at Malton (FCLAY Fabric 2) but basic igneous rock fragments have not been noted in the two thin sections of this fabric. Nevertheless, a very local origin is possible.

Fabric 2

The distinguishing feature of fabric 1 is the presence of angular flint fragments. The following inclusion types were noted:

- “Grog”. As in Fabric 1.
- Flint. Sparse, extremely angular unstained fragments up to 2.0mm long.
- Quartz. Sparse subangular grains up to 0.2mm across.

The groundmass is identical to that of Fabric 1

Interpretation: It is very likely that Fabrics 1 to 5 originate in the same area which, from its similarity to FCLAY Fabric 2 might be very close to the Melton site. Angular flint was not present in FCLAY Fabric 2 but is present in such small quantities that this may not be significant.

Fabric 3

The distinguishing feature of fabric 1 is the presence of quartz sand and basic igneous rock fragments. The following inclusion types were noted:

- “Grog”. As in Fabric 1.
- Basic igneous rock. Sparse angular fragments up to 0.5mm across
- Quartz. Moderate subangular grains up to 0.2mm across.

The groundmass is similar to those of other IAGROG samples.

Interpretation: It is very likely that Fabrics 1 to 5 originate in the same area which, from its similarity to FCLAY Fabric 2 might be very close to the Melton site. Basic igneous rock was not present in FCLAY Fabric 2 but is present in such small quantities that this may not be significant.

Fabric 4

The distinguishing feature of fabric 1 is the presence of shelly limestone fragments. The following inclusion types were noted:

- “Grog”. As in Fabric 1

- Shelly limestone. Sparse angular fragments of large nacreous bivalve shell, some with ferroan calcite infilling of bore holes and some angular fragments composed of angular fragments of large, nacreous bivalve shell with a ferroan calcite cement.

The groundmass is similar to those of other IAGROG samples.

Interpretation: It is very likely that Fabrics 1 to 5 originate in the same area which, from its similarity to FCLAY Fabric 2 might be very close to the Melton site.

Fabric 5

The distinguishing feature of fabric 1 is the presence of opaque fragments. The following inclusion types were noted:

- “Grog”. As in Fabric 1.
- Opaques. Moderate angular fragments of similar shape and size to the “Grog” fragments but completely opaque.

The groundmass is similar to those of other IAGROG samples.

Interpretation: It is very likely that Fabrics 1 to 5 originate in the same area which, from its similarity to FCLAY Fabric 2 might be very close to the Melton site. The opaque fragments suggest that the parent clay was rich in iron rather or as well as organic matter.

IAGSQ Greensand-quartz-tempered ware (IAGSQ)

This fabric was defined visually by the common presence of water-polished quartz grains of Lower Cretaceous character. In thin section these could be divided into two fabrics.

Fabric 1

The following inclusion types were noted:

- Quartz. Moderate rounded grains c.0.5mm to 1.0mm across, most probably of Lower Cretaceous origin.
- Limestone. Sparse rounded fragments of fossiliferous limestone c.0.3mm to 1.0mm across, including echinoid shell and non-ferroan bivalve shell in a matrix of ferroan calcite.
- Chalk. Rare rounded fragments up to 0.5mm across
- Clay pellets. Sparse dark brown oolitic concretions c.1.0mm across.
- Opaques. Sparse, well-rounded ovoid grains up to 0.5mm across
- Shell. Sparse non-ferroan nacreous bivalve shell up to 1.0mm long.
- Flint. Sparse rounded grains up to 1.0mm across.

The groundmass consists of dark brown, optically anisotropic baked clay minerals, sparse angular quartz and sparse rounded opaque inclusions up to 0.05mm across. Ferroan calcite fills several of the laminae with run parallel to the vessel wall and this is presumably post-depositional.

Interpretation: A Jurassic clay tempered with a mixed rounded sand. The sand includes material of Jurassic, Lower and Upper Cretaceous origin and this combination probably excludes a Lincolnshire Wolds origin for this fabric which probably originated in the area immediately south or west of the chalk outcrop.

Fabric 2

The following inclusion types were noted:

- Quartz. Abundant angular and subangular grains up to 0.2mm across. Sparse well-rounded grains up to 0.2mm across were present. Sparse rounded grains, some of which are probably of Lower Cretaceous origin. Sparse angular grains with one or more flat faces, up to 1.5mm long.
- Organics. Sparse carbonised inclusions up to 1.5mm long and 0.03mm wide.
- Muscovite. Sparse laths up to 0.5mm long

The groundmass consists of opaque black clay minerals, sparse angular quartz and sparse muscovite up to 0.1mm across

Interpretation: the texture of this fabric suggests the use of a lacustrine deposit although similar textures have been observed in samples of clay-rich blown sand from the western slopes of the chalk scarp. The character of the sand inclusions is consistent with a source close to the south or west scarps of the chalk.

Fabric 3

The following inclusion types were noted:

- Calcareous sandstone. Moderate fragments up to 3.0mm across with a ferroan calcite cement and rounded quartz, opaque grains and nacreous bivalve shell fragments.
- Flint. Moderate well-rounded fragments up to 3.0mm long.
- Quartz. Moderate fragments, mostly c.0.2mm to 1.0mm across and of Lower Cretaceous character.
- Mudstone. Sparse, rounded fragments of mudstone with bedding visible. The only inclusions are abundant rounded dark brown grains up to 0.1mm across, as in the groundmass.

The groundmass consists of dark brown optically anisotropic baked clay minerals with abundant dark brown rounded grains up to 0.1mm across.

Interpretation: the calcareous sandstone is either Spilsby Sandstone, which does not outcrop north of the Humber, or the Carstone. A Red Chalk origin can be discounted because of the ferroan calcite matrix. The well-rounded flint fragments are not typical of sands and gravels in the southwestern Lincolnshire Wolds area, where the Spilsby Sandstone has its largest outcrop. The parent clay is of Jurassic character.

IALST Limestone-tempered ware (IALST)

Nine samples of this group were thin-sectioned. Two distinct fabric groups were present whilst one of the samples was leached and could be tentatively assigned to a sub-fabric.

Fabric 1

Fabric 1 contains angular fragments of limestone in a relatively fine-textured groundmass. The following inclusion types were present:

- Fossiliferous Limestone. Moderate angular fragments up to 2.0mm long.
- Calcareous sandstone. Sparse angular fragments up to 1.0mm across
- Opaques. Sparse rounded grains up to 0.5mm across.
- Quartz. Sparse rounded and subangular grains up to 0.2mm across.

The groundmass consists of dark brown to black optically anisotropic baked clay minerals, moderate opaque and dark brown rounded grains up to 0.1mm across and sparse angular quartz up to 0.05mm across.

Interpretation: The limestone and calcareous sandstone are probably different facies of the same formation. They were probably added as angular gravel to a Jurassic clay. The lack of rounding and the lack of variability in the inclusions suggests that the gravel was obtained close to the outcrop.

Fabric 2

Fabric 2 contains angular fragments of limestone and abundant quartz of coarse silt/fine sand grade. The following inclusion types were present:

- Limestone. Moderate angular fragments of fossiliferous limestone similar to that in Fabric 1 and fragments of limestone replaced by dolomite or sparry calcite, both up to 2.0mm across.
- Quartz. Abundant angular and subangular quartz up to 0.3mm across. Sparse rounded quartz up to 0.5mm across, some of which is likely to be of Lower Cretaceous origin.

- Organics. Sparse linear voids up to 1.0mm long.
- Chert. Rare rounded fragments up to 1.0mm across.

The groundmass consists of optically anisotropic baked clay minerals, sparse angular quartz and sparse muscovite laths.

Interpretation: the limestone inclusions were probably added to the clay as a gravel. They are similar but not identical to those found in Fabric 1, suggesting a separate source. The abundant quartz and its character suggest either a lacustrine deposit or blown sand.

IAOOL Oolitic-limestone-tempered ware (IAOOL)

Seven samples of this ware were thin-sectioned. All have a similar character with the following inclusion types:

- Oolitic limestone. Moderate subangular grains up to 1.0mm across
- Quartz. Moderate subangular grains between 0.1mm and 0.2mm across.
- Organics. Sparse organic laminae up to 2.0mm long.

The groundmass consists of optically anisotropic baked clay minerals, abundant dark brown grains up to 0.05mm across with very few other visible inclusions.

Interpretation: the oolitic limestone is probably derived from a colluvial deposit close to the outcrop of the limestone since the grains show slight signs of rounding and were therefore not crushed to use as temper. The groundmass is typical of Jurassic clays.

IASH Shell-tempered ware (IASH)

Six samples of IASH were thin-sectioned. The sections could be grouped into three fabrics characterised respectively by a high proportion of echinoid spine and shell fragments; large nacreous bivalve shell and “grog” fragments and a more silty groundmass.

Fabric 1

The following inclusion types were noted:

- Shelly limestone. Abundant fragments of limestone up to 1.0mm across and individual echinoid spines, sparry ferroan calcite grains, bivalve shell fragments and ostracods shell fragments. The matrix contains moderate dark brown material (clay minerals?) and aggregates of opaque to dark brown grains (faecal material?). These also occur within the bivalve shell and echinoid spines.
- Opaques. Moderate rounded dark brown to opaque grains up to 0.2mm across.
- Quartz. Rare subangular grains c.0.1-0.2mm across

The groundmass consists of dark brown to black, optically anisotropic baked clay minerals, sparse angular quartz and sparse muscovite laths up to 0.1mm long.

Interpretation: The limestone is distinctive and almost certainly of Lower Jurassic age. The opaque grains are probably limonite ooliths which are particular common in the middle Lias deposits to either side of the Humber (e.g. Dales shelly ware). However, in contrast to Dales shelly ware this fabric contains very little quartz silt.

Fabric 2

The following inclusion types were noted:

- Bivalve shell. Moderate angular fragments of nacreous, non-ferroan calcite bivalve shell up to 4.0mm across with bore holes filled with ferroan calcite.
- Limestone. Sparse angular fragments of sparry ferroan calcite, up to 0.5mm across. Some of these have a tabular prismatic structure and may have been a thin covering on the bivalve shell fragments.
- Quartz. Sparse subangular grains up to 0.2mm across and sparse rounded grains up to 0.5mm across.
- Clay/iron. Sparse rounded dark brown grains c.0.2mm across.

The groundmass consists of dark brown optically anisotropic baked clay minerals and sparse angular quartz.

Interpretation: This fabric is extremely similar to that of Mid Saxon, late Saxon and Medieval shell-tempered wares which originate in central Lincolnshire. In those cases, the shell inclusions appear to be from shelly marls and limestones within the Great Oolite or Cornbrash. The strata of equivalent age north of the Humber contain quartz sand absent from those wares (derived from the Kellaways Rock and Kellaways Sand) and this suggests a source north of the Humber. The groundmass is typical of Jurassic clays.

Fabric 3

The following inclusion types were noted:

- Bivalve shell. Sparse fragments of bivalve shell of similar character to those in IASH Fabric 2.
- Ferroan calcite. Sparse rounded fragments up to 0.5mm across.
- Quartz. Sparse rounded grains up to 0.3mm across.
- Clay/iron. Moderate rounded dark brown grains with few inclusions, up to 0.5mm across.
- “Grog”. Moderate subangular fragments up to 2.0mm long, of similar character to the groundmass, including sparse shell fragments.

The groundmass consists of optically anisotropic baked clay minerals with moderate angular quartz and dark brown clay/iron grains up to 0.1mm across. The core is opaque back and the margins dark brown.

Interpretation: The shell and ferroan calcite inclusions may have a similar origin to those in IASH Fabric 2. However, the groundmass has a higher quartz silt and clay/iron content and this fabric may be from a similar but distinct source, or from a source with a variable clay characteristics.

IASLAG Slag-Tempered ware (IASLAG)

Five samples of IASLAG were thin-sectioned. Four of these are remarkably similar and the fifth varies only in the quantity of slag inclusions and therefore all five are included in the same fabric group. The following inclusion types were noted:

- Slag. Sparse (V3860) to moderate angular fragments of vesicular slag. Some fragments consists of glass, varying in colour from colourless to dark brown, with abundant spherical voids up to 0.2mm across and abundant quartz grains up to 0.2mm across whilst others contain crystals of olivine in an opaque matrix, usually with opaque dendrites within the olivine.
- Oolitic limestone. Sparse angular fragments up to 1.0mm across. Similar in appearance to those in IAOOL.
- Quartz. Moderate subangular grains up to 0.2mm across and sparse rounded grains up to 0.5mm across, some of which are probably of Lower Cretaceous origin.
- Clay/iron. Sparse rounded pellets up to 0.5mm across with few visible inclusions.

The groundmass consists of dark brown to black optically anisotropic baked clay minerals with sparse angular quartz inclusions and sparse rounded dark brown to opaque grains up to 0.05mm across.

Interpretation: The slag inclusions show no sign of rounding and are presumably crushed metal-working slag to two types: vitrified quartz sand and clay and fayalite (iron-rich olivine) slag. The quartz sand is likely to be derived from Jurassic and Lower Cretaceous rocks and the groundmass is typical of Jurassic clays. This fabric was therefore probably produced close to the chalk scarp (although neither chalk nor flint are present).

IASST Sandstone-tempered ware (IASST)

Four samples were thin-sectioned. The following inclusion types were noted:

- Sandstone. Abundant fragments up to 1.5mm across.
- Quartz. Abundant subangular grains similar in size to those in the sandstone fragments. Also rare well-rounded grains up to 0.3mm across and rare grains of probable lower Cretaceous origin up to 1.0mm across.

- Flint. Sparse angular fragments up to 0.5mm long.
- Phosphate. Sparse angular fragments up to 0.5mm across. Some of these are clearly post-burial filling of pores but others appear to be original.
- Clay pellets. Sparse angular fragments similar in texture to the groundmass
- Basic igneous rock. Rare angular fragments up to 1.0mm across.
- Shell. Sparse fragments of non-ferroan nacreous bivalve shell up to 1.0mm across with ferroan calcite infilling of fungal borings. These are only present in one section (V3843) but similar-sized and shaped voids in the second section.
- Limestone. Rare rounded voids, up to 1.5mm across, some containing “ghosts” of ooliths.
- Clay/iron. Moderate rounded and subangular dark brown fragments up to 0.3mm across. Also one large concretion of similar appearance but 2.0mm across.

The groundmass consists of optically anisotropic baked clay minerals, sparse angular quartz grains up to 0.05mm across and dark brown grains from c.0.05mm upwards. The texture of this fabric is blocky indicating that the clay was mixed when crumbly. Within the individual blocks the texture has a preferred direction but since these blocks include shell fragments they are unlikely to represent relict fragments of the parent clay.

Interpretation: The range of inclusions present is very similar to that of IAERR Fabrics 1, 3 and 4 but the relative proportions are quite different as is the character of the groundmass which is clearly derived from a weathered Jurassic mudstone. It is unlikely that the basic igneous rocks were deliberately added and they therefore either indicate that the parent rock was a glacial till or that a glacial-derived gravel was used to temper a Jurassic clay or perhaps that a more complex interpretation is required. Perhaps a weathered Jurassic mudstone was contaminated by overlying fluvio-glacial sands and then tempered with crusted/fired-cracked sandstone.

LOOL Oolitic limonite-tempered ware (LOOL)

Eight samples of this fabric were thin-sectioned. They can be divided into two fabrics based on the character of the limestone inclusions and then further subdivided on the basis of the texture of the groundmass, giving four fabric groups. However, only one of these, Fabric 1, is represented by more than one section.

Fabric 1

The following inclusion types were noted:

- Fossiliferous limestone. Abundant subangular or rounded fragments up to 2.0mm long. These include fragments of large nacreous bivalve shell but in the main consist of ferroan calcite matrix with abundant micrite pellets surrounding shell and other fossil nuclei, all partially replaced by opaque material.

- Quartz. Sparse subangular grains up to 0.2mm across.
- Opaques. Sparse rounded ovoid grains up to 0.4mm long.

The groundmass consists of optically anisotropic baked clay minerals, moderate angular quartz up to 0.05mm and limestone fragments up to 0.1mm across.

Interpretation: the limestone fragments appear to be a detrital sand although the angularity of the fragments in most sections suggests that the source rock was not any great distance away. The iron replacement indicates that this rock was probably a middle Lias ironstone, such as the Frodingham ironstone in the Scunthorpe area or its equivalent north of the Humber. The character of the groundmass indicates that the parent clay was calcareous but the lack of opaque inclusions might suggest that it was not derived from weathering of (or a mudstone facies within) the same formation. The middle Lias mudstones are, however, more silty that other lower Jurassic clays in this area. The most likely source for the clay is therefore the Scunthorpe Mudstones formation (1992, 32-36) which outcrops on both sides of the Humber.

Fabric 2

The following inclusion types were noted:

- Fossiliferous limestone. Moderate subangular fragments similar to those in LOOL Fabric 1.
- Quartz. Sparse subangular grains similar to those in LOOL Fabric 1.
- Opaques. Moderate rounded grains up to 0.5mm across.

The groundmass consists of optically anisotropic baked clay and abundant angular quartz and moderate limestone fragments up to 0.1mm across.

Interpretation: This is probably a siltier variant of Fabric 1 and could come from the same source.

Fabric 3

The following inclusion types were noted:

- Fossiliferous Limestone. Moderate angular fragments up to 2.0mm across composed of sparry dolomite or calcite in which ghosts of the original fossil content (mostly nacreous bivalve shell) survive.
- Sandstone. Sparse fragments up to 1.0mm across. The rock contains poorly sorted subangular quartz grains in an opaque groundmass.

- Quartz. Abundant subangular fragments up to 0.2mm across and sparse rounded grains up to 0.5mm across, including some of probably Lower Cretaceous origin.

The groundmass consists of dark brown to black, optically anisotropic baked clay minerals, sparse angular quartz and sparse muscovite up to 0.1mm long.

Interpretation: this fabric should probably not be included in the LOOL group since no oolitic iron ore inclusions are visible in thin section. The limestone might be of Permian age but is much more likely, given the presence of Lower Cretaceous quartz, to be of Jurassic origin. The sandstone might be a Jurassic ironstone, such as the Northampton sands, or recent iron panning. The quartz sand and clay groundmass are similar to others from Melton which appear to be either lacustrine or aeolian in origin.

Fabric 4

The following inclusion types were noted:

- Fossiliferous limestone. Abundant fragments up to 2.0mm across. The rock contains nacreous bivalve shell, echinoid shell and echinoid spines all partially replaced by sparry dolomite or calcite. This process, however, is less advanced than in Fabric 3 and is mainly shown by the lack of Dickson's staining and the development of a single extinction orientation for the whole fragment. Opaque grains up to 0.05mm across occur separately and as aggregates both within fossils (such as echinoid spines and shell fragments, especially on or close to the surfaces) and in the groundmass.
- Quartz. Sparse subangular grains up to 0.2mm across.

The groundmass consists of optically anisotropic baked clay minerals, moderate angular quartz up to 0.05mm across, moderate limestone fragments up to 0.1mm across and moderate dark brown to opaque rounded grains up to 0.05mm across.

Interpretation: it is arguable whether this fabric should be classed as LOOL, since it contains no oolitic iron ore fragments. The limestone is clearly similar to that found in IALST and is probably of lower Jurassic origin. The character of the groundmass is similar to that of LOOL fabrics 1 and 2 and probably of similar, middle Lias, origin.

Chemical Analysis

The ICPS data for each fabric group defined through petrological study was examined using a standard protocol:

Firstly, the values for each element were examined to determine whether or not any lie more than 4 SD from the mean, If so, an attempt was made to interpret the result. For example, it might be due to a single large grain high in a particular element, such as zirconium in zircon or to post-burial contamination or leaching). If no such explanation was possible, and especially if more than one element is involved, the possibility that the sample comes from a chemically-distinct group was considered. This might either be interpreted as a sub-group within the petrological group or as evidence that despite similar petrological characteristics the sample came from a different source.

For those samples which passed this first test, the data was then compared with that from the fired clay to see whether or not the fabric group could have been produced locally.

Finally, the data were compared with that from related wares, both from the Melton site and elsewhere and conclusions drawn over the likely geological origin of the clay and inclusions.

EBAERR

The ICPS data show that the sample has Al, Na and Cr values which are significantly different from FCLAY Fabric 1 but that all measured elements are within 4 SD of the mean for FCLAY Fabric 2 and for IAERR Fabric 1.

Factor analysis also fails to find any distinction between EBAERR and IAERR Fabric 1.

EBAGROG

The ICPS data shows that the EBAGROG sample has a higher Al value than FCLAY Fabric 1 and that this is more than 4 SD from the mean. All measured elements are within 4 SD of the mean for FCLAY Fabric 2 and for IAGROG Fabrics 1 to 4 (Fabric 5 has higher Fe and K).

Factor analysis, however, indicates a difference between the fired clay and grog-tempered samples (Fig 1) but confirms that there is no distinction between the Bronze Age and Iron Age samples. The IAGROG Fabric 5 sample is an outlier in this analysis, as a result of the Fe and K values.

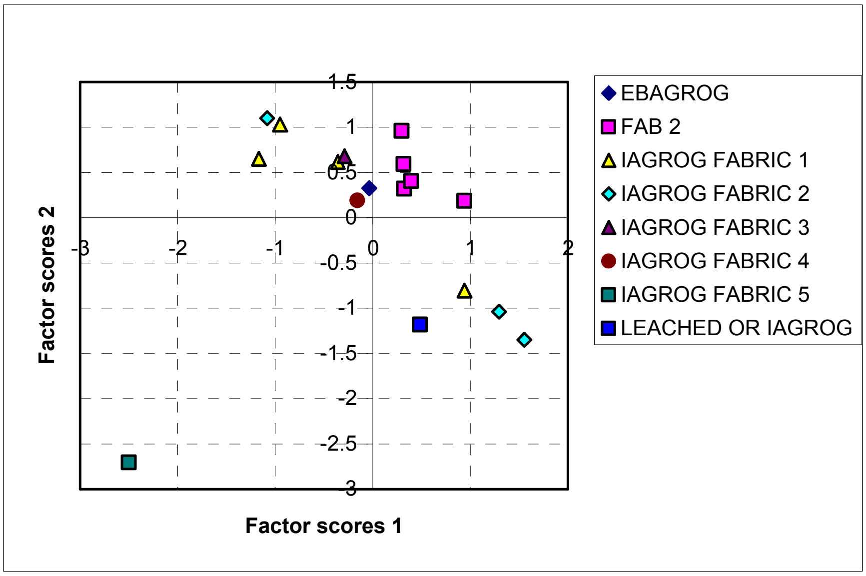

Figure 1

IACALC

The ICPS data shows that the IACALC samples do not significantly differ from either FCLAY Fabric 1 or Fabric 2 (apart from one Fabric 2 sample which has significantly higher Mn).

However, Factor analysis reveals that IACALC Fabric 3 can be distinguished from IACALC Fabrics 1 and 2 by its F1 scores whilst the F3 scores distinguish the fired clay fabrics from the calcite-gritted samples. The IACALC Fabric 3 samples also have slightly different F3 scores from IACALC Fabrics 1 and 2. These results indicate that IACALC is not a local product and that the petrological difference between Fabric 3 and Fabrics 1 and 2 is reflected in chemical composition but the difference between Fabrics 1 and 2 is not.

The IACALC data were then compared with a range of calcite-tempered ware samples from sites in Yorkshire. Most of these are of late Roman date (Elloughton, West Heslerton and West Lilling) whilst the samples from Ferrybridge and Kexby are apparently prehistoric but poorly-dated. The samples from Reighton are of definite Iron Age date. Factor analysis indicates that the Melton Fabric 1 and 2 samples have similar compositions to the Roman calcite-tempered ware and the putative prehistoric samples from Ferrybridge. Three of the four Reighton samples, however, are distinguished by high F1 scores. The Melton Fabric 3 samples, together with those from Kexby and three from West Heslerton have higher F2 scores than the majority of the comparanda (Fig 2). The F3 scores distinguish the Kexby samples (which are all heavily leached) from the remainder. These results suggest that IACALC Fabrics 1 and 2 are certainly Vale of Pickering products, being indistinguishable from Roman wares produced in the vicinity of Malton. However, Iron Age samples from Reighton, at the east end of the Vale of Pickering, appear to have a different composition as do samples from Kexby and the Melton IACALC Fabric 3. It is possible, therefore, that the Kexby and Melton IACALC Fabric 3 samples come from a different source, perhaps in the Vale of York. The calcite seems to have filled fractures in the chalk and the chalk in the Melton area itself is heavily fractured. However, this appears to be relatively recent (but pre-glacial) and superficial faulting and more massive, and earlier, faults occur more frequently in the northern part of the chalk outcrop (1992, 106-8). These are probably the source of the calcite found in these fabrics.

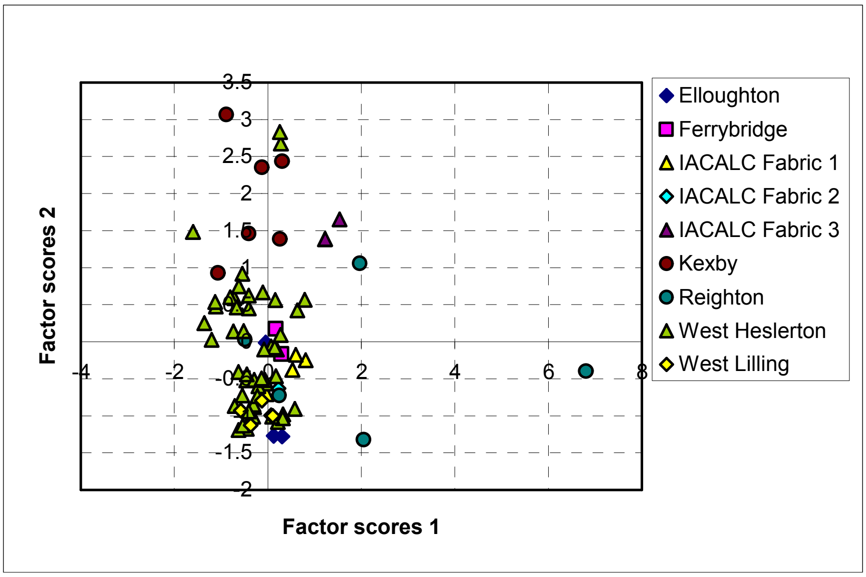

Figure 2

Figure 3

IAERR

The ICPS data shows that most of the IAERR Fabric 1 samples significantly differ from both FCLAY Fabric 1 and FCLAY Fabric 2.

Similarly, IAERR Fabrics 2 to 4 also include some samples which are significantly different from the local fired clay fabrics.

Factor analysis of the fired clay and IAERR samples found four factors which between them also distinguish the local fired clay samples from the pottery samples. The main distinguishing elements are Fe and Co, both of which are lower in six of the IAERR Fabric 1 samples than in the remainder. However, even the remaining IAERR samples which are more similar to the local fired clays can be distinguished from those clay samples. Thus, none of the IAERR samples are likely to be made as close to Melton as the fired clay. One of the IAERR Fabric 2 samples is also clearly separated from the remainder whilst the two other fabrics, IAERR Fabrics 3 and 4, are similar to IAERR Fabric 1. .

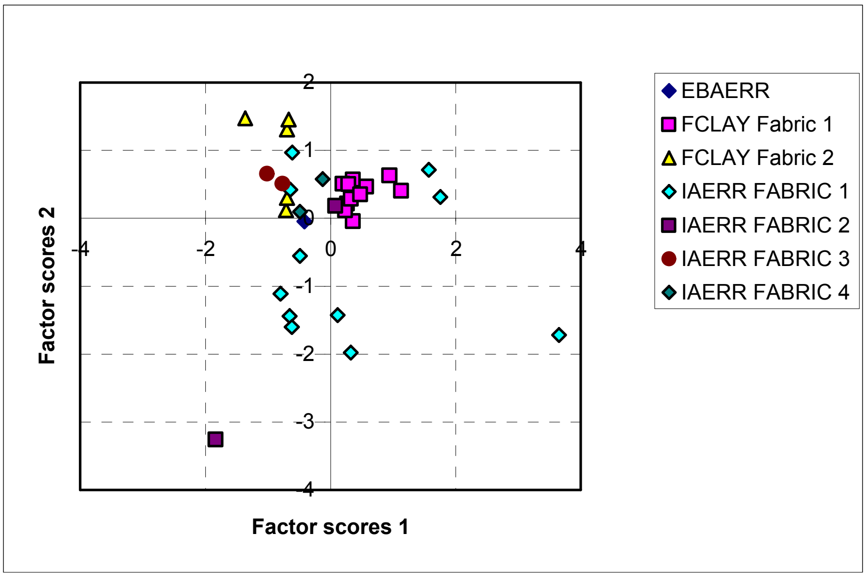

Figure 4

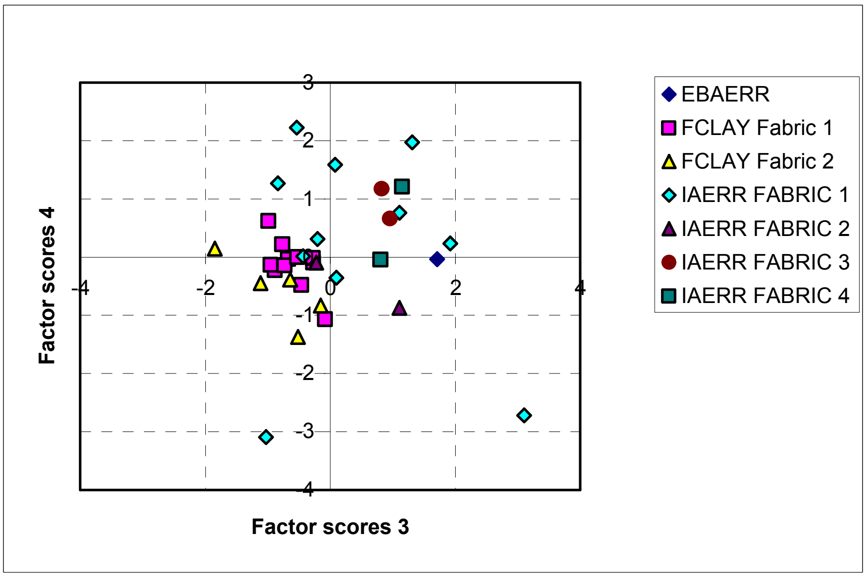

Figure 5

IAFLINT

The ICPS data shows that the two IAFLINT samples do not significantly differ from either FCLAY Fabric 1 or FCLAY Fabric 2. However, factor analysis clearly separates these groups (Fig 6). This appears to be due to lower rare earth element values and higher zirconium in the flint-tempered samples. This appears to show conclusively that IAFLINT was not produced from local clays.

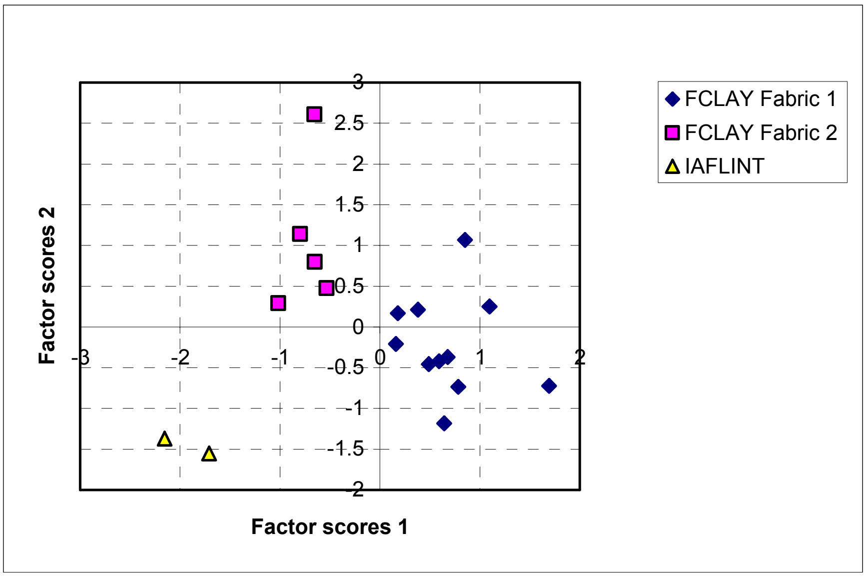

Figure 6

IAGROG

The various IAGROG samples mainly have similar values to the FCLAY Fabric 1 and 2 samples, with the exception of IAERR Fabric 5, mainly in the Fe; and K values.

Factor analysis of these samples, indicates that the FCLAY Fabric 1 samples can be distinguished from the remainder but the FCLAY Fabric 2 samples are indistinguishable from the IAGROG Fabric 1-4 samples whilst the IAGROG Fabric 5 sample is an outlier. This suggests that most of the IAGROG samples could be of local origin.

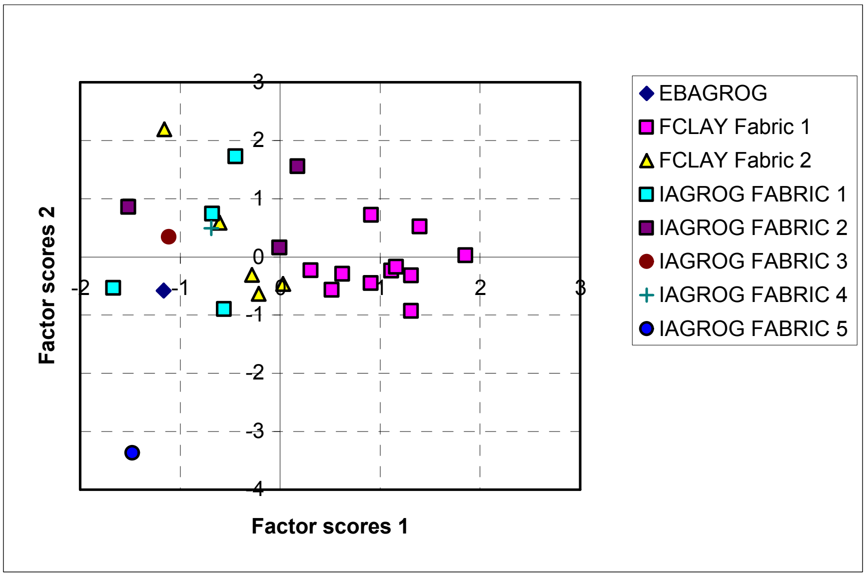

Figure 7

IAGSQ

The IAGSQ samples have similar values for all elements to the FCLAY Fabric 1 and 2 samples, with the exception of IAGSQ Fabric 3.

Factor analysis distinguishes all three IAGSQ fabric groups from the fired clays although in most cases only a combination of factors will distinguish the fabric groups. Fabric 3, however, can be distinguished by its F3 score. These results are consistent with the conclusions of petrological analysis and suggest that IAGSQ Fabrics 1 and 2 were produced north of the Humber, but not as close to the Melton site as the fired clay whilst Fabric 3 may be non-local.

Factor analysis of the Melton IAGSQ samples together with those from various sand-tempered wares (mostly early to Anglo-Saxon in date) which include polished quartz grains. These come from sites in the Vale of York; western Lincolnshire, on either side of the Jurassic ridge; the Lincolnshire Wolds and South Yorkshire (Doncaster). In most cases these samples are from fabrics which stand out from the remainder of the assemblages and are likely to be regional imports. Fabric 4 scores appear to distinguish samples from sites south of the river from those from sites to the north, and all of the Melton samples fall into that north-of-the-Humber group. Otherwise, there is little patterning in the data and little difference in the scores assigned to the three different Melton fabrics (Fig 8). It does, however, seem likely that Melton IAGSQ Fabrics 1 and 2 were produced north of the Humber whilst IAGSQ Fabric 3 (whose plot in Fig 8 is obscured by two others, one from a site north of the river and the other from a site in Lincolnshire, could be from either north or south.

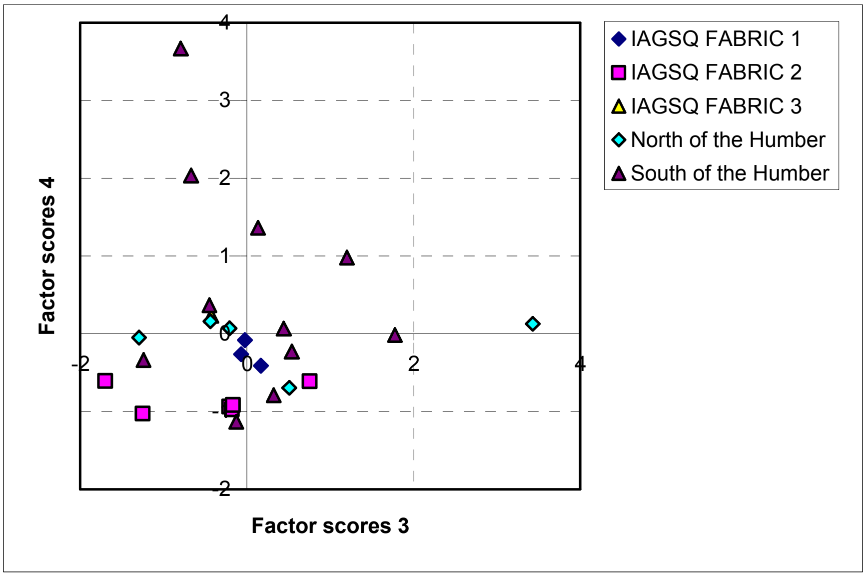

Figure 8

IALST

The ICPS data for the nine IALST samples mainly have element values with 4 SD of the group mean. The exceptions are Zn in V3893 and Sc in V3896.

Factor analysis of the IALST and fired clay samples reveals five factors of which the first two together separate the two fired clay fabrics from each other and from the IALST samples. None of the other factors clearly separate any of the fabrics and there is no clear distinction between the two IALST fabrics. The ICPS data therefore suggests a non-local source for the IALST fabric but does not support the petrological conclusion that the two IALST fabrics come from separate sources.

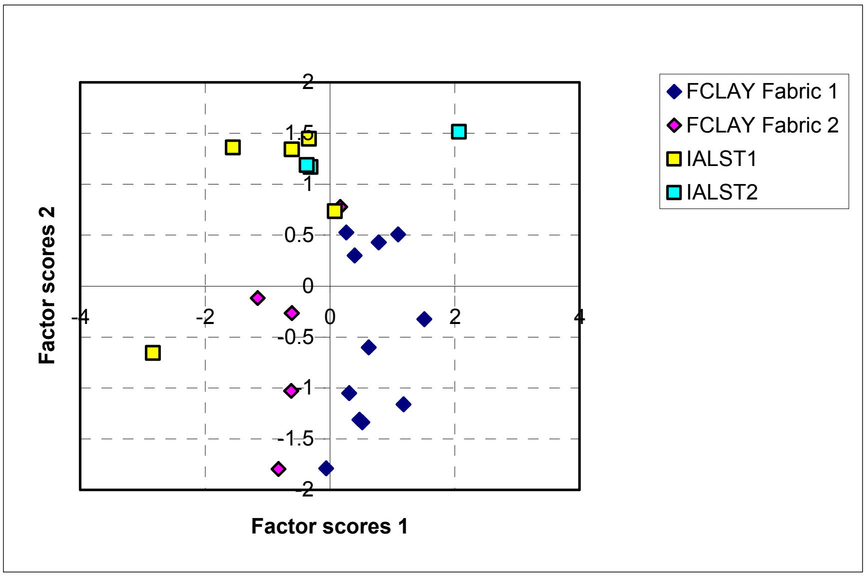

Figure 9

IAOOL

The ICPS data from the six IAOOL samples mainly have element values within 4 SD of those found in the local fired clays. The exception is the zirconium value found in one of the IAOOL samples.

Factor analysis of this data, however, reveals five factors, of which the second clearly distinguishes the IAOOL from the fired clay samples. Examination of the data suggests that the IAOOL samples are distinguished mainly by higher V and Sc and by lower Na (Fig 10).

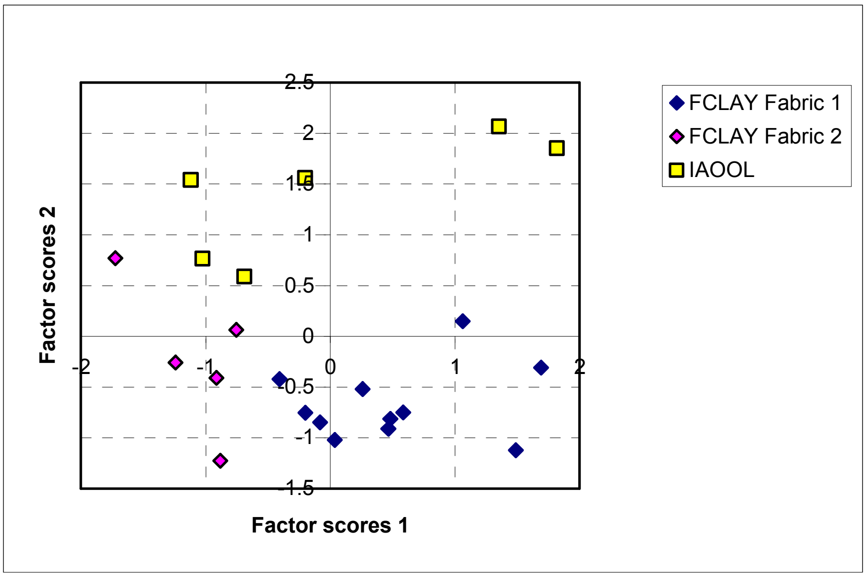

Figure 10

IASH

Apart from a high P value in one of the IASH samples, their ICPS results are within 4 SD of the mean for the local fired clays.

Factor analysis of the IASH data alongside that from the fired clays indicates that IASH Fabric 1 is distinguished from the local clays but that IASH Fabrics 2 and 3 are similar to FCLAY Fabrics 2 and 1 respectively. A similar result is obtained from the fourth factor, which distinguished IASH Fabric 1 from the FCLAY Fabric 1 samples and IASH Fabrics 2 and 3, but not in this instance from the FCLAY Fabric 2 samples, two of which also have high F4 scores. The ICPS data therefore suggests that IASH Fabric 1 was not locally-produced but that IASH Fabrics 2 and 3 are made from similar raw materials and might be locally-produced.

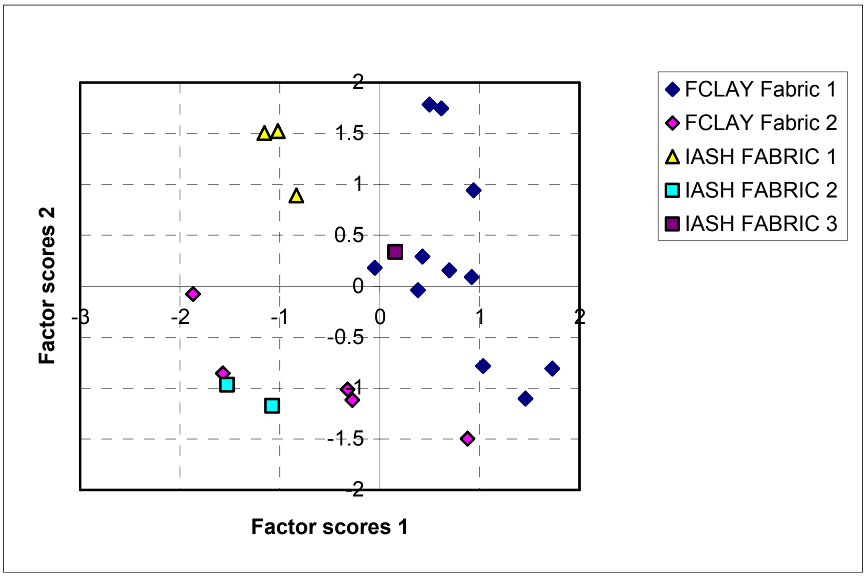

Figure 11

IASLAG

Two of the five IASLAG ICPS samples have element values in excess of 4 SD from the group mean for the IASLAG and local fired clays. These elements (Mn and Ni) were possibly introduced with the slag.

Factor analysis of the IASLAG and fired clay data revealed five factors, of which Factor 2 distinguished four of the IASLAG samples from the remainder. The fifth sample has F1 and F2 scores intermediate between the two fired clay fabrics (Fig 12). The high F2 scores are due to Fe, Cr, Zr and V. Three of these elements (Fe, Cr and V) are likely to have been present in the slag and therefore it is possible that the Zr too is present in the slag. Repeating the factor analysis whilst omitting these elements shows that the remaining elements are in similar frequencies and proportions to those found in the fired clays. Four of the samples plot with FCLAY Fabric 2 and one with FCLAY Fabric 1 (Fig 13). This suggests that IASLAG was probably produced locally and that slag with a higher Zr content that the local clays was crushed and added to the local clays. The IASLAG data was then compared with those from IAERR Fabric 1 and IAFLINT, both of which have a similar groundmass. This demonstrated that the IASLAG samples have a similar composition to the IAERR Fabric 1 samples but that the IAFLINT samples are distinctly different.

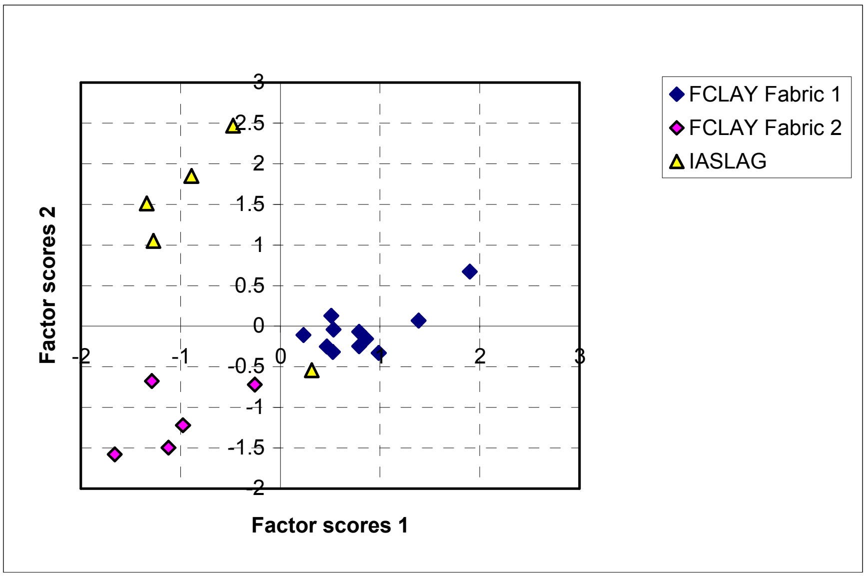

Figure 12

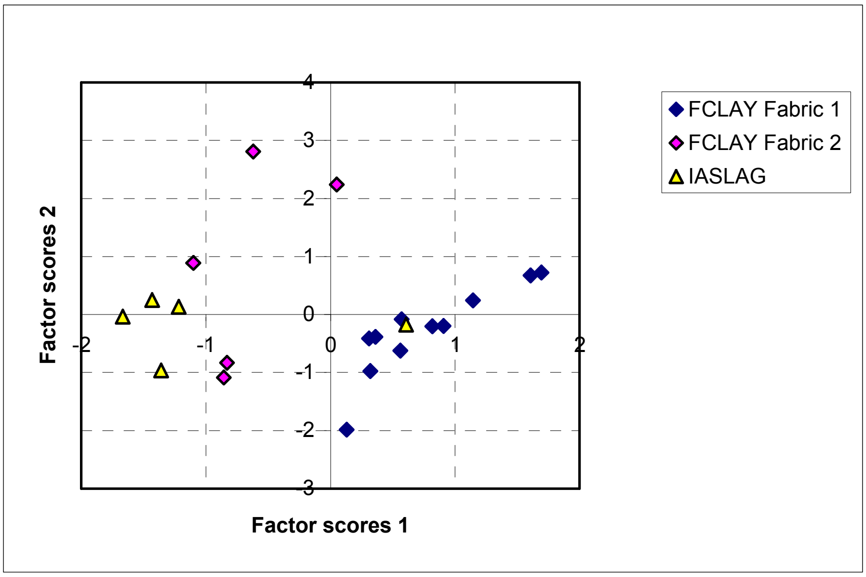

Figure 13

IASST

One of the four IASST ICPS analyses has element values which are more than 4 SD from the group mean for IASST and the fired clay samples. These are for Fe, Mg, K, Zn and four rare earths. One other IASST sample has a significantly high V value.

Factor analysis revealed four factors, of which the first two together distinguish the IASST samples from the two local fired clay fabrics (Fig 14).

Factor analysis of the IASST data together with IAERR (all fabrics) and IAGROG (all fabrics) revealed that the IAGROG Fabric 5 sample forms an outlier but that the remaining samples form a single cluster.

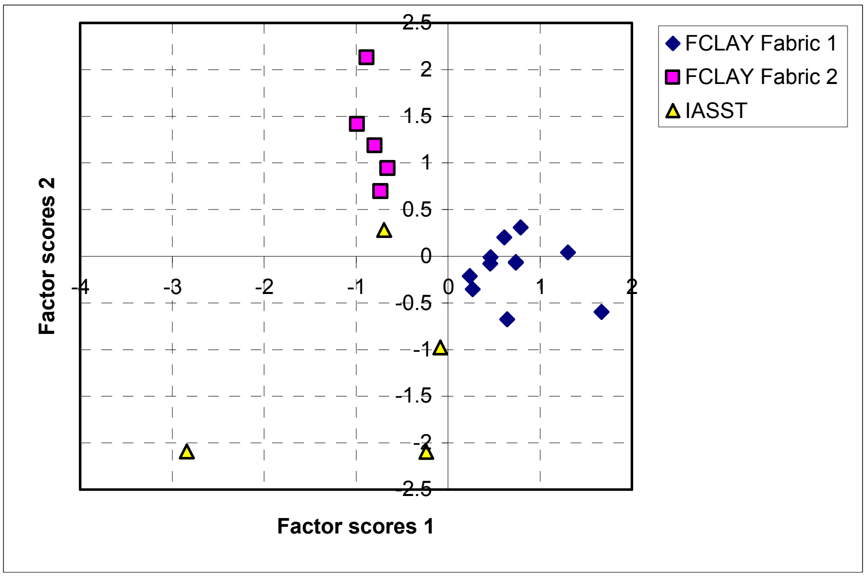

Figure 14

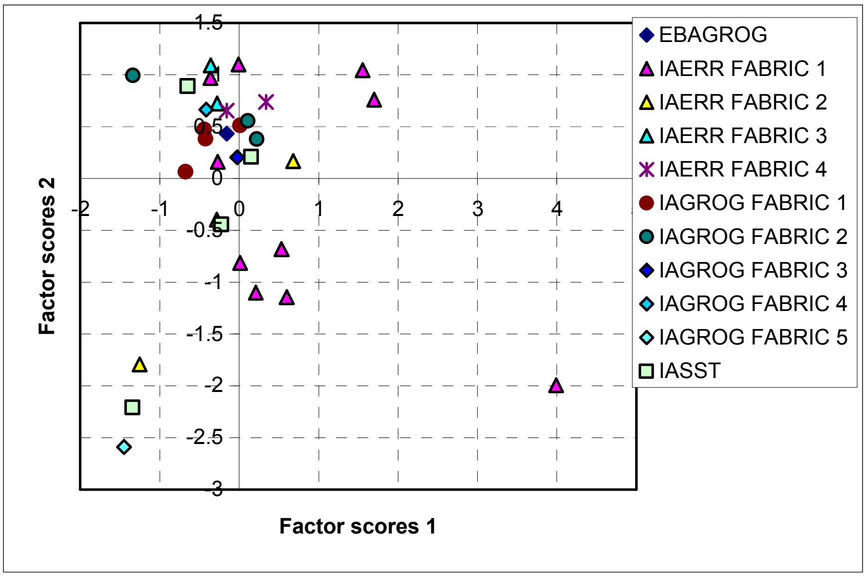

Figure 15

LOOL

Four of the LOOL samples have element values which are significantly different from the mean for the LOOL and local fired clay samples.

However, factor analysis of this data revealed four factors, none of which distinguished the majority of the LOOL samples from the local fired clays.

The LOOL data was then compared with that from three samples of LOOL from Elloughton and a series of samples of Roman Dales shelly ware. These include the standard micaceous silty fabric, probably a north Lincolnshire product (DWSH Fabric S) as well as a group of samples of probable Lincolnshire origin (DWSH SW Lincs Wolds). Factor analysis of this data reveals that the Dales shelly ware Fabric S samples are distinguishable from the remainder (together with the sample of LOOL Fabric 2) but that the remaining LOOL samples and the Lincolnshire Wolds Dales shelly ware form a single group. These results are contrary to the petrological analysis which links LOOL Fabric 2 with LOOL Fabric 1 and suggests a lower Jurassic source north of the Humber. They do, however, show that it is unlikely that LOOL is the earlier predecessor to Dales shelly ware.

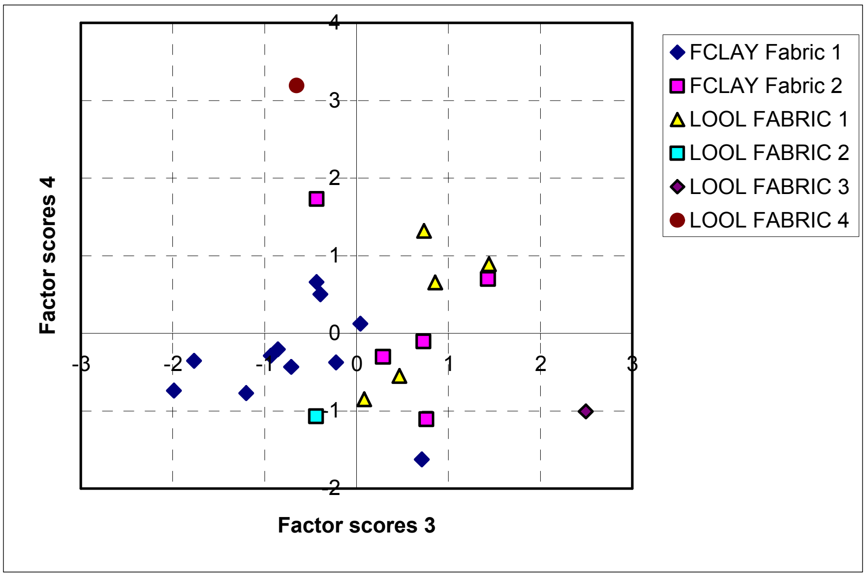

Figure 16

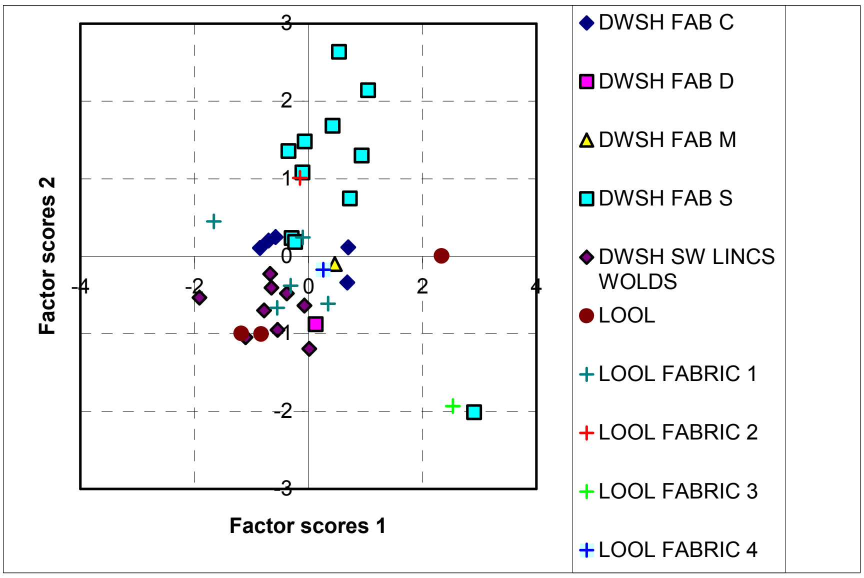

Figure 17

Conclusions

Source

The Melton site sits on gravels and even the deepest ditches hardly penetrate below this. Therefore potting clay and clay for use as daub, loom weights and ovens had to be sought elsewhere. It is reasonable to assume that the fired clays, which had to be brought to the site in an unfired state would have been collected from the closest sources. Where the pottery fabrics have similar characteristics to the fired clays it is likely that these too were locally produced and certainly, in those cases, we cannot prove that the pottery was brought to the site in a finished state.

The closest matches between the fired clays and the pottery come from FCLAY Fabric 2, which is closely matched in appearance in thin section with EBAGROG and IAGROG as well as with IAERR Fabric 1, IASLAG and IAFLINT. It is assumed that since the FCLAY fabric 2 clay is of Jurassic character and obviously obtained fairly close to Melton that it is either the Upper Jurassic Ancholme clay or a boulder clay derived in its entirety from this clay. The lower part of the Ancholme Clay Group contains more silt than the upper part and the sparse subangular quartz seen in many of the Melton fabrics may therefore originate in the parent clay (1992, 62-69). Fig 00 shows the outcrop of Ancholme clay, but most of this outcrop is actually obscured by thick quaternary deposits. Even so, the entire outcrop of Ancholme Clay north of the Humber is no more than 2km wide and 10km from north to south and these fabrics must have been produced within a day’s walk of the Melton site, although we cannot say from this evidence whether the pottery was made by the inhabitants or in a neighbouring community nor, whether its production was carried out by specialists or on a household by household basis. The slag-tempered pottery, IASLAG, also has a number of petrological characteristics which suggest a similar, very local, source.

The chemical composition of these “local” fabrics indicates that most can be distinguished from the local clays, although in some cases this is probably due to the nature of the inclusions (as with IASLAG). Factor analysis, excluding elements which may have been present in added slag, indicates that there is some patterning within these “local” fabrics. One group is most similar to the sandy fired clay, Fabric 1. It includes the samples of IAGSQ Fabric 2; IAERR Fabric 1 and one of the IASLAG samples. The other group is more similar to the fine-textured fired clay, Fabric 2. It includes samples of the two Early Bronze Age fabrics; IAGROG, the minor IAERR fabrics (2-4); the two IAFLINT samples; IAGSQ Fabrics 1 and 3; the majority of the IASLAG samples and the IASST samples.

At the base of the Ancholme Clay group is the Kellaways Beds formation. This includes the Kellaways rock, a calcite-cemented sandstone, which is a possible candidate for some of the calcareous sandstones seen in thin section. This sandstone overlies the Kellaways Clay, which varies from a dark grey mudstone to the south of the Humber to a silty mudstone or sand to the north. Much of the subangular quartz seen in the Melton thin sections may originate in this deposit and is much more common than the calcareous sandstone inclusions.

The Middle Jurassic Redbourne Group north of the Humber consists mainly of the Cave Oolite Member. This member has been subdivided by Gaunt into three and the oolitic limestone fragments found in IAOOL and, rarely, in other fabrics are best paralleled by the upper part of the member containing, as they do, examples of tall thin gastropod shells (nerineids). It may be significant that two components of the Redbourne Group which do not outcrop north of the Humber, the Northampton Sands and the Cornbrash, both of which include distinctive rocks, are apparently not represented in the Melton thin sections. The Cave Oolite outcrops within to the west of Melton and the interpretation of the IAOOL thin sections suggests that they were made from materials collected on or very close to this outcrop.

Factor analysis indicates that this group is distinguishable from the sandy “local” group defined above and is more similar to, but still distinguishable from, the finer local group. The distinguishing elements are Ti, Sc and the rare earth elements.

Further to the west the Lower Jurassic Lias Group outcrops. This is probably the source of the IALST, IASH Fabric 1, and LOOL fabrics. There is no clear difference in the chemical composition of these wares.

The sparry calcitic limestone with traces of the original shell fauna, including echinoids, and the fossiliferous limestone with echinoid shell and spines are probably from the Scunthorpe Mudstone formation (1992, 32). The sparry limestones (formerly called the Hydraulic Limestones) account for a greater proportion of the upper than the lower part of the formation and are thicker and more prominent north of the river than south.

The iron-rich ooliths found in LOOL, probably come from one of the ironstones within the Scunthorpe Mudstones Formation, such as the Frodingham Ironstone, or from the younger Pecten Ironstone or Marlstone Rock. All three outcrop as narrow bands running south-North from the Humber towards Market Weighton (1992, 32-44).

However, in each of these cases similar deposits outcrop north and south of the Humber, and are better developed to the south. Establishing exactly where these fabrics might have been produced, within this area, is difficult but it may be significant that some contain sparse inclusions of Cretaceous origin (flint, chalk, polished quartz grains) and these are likely to have been present in higher frequencies to the north of the river. Conversely, most fabrics produced on the Jurassic strata to the south of the river include at least some grains of Triassic origin, as a result of contamination with windblown sand derived from the Trent valley. These are rare or absent in any of the Melton fabrics which again suggests a source to the north of the Humber. These factors suggest a source north of the Humber but much of the potential outcrop is obscured by Quaternary deposits and whereas in theory even the lowest strata of the Lower Jurassic outcrop less than 10km from Melton it is likely that exposures of these rocks were more distant, perhaps even to the north of the wetland deposits around Holme upon Spalding Moor.

The fact that these various wares all contain rocks originating in the Lower Jurassic, probably all to the north of the Humber, raises the possibility that the fabrics are an artificial division of a single production centre where clay was collected over an area wide enough to span several different Lower Jurassic outcrops. Without considerable further work it is unlikely that it would be possible to establish how far part these different clay and temper sources were but differences in the chemical composition and texture in thin section do indicate that it is not just the inclusions in these ware which differ but that the clays too were collected from chemically and lithologically distinct outcrops.

It is possible that in the Iron Age this area specialised in the production of pottery and that neighbouring settlements in the area might have shared that specialisation, but it is just as possible that the source of clay and temper changed over time but that only one community was involved.

The Quaternary and Jurassic clays which outcrop north of the Humber and to the south and west of the Chalk account for the majority of the fabrics found in the prehistoric period at Melton but there are two fabrics which are probably non-local, IACALC and IAGSQ Fabric 3. In both cases there is some support for the petrological conclusion from the analysis of the ICPS data.

Bibliography

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Appendix 1

TSNO	drawing no	cname	trench	Context	subfabric	Form	Use
V3795	1	IASST	01	4375		JAR	SOOTED EXT
V3818	0	IAERR	17	5931	IAERR FABRIC 2	JAR	
V3819	75	IAOOL	20	3905		JAR	LEACHED INT/RIM
V3820	76	IALST	20	3487	IALST2	JAR	SOOTED EXT; BLACK DEP INT
V3823	83	LOOL	20	3368		JAR	SOOTED EXT; BLACK DEP INT
V3824	80	LOOL	20	3368		JAR	SOOTED EXT; BLACK DEP INT
V3825	81	IAERR	20	3368	IAERR FABRIC 1	JAR	SOOTED EXT; BLACK DEP INT; SPALLING ON RIM/NECK
V3826	0	IAGSQ	20	3798	IAGSQ FABRIC 2	JAR	SOOTED EXT; BLACK DEP INT
V3827	0	IAGROG	20	4022	+IRONSTONE	JAR	
V3828	0	IAGSQ	20	3801	IAGSQ FABRIC 2	JAR	SOOTED EXT; LOST SURFACE INT
V3829	22	IALST	3	3362	IALST1	JAR	
V3830	0	IAERR	3	3362	IAERR FABRIC 1	JAR	SOOTED EXT
V3833	0	IASH	4	2587	IASH FABRIC 3	JAR	

V3834	0	IAGSQ	4	2732	IAGSQ FABRIC 2	JAR	BLACK DEP INT
V3835	0	LOOL	4	2734		JAR	
V3836	1	IASST	4	2791		JAR	BLACK DEP INT; LEACHED INT
V3837	0	IASH	4	2819	IASH FABRIC 2	JBNAT	
V3838	0	IAGSQ	4	2819	IAGSQ FABRIC 1	JAR	SOOTED EXT; WHITE DEP INT
V3839	0	IAGSQ	4	2819	IAGSQ FABRIC 1	JAR	BLACK DEP INT
V3840	0	IAGSQ	4	3225	IAGSQ FABRIC 2	JAR	
V3841	4	IAERR	4	3309	IAERR FABRIC 1	JAR	SOOTED EXT
V3842	5	IALST	4	3309	IALST2	JAR	SOOTED EXT; BLACK DEP INT; LEACHED AT BOTTOM
V3843	1	IASST	4	3348	+SHELL	JAR	BLACK DEP INT
V3844	0	LOOL	4	3576		JAR	SOOT UNER RIM
V3845	6	IALST	4	3576	IALST2	JAR	SOOTED EXT; LEACHED LOWER INT
V3846	0	IASLAG	4	3945		JAR	
V3848	0	IAERR	4	3948	IAERR FABRIC 1	JAR	SOOTED EXT
V3849	0	IASLAG	4	3949		BOWL	
V3850	1	LOOL	4	3954		JAR	SOOTED EXT; BLACK DEP INT

V3851	0	IASLAG	4	3954		JAR	
V3852	0	IASLAG	4	3979		JAR	BLACK DEP INT
V3853	0	IAERR	4	3948	IAERR FABRIC 1	JAR	
V3854	0	IAGSQ	4	3948	IAGSQ FABRIC 1	JAR	SOOTED EXT; BLACK DEP INT
V3855	0	IAOOL	4	3948		JAR	SOOTED EXT
V3856	0	LOOL	5	1297		JAR	SOOTED EXT
V3857	0	IAERR	5	1336	IAERR FABRIC 2	JAR	SOOTED EXT
V3858	0	IAGSQ	5	1336	IAGSQ FABRIC 3	JAR	
V3859	0	IAGROG	5	1392	IAGROG FABRIC 1	JAR?	
V3860	0	IASLAG	5	1417	WAS IAERR	JAR	SOOTED EXT
V3861	0	IAGROG	5	1445	IAGROG FABRIC 2	JAR	
V3864	0	IAGROG	5	1457	IAGROG FABRIC 1	JAR	
V3866	0	IAERR	5	1471	IAERR FABRIC 3	JAR	BLACK DEP INT
V3868	30	IAERR	5E	5122	IAERR FABRIC 1	JAR	
V3869	28	IAERR	5E	5128	IAERR FABRIC 4	JAR	SOOTED EXT; BLACK DEP INT
V3870	0	IAERR	5E	5181	IAERR FABRIC 1	JAR	SOOTED EXT; BLACK DEP INT

V3872	1	IASST	5E	5218		JAR?	
V3873	0	IAFLINT	5E	5229	IAFLINT	JAR	BLACK DEP INT
V3875	0	IAFLINT	5E	5240	IAFLINT	JAR	
V3876	0	IAGROG	5E	5479	+SHELLY LST	JAR	BLACK DEP INT
V3877	0	IACALC	5E	5491		JAR	
V3878	0	IAGROG	5E	5907	IAGROG FABRIC 2	JAR	BLACK DEP INT
V3879	0	IAERR	7	2831	IAERR FABRIC 1	JAR	
V3883	37	IAERR	8	2886	IAERR FABRIC 3	JAR	
V3886	44	IALST	8	1599	IALST1	JAR	BLACK DEP INT
V3888	46	IAERR	8	2717	IAERR FABRIC 1	JAR	SOOOTED EXT; BURNT DEP INT
V3891	50	LOOL	8	2538		JAR	SOOTED EXT; BLACK DEP INT; LEACHED INT
V3892	51	IALST	8	2538	IALST1	JAR	SOOTED EXT; BLACK DEP INT; LEACHED INT
V3893	52	IALST	8	1706	LEACHED OR IAGROG	BOWL	SOOTED EXT; BLACK DEP INT
V3895	54	IALST	8	2564	IALST1	JAR	SOOTED EXT
V3896	55	IALST	8	2434	IALST1	JAR	
V3898	0	IAERR	8	1406	IAERR FABRIC 1	JAR	
V3899	0	IAOOL	8	1407		JAR	SOOTED EXT

V3900	0	IACALC	8	1407		JAR	WHITE DEP INT
V3901	0	IAGROG	8	1415	IAGROG FABRIC 1	JAR	
V3902	0	IAOOL	8	1599		JAR	SOOTED EXT; BLACK DEP INT
V3903	0	IASH	8	1601	IASH FABRIC 1	JAR	SOOTED EXT
V3904	0	IAERR	8	1682	IAERR FABRIC 4	JAR	BLACK DEP INT
V3905	0	IACALC	8	1706	BELEMNITE	JAR	WHITE DEP INT
V3906	0	IAERR	8	1706	IAERR FABRIC 1	JAR	SOOTED EXT; BLACK DEP INT
V3907	0	IAGSQ	8	1706	IAGSQ FABRIC 2	JAR?	SOOTED EXT; BLACK DEP INT
V3908	0	IAOOL	8	1706		JAR	SOOTED EXT; BLACK DEP INT; LEACHED INT
V3909	0	IAGSQ	8	1706	IAGSQ FABRIC 2	JAR	SOOTED EXT; BLACK DEP INT; LEACHED INT
V3910	0	IACALC	8	1934		JAR	BLACK DEP INT
V3911	0	IAGROG	8	1955	IAGROG FABRIC 1	JAR?	
V3912	0	IAOOL	8	1961		JAR	SOOTED EXT; BLACK DEP INT
V3913	0	IAOOL	8	1961		JAR	BLACK DEP INT
V3914	0	IASH	8	2028	IASH FABRIC 1	JAR	SOOOTED EXT; BURNT DEP INT
V3915	0	IACALC	8	2136		JAR	SOOTED EXT; BLACK DEP

							INT
V3916	0	IACALC	8	2136		JAR	SOOTED EXT; BLACK DEP INT
V3917	0	IACALC	8	2136		JAR	BLACK DEP INT
V3918	0	IASH	8	2759	IASH FABRIC 1	JAR	SOOOTED EXT; BURNT DEP INT
V3919	0	IAERR	8	2765	IAERR FABRIC 2	JAR	BLACK DEP INT
V3920	0	IAGROG	8	2964	IAGROG FABRIC 3	JAR	BLACK DEP INT
V3921	0	IACALC	8	2992		JAR	BLACK DEP INT
V3922	0	IAGROG	8	3048	IAGROG FABRIC 2	JAR	BLACK DEP INT
V3923	0	IASH	4	4046	IASH FABRIC 2	JAR	SOOTED EXT
V3924	0	LOOL	4	3348		JAR	
V4497	86	EBAGROG	5	3336		JAR	BLACK DEP INT
V4498	20	EBAERR	5	3415		BEAKER	

Appendix 2

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V3795	16.69	6.81	1.26	1.61	0.37	2.1	0.69	1.09	0.056
V3799	18.67	7.16	1.07	1.7	0.29	2.56	0.83	0.31	0.018
V3800	16.99	7.55	1.09	1.28	0.38	2.72	0.8	0.36	0.024
V3801	15.26	2.23	0.27	0.66	0.11	0.39	0.59	0.14	0.005
V3802	17.23	7.1	1.41	1.46	0.28	2.57	0.74	0.6	0.103
V3803	16.69	7.73	1.25	1.2	0.29	2.39	0.75	0.2	0.02
V3804	17.05	8.11	1.37	1.08	0.25	2.23	0.71	0.79	0.062
V3805	16.3	4.28	0.98	0.83	0.33	2.52	0.72	0.12	0.012
V3806	16.57	3.27	0.98	1.09	0.64	1.47	0.71	0.17	0.011
V3808	17.24	6.04	1.23	1.17	0.32	2.42	0.82	0.22	0.015
V3809	15.96	6.47	0.86	1.29	0.38	2.28	0.7	0.32	0.017
V3810	17.14	7.72	1.08	0.79	0.32	2.32	0.77	0.23	0.105
V3813	15.28	4.77	1.12	0.85	0.2	1.92	0.67	0.18	0.014
V3814	15.62	4.23	1.1	1.22	0.31	2	0.66	0.51	0.012
V3815	20.78	2.39	0.7	0.38	0.22	1.79	0.94	0.12	0.065
V3816	19.18	7.47	1.4	4.32	0.24	2.06	0.77	0.65	0.047
V3817	21.26	7.49	0.95	6.35	0.21	2.11	0.86	0.43	0.055
V3818	21.9	3.68	0.39	1.22	0.56	1.1	0.89	0.05	0.029
V3820	11.72	4.64	1.18	19.35	0.15	1.66	0.48	0.78	0.09
V3823	13.05	6.06	1.31	13.34	0.18	1.99	0.54	0.5	0.093
V3824	11.8	5.38	1.13	13.84	0.18	1.84	0.5	0.57	0.087
V3825	12.04	3.71	0.94	2.12	0.72	1.59	0.55	1.01	0.021
V3826	13.98	4.3	0.87	3.41	0.54	1.51	0.58	1.01	0.042
V3827	21.57	3.07	0.24	1.8	0.14	0.53	0.87	1.11	0.051
V3828	13.49	3.7	0.83	3.84	0.55	1.48	0.53	1.15	0.095
V3829	12.29	5.27	1.24	20.36	0.2	1.72	0.53	0.49	0.083
V3830	14.01	3.96	0.87	1.83	0.6	1.44	0.64	0.85	0.054
V3831	23.6	6.64	1.39	0.87	0.21	3.03	1.09	0.26	0.016
V3832	22.65	7.46	1.35	0.76	0.26	2.6	0.96	0.25	0.081
V3833	17.71	6.36	0.86	6.07	0.24	2.34	0.77	0.45	0.032
V3834	12.73	3.64	1	10.53	0.39	1.33	0.48	0.68	0.071
V3835	12.41	3.47	0.97	9.42	0.38	1.33	0.5	0.46	0.055
V3836	18.8	3.21	0.38	1.84	0.21	0.55	0.77	0.79	0.025
V3837	13.39	5.28	0.93	18.06	0.22	2.12	0.56	0.25	0.043
V3838	15.39	5.99	1.1	3.32	0.2	2.37	0.64	0.75	0.024
V3839	16.15	5.97	0.89	3.11	0.23	2.41	0.68	0.87	0.024
V3840	12.78	5.34	0.91	1.3	0.46	1.84	0.59	0.8	0.035
V3841	11.46	3.06	0.6	1.47	0.78	1.48	0.49	0.77	0.019
V3842	10.24	3.04	0.68	10.95	0.45	1.22	0.43	0.62	0.046
V3843	14.09	5.77	1.42	3.24	0.26	2.22	0.65	0.64	0.036
V3844	12.46	6.36	0.98	17.99	0.19	1.67	0.55	0.79	0.117

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V3845	10.2	3.84	1.34	21.77	0.21	1.6	0.46	0.49	0.118	V3873	18.42	2.31	0.3	2.81	0.26	0.59	0.75	0.61	0.005
V3846	14.65	17.12	1.15	2.17	0.4	2.35	0.58	0.45	0.069	V3875	16.34	2.35	0.26	2.15	0.15	0.5	0.71	1.31	0.006
V3848	15.61	4.32	1.13	1.92	0.82	1.55	0.67	0.76	0.029	V3876	20.62	8.35	1.42	2.67	0.38	2.72	1.06	0.66	0.071
V3849	14.89	15.6	1.06	2.2	0.37	2.31	0.62	0.56	0.067	V3877	13.51	4.04	0.87	19.83	0.2	1.43	0.54	0.51	0.039
V3850	14.86	8.4	0.89	10.84	0.19	1.47	0.61	0.94	0.072	V3878	19.79	7.69	1.35	1.99	0.19	3.2	0.9	1.26	0.025
V3851	15.2	20.01	1.14	2.21	0.41	2.49	0.63	0.44	0.062	V3879	14.96	6.34	1.2	1.42	0.47	2.72	0.76	0.28	0.018
V3852	15.83	13.16	1.29	2.02	0.39	2.54	0.65	0.62	0.096	V3883	14.48	6.26	1.74	7.75	0.63	2.05	0.69	1.39	0.067
V3853	13.21	3.2	0.77	1.5	1.29	2.24	0.57	1.18	0.072	V3886	15.84	5.27	1.03	15.41	0.36	2.09	0.83	0.67	0.033
V3854	14.36	6.14	1.34	3.55	0.23	1.89	0.61	0.56	0.112	V3888	15.72	5.23	2.17	3.59	1.2	1.97	0.7	2.06	0.081
V3855	11.78	5	1.17	22.26	0.15	1.69	0.5	0.72	0.055	V3891	14	8.85	1.27	14.23	0.19	1.82	0.59	0.77	0.139
V3856	8.82	5.25	1.07	28.65	0.19	1.24	0.38	0.29	0.171	V3892	9.8	5.09	1.11	18.84	0.22	1.27	0.44	0.42	0.203
V3857	17.34	5.34	1.27	1.89	0.26	2.84	0.77	0.97	0.031	V3893	15.85	4.36	1.02	6.66	0.48	1.71	0.63	2.19	0.07
V3858	12.71	4.84	0.91	8.62	0.13	2.09	0.42	2.42	0.076	V3895	13.78	6.36	1.33	14.4	0.18	2.1	0.63	1.16	0.076
V3859	20.2	8.05	1.21	1.95	0.17	2.52	0.91	1.46	0.027	V3896	14.58	4.78	0.95	18.92	0.16	1.64	0.6	2.08	0.067
V3860	12.66	5.77	0.91	1.32	0.55	1.71	0.58	0.86	0.048	V3898	15.44	6.7	1.55	6.9	0.74	2.52	0.91	1.17	0.091
V3861	20.49	7.01	1.28	1.32	0.16	2.57	1.12	0.32	0.039	V3899	12.45	5.43	1.11	20.96	0.14	1.64	0.53	1.49	0.037
V3864	18.34	7.54	1.8	2.5	0.67	2.67	1.04	1.35	0.04	V3900	8.72	2.44	0.84	31.29	0.13	0.96	0.36	0.4	0.049
V3866	19.08	7.81	2.06	3.14	0.6	3.09	0.97	0.63	0.047	V3901	18.17	7.65	1.42	2.38	0.18	2.98	0.8	0.94	0.026
V3868	14.18	6.58	1.66	1.74	0.65	2.3	0.74	0.31	0.033	V3902	15.56	5.05	1.27	17.36	0.09	2.04	0.79	0.21	0.035
V3869	14.75	6.7	1.57	1.72	0.56	2.28	0.72	0.28	0.041	V3903	12.3	7.9	1.27	19.03	0.22	1.82	0.52	1.1	0.138
V3870	12	6.27	1.18	3.28	0.33	1.93	0.56	0.31	0.037	V3904	18.03	6.53	1.91	4.41	0.77	3.27	0.75	1.18	0.094
V3872	14.73	5.55	0.92	1.34	0.18	2.25	0.69	0.46	0.018	V3905	9.32	2.64	0.88	29.69	0.14	1.06	0.38	0.47	0.051

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V3906	14.71	4.02	0.7	2.14	0.92	2.05	0.26	2.65	0.03	V3929	13.46	4.57	1.13	9.27	0.21	2.17	0.56	0.53	0.054
V3907	13.85	6.81	0.3	2.03	0.2	0.59	0.47	2.03	0.024	V3930	14.64	5.25	1.44	2.43	0.22	2.56	0.6	0.45	0.042
V3908	13.98	4.92	1.2	17.15	0.13	1.78	0.72	0.73	0.031	V3931	12.92	4.8	1.09	10.54	0.22	2.15	0.53	0.48	0.042
V3909	13.65	4.23	0.32	2.13	0.2	0.6	0.56	2.36	0.009	V3932	11.77	4.33	1.33	9.84	0.19	2.15	0.45	1.44	0.044
V3910	13.09	3.54	0.64	23.34	0.16	1.65	0.48	0.7	0.051	V3933	11.45	4.29	1.39	10.64	0.19	2.08	0.45	1.07	0.038
V3911	19.25	7.39	1.32	1.88	0.23	2.93	0.82	1.63	0.119	V3934	13.86	4.34	1.33	13.98	0.2	2.39	0.54	0.58	0.047
V3912	14.28	4.83	1.18	16.22	0.15	1.83	0.74	0.84	0.036	V4067	16.93	7.08	1.45	10.77	0.35	2.24	0.71	0.75	0.16
V3913	15.38	5.27	1.15	15.87	0.13	1.95	0.81	1.44	0.035	V4068	10.81	4.53	1	8.18	0.53	1.75	0.5	0.32	0.048
V3914	10.52	6.34	1.25	20.79	0.15	1.56	0.45	1.52	0.112	V4069	18.28	6.91	1.56	1.02	0.39	2.52	0.76	0.25	0.129
V3915	11.06	3.3	0.79	22.02	0.11	1.06	0.44	0.81	0.035	V4070	17.48	7.36	1.47	1.2	0.47	2.49	0.8	0.72	0.165
V3916	12.12	3.53	0.77	21.56	0.15	1.27	0.49	1.16	0.037	V4071	8.72	3.86	0.8	8.97	0.41	1.37	0.41	0.32	0.044
V3917	13.73	3.91	0.75	19.63	0.23	1.37	0.5	1.44	0.041	V4072	10.54	4.32	0.97	9.43	0.5	1.74	0.5	0.34	0.047
V3918	11.78	6.62	1.07	20.53	0.14	1.47	0.5	0.45	0.114	V4073	7.71	3.07	0.63	10.35	0.44	1.37	0.38	0.63	0.066
V3920	16.95	6.6	1.49	2.82	0.25	2.79	0.76	0.77	0.035	V4074	9.5	3.71	0.7	4.7	0.54	1.59	0.46	0.44	0.061
V3921	9.15	2.51	0.87	29.3	0.15	1.13	0.37	0.7	0.05	V4075	9.5	3.95	0.75	5.3	0.52	1.59	0.46	0.67	0.068
V3922	21.89	7.47	0.97	1.92	0.19	2.62	0.94	0.85	0.095	V4076	10.57	4.37	0.78	3.38	0.54	1.69	0.52	0.25	0.056
V3923	14.86	5.15	0.89	10.83	0.26	1.82	0.64	1.05	0.027	V4077	9.6	3.78	0.84	8.25	0.51	1.61	0.44	0.36	0.057
V3924	12.45	9.22	0.78	14.4	0.16	1.56	0.57	1.16	0.142	V4078	10.03	4.04	0.86	8.3	0.55	1.63	0.46	0.37	0.059
V3925	12.35	4.54	1.43	10.61	0.22	2.4	0.51	0.69	0.086	V4079	19.2	9.84	1.15	6.56	0.11	2.68	0.78	1.31	0.134
V3926	16.13	6.45	1.42	6.19	0.33	2.77	0.71	0.68	0.103	V4080	11.2	4.86	0.99	4.25	0.48	1.92	0.5	0.27	0.08
V3927	11.95	4.32	1.23	11.9	0.2	2	0.44	2.79	0.072	V4081	13.97	5.8	0.82	1.86	0.43	1.88	0.62	0.82	0.065
V3928	14.36	5.27	1.32	2.97	0.22	2.56	0.61	0.62	0.054	V4082	19.61	7.15	1.48	2.75	0.44	2.86	0.84	0.54	0.106

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V4083	17.52	6.55	1.42	8.54	0.34	2.52	0.74	0.33	0.073	V4552	19.53	6.01	1.1	0.81	0.31	2.61	0.98	0.47	0.089
V4084	17.01	5.81	1.51	11.18	0.51	3.35	0.71	0.59	0.276	V4553	18.14	8.08	1.16	0.58	0.24	2.91	0.84	0.17	0.025
V4497	18.07	6.62	1.97	2.36	0.27	2.3	0.81	0.23	0.058	V4554	17.74	8.98	1.04	0.74	0.23	2.74	0.75	0.28	0.025
V4498	18.92	7.55	1.21	2.18	0.22	2.23	0.9	1.24	0.041	V4555	15	5.07	0.81	1.21	0.32	2.14	0.69	0.71	0.041
V4551	21.9	7.63	1.33	0.73	0.37	2.95	1.01	0.22	0.024	V4556	18.6	7.29	1.52	1.14	0.35	2.52	0.75	0.15	0.067

Appendix 3

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3795	518	158	27	70	63	16	79	178	21	89	36	76	36	5	1	3	2	21	139	17
V3799	638	102	35	48	50	18	96	186	24	91	44	68	44	7	1	3	3	16	97	16
V3800	904	149	31	41	43	17	106	166	19	94	39	71	39	6	1	3	2	20	114	14
V3801	682	111	34	38	20	13	53	113	11	98	21	30	20	2	0	1	2	19	45	10
V3802	726	147	31	54	54	16	82	156	23	99	43	74	43	7	1	3	3	20	119	18
V3803	956	131	28	54	61	15	73	161	25	84	37	64	38	7	1	4	3	20	123	19
V3804	611	137	33	81	102	16	75	172	32	102	45	91	47	8	2	5	3	17	167	30
V3805	969	91	27	41	49	14	87	139	26	79	42	79	43	9	1	4	3	14	82	18
V3806	1,022	114	25	63	48	15	113	111	28	59	45	80	46	10	2	4	2	15	79	15
V3808	523	144	29	41	55	16	80	154	25	116	41	70	43	7	1	4	3	22	105	14
V3809	799	131	33	43	56	15	86	165	22	90	42	81	42	7	1	3	2	24	112	17
V3810	651	148	33	48	57	16	59	154	25	110	42	81	43	7	1	4	3	19	103	18
V3813	551	120	30	44	56	15	45	153	23	98	34	68	35	7	1	3	2	18	104	18

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3814	472	110	30	53	67	14	70	127	20	69	29	63	30	6	1	3	2	20	179	17
V3815	445	114	31	103	47	18	67	102	25	115	52	90	51	8	2	5	3	20	44	15
V3816	826	113	35	68	60	18	123	111	17	71	42	70	42	7	1	3	2	20	101	17
V3817	539	114	35	67	67	20	165	126	37	90	53	111	56	12	2	7	4	20	113	18
V3818	441	153	57	56	49	19	51	182	24	150	30	51	27	4	1	4	3	21	51	13
V3820	584	83	26	45	35	11	159	77	20	47	29	56	30	4	1	3	2	7	53	10
V3823	441	94	24	62	44	13	155	103	21	58	36	83	37	7	1	3	2	15	68	16
V3824	455	75	21	56	38	11	168	89	18	41	29	61	30	6	1	3	2	12	57	14
V3825	573	84	18	52	27	11	170	81	15	47	27	48	27	5	1	2	2	15	56	10
V3826	792	100	27	83	38	14	143	86	31	78	43	88	46	9	2	6	3	20	130	11
V3827	280	133	41	49	21	16	116	131	13	135	29	49	29	2	1	2	2	23	61	8
V3828	886	95	27	83	38	13	154	79	28	68	43	83	46	9	1	6	3	18	124	13
V3829	320	88	22	63	41	12	200	99	17	50	31	65	32	6	1	3	2	12	62	13
V3830	535	96	14	74	26	11	144	84	16	83	34	63	35	4	1	3	2	16	74	9
V3831	379	131	22	138	37	21	180	141	16	99	56	92	56	8	1	4	2	24	63	13
V3832	624	111	23	114	53	17	115	106	20	51	58	89	59	10	2	4	2	28	92	18
V3833	380	134	31	65	68	16	192	112	36	80	49	83	52	9	2	6	3	17	79	16
V3834	523	93	36	64	34	12	125	77	30	63	40	75	41	8	2	4	3	13	82	10
V3835	447	92	32	64	34	13	119	78	29	77	44	80	47	9	2	6	3	15	82	9
V3836	332	117	36	45	22	16	101	117	15	120	25	41	26	3	1	3	2	17	44	9
V3837	312	103	18	47	40	12	328	109	15	63	32	52	33	6	1	3	2	12	82	14
V3838	603	123	24	53	41	14	121	133	14	75	33	60	34	6	1	3	2	13	94	12

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3839	604	129	24	42	42	14	138	129	16	83	34	59	35	6	1	3	2	18	96	13
V3840	516	92	20	65	34	10	97	87	14	81	31	53	32	4	1	3	2	16	70	11
V3841	579	82	20	45	28	10	122	72	19	45	32	53	33	7	1	3	2	11	69	10
V3842	474	68	34	43	32	10	137	64	21	38	33	57	34	7	1	3	2	13	89	9
V3843	524	112	28	45	42	13	134	116	19	85	37	67	38	6	1	4	2	12	82	13
V3844	428	89	21	55	42	12	194	108	18	54	31	58	33	6	1	4	2	16	92	15
V3845	295	76	21	50	32	10	177	69	15	50	25	52	26	4	1	3	2	8	67	12
V3846	414	126	33	63	53	14	123	158	17	96	32	67	32	4	2	2	2	17	81	17
V3848	660	104	26	75	39	13	150	105	20	72	39	74	39	7	1	3	2	18	55	13
V3849	500	125	26	69	53	13	126	152	16	90	31	63	31	4	1	2	2	13	80	19
V3850	461	110	20	102	52	13	185	219	16	63	25	57	26	4	1	3	3	22	88	13
V3851	421	120	28	58	49	13	129	137	17	97	32	54	33	8	1	3	3	15	83	15
V3852	579	127	26	61	54	14	120	150	19	105	34	63	35	7	1	4	3	18	83	20
V3853	731	75	23	51	33	10	147	58	31	87	76	131	77	10	1	6	3	16	100	10
V3854	535	99	24	52	48	13	97	90	28	73	39	73	41	8	1	5	3	15	59	14
V3855	434	101	21	62	48	12	482	107	25	82	39	70	41	6	1	5	3	10	94	13
V3856	273	66	23	40	29	7	214	53	19	40	28	45	29	4	1	3	2	9	38	9
V3857	656	100	27	80	63	16	162	136	33	99	49	87	52	9	2	6	3	20	88	19
V3858	681	72	20	47	48	11	317	120	25	58	31	55	33	5	1	4	3	17	162	13
V3859	697	136	37	85	95	18	96	161	30	118	52	80	54	10	2	5	3	20	159	24
V3860	498	74	21	61	46	11	97	87	23	67	37	62	39	8	1	4	2	15	69	13
V3861	404	124	28	71	60	21	88	207	30	108	58	98	60	10	2	6	3	13	100	23

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3864	671	118	35	50	40	20	156	160	20	121	40	63	41	7	1	4	3	19	108	16
V3866	609	120	35	59	61	19	167	175	22	128	42	73	43	7	1	4	3	16	125	21
V3868	302	120	25	35	42	14	116	128	19	61	33	59	33	7	1	3	2	12	84	14
V3869	470	124	25	35	39	15	87	137	19	88	38	68	38	6	1	3	2	13	77	14
V3870	383	105	30	34	55	12	109	112	25	75	49	83	50	9	1	5	2	10	90	12
V3872	464	136	29	33	30	14	95	129	18	98	37	64	36	6	1	3	2	14	68	9
V3873	364	121	31	40	18	14	119	100	11	111	24	39	24	2	1	1	2	18	65	9
V3875	375	108	44	40	17	12	136	94	13	95	21	36	21	2	1	1	2	19	57	9
V3876	609	145	32	58	62	20	143	216	27	130	44	85	46	7	1	5	3	19	132	22
V3877	408	112	29	39	27	11	764	79	14	70	28	50	28	4	1	3	2	13	55	9
V3878	623	123	28	56	73	19	136	222	19	84	33	63	34	6	1	4	3	26	133	20
V3879	292	135	25	31	25	15	88	138	17	101	34	58	37	6	1	3	2	13	85	12
V3883	528	123	24	64	45	15	227	133	18	71	30	56	31	5	1	3	2	7	87	16
V3886	297	125	21	58	41	15	282	157	20	59	35	74	36	7	1	3	3	13	79	18
V3888	697	158	48	51	70	18	283	105	46	62	47	90	50	11	2	6	4	16	198	17
V3891	454	111	26	64	52	14	158	157	22	53	34	69	36	7	1	4	3	16	75	18
V3892	383	79	17	53	32	9	288	71	17	58	26	48	28	4	1	3	2	8	49	12
V3893	760	108	22	85	48	15	277	92	24	67	40	76	41	7	1	3	2	16	337	16
V3895	436	101	23	64	45	13	292	110	19	50	34	68	35	7	1	3	2	11	74	15
V3896	614	100	21	90	45	11	401	169	16	48	27	50	28	4	1	3	2	15	97	14
V3898	463	92	22	57	40	15	299	162	20	83	34	65	36	6	1	4	3	15	95	17
V3899	494	81	26	56	41	12	454	100	23	69	32	60	33	5	1	4	2	15	96	11

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3900	241	62	22	60	55	8	684	60	15	60	23	49	26	4	1	3	1	11	60	13
V3901	602	170	34	55	39	18	130	153	20	110	35	58	37	7	1	4	3	15	97	12
V3902	301	85	20	62	40	15	344	157	21	67	38	68	40	7	2	4	3	16	80	18
V3903	416	70	28	53	43	11	245	84	22	26	32	54	34	7	1	4	3	18	64	13
V3904	582	151	36	74	73	17	161	169	30	119	45	77	46	9	2	6	3	20	114	19
V3905	245	37	28	64	58	8	715	63	16	55	25	59	26	5	1	3	2	12	65	14
V3906	1,036	61	31	50	35	12	425	93	28	18	44	71	46	9	2	5	3	26	66	9
V3907	575	110	36	23	23	14	243	134	14	68	25	43	25	3	1	2	2	25	48	8
V3908	311	119	19	73	41	14	359	153	17	70	35	73	35	5	1	3	2	16	71	18
V3909	273	130	33	21	21	15	289	130	18	160	26	48	24	3	1	3	2	21	40	9
V3910	341	56	32	57	59	12	868	109	16	57	32	64	33	6	1	3	2	18	65	14
V3911	635	125	36	48	56	18	122	179	24	85	46	67	47	7	2	4	3	26	144	18
V3912	298	126	19	72	41	15	360	153	25	83	40	84	44	9	2	5	3	16	72	18
V3913	356	103	20	53	42	15	384	154	23	135	38	72	44	7	1	5	2	16	82	18
V3914	373	88	23	50	32	10	267	79	20	65	29	53	35	6	1	4	2	12	51	11
V3915	264	92	29	61	26	12	772	117	14	75	22	46	27	4	1	3	2	11	47	7
V3916	317	99	33	53	29	12	851	119	14	73	24	52	29	4	1	3	2	12	55	8
V3917	349	71	37	50	31	13	791	127	16	58	26	56	27	5	1	3	2	16	61	9
V3918	374	97	29	59	39	11	165	84	22	60	33	51	38	6	1	4	2	16	59	12
V3920	526	160	39	53	50	17	117	150	41	105	37	66	38	6	1	4	3	15	99	13
V3921	275	36	33	57	59	9	958	58	17	44	26	60	27	5	1	3	2	11	66	14
V3922	508	117	42	67	96	19	115	177	35	96	57	121	59	12	2	6	3	23	145	29

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3923	502	125	24	47	35	13	239	103	19	82	38	64	35	6	1	3	2	12	56	11
V3924	468	117	19	55	50	11	174	176	20	64	35	61	36	7	1	4	3	20	73	18
V3925	417	73	20	69	42	11	222	91	19	62	32	55	33	5	1	4	2	11	64	13
V3926	459	87	29	81	55	15	144	107	20	70	36	62	38	6	1	4	3	19	86	18
V3927	316	67	30	53	43	11	387	88	19	63	31	51	32	6	1	3	2	12	58	13
V3928	465	95	22	50	37	12	109	94	19	57	34	60	35	5	1	4	2	17	58	13
V3929	390	95	19	52	37	11	216	103	18	58	33	57	34	6	1	4	2	11	57	13
V3930	437	92	18	55	36	13	102	94	19	52	34	61	36	6	1	4	2	16	77	12
V3931	384	96	76	60	38	11	249	97	19	55	34	59	36	6	1	4	2	14	96	12
V3932	474	91	25	51	38	10	265	88	18	57	33	56	34	5	1	3	2	13	68	10
V3933	391	88	22	50	37	10	255	87	18	54	29	47	30	5	1	3	2	13	62	11
V3934	333	103	19	69	37	12	339	108	19	57	34	61	35	5	1	3	2	12	65	11
V4067	685	108	38	95	66	16	237	119	25	63	44	79	42	10	2	4	3	16	101	23
V4068	380	71	21	53	36	10	188	72	19	45	33	60	30	6	1	3	2	16	59	11
V4069	470	112	31	90	58	17	113	138	28	86	49	95	47	10	2	5	3	18	82	22
V4070	519	119	26	82	59	16	136	129	25	46	50	96	49	12	2	5	2	20	91	20
V4071	329	57	17	41	28	8	185	58	15	37	25	44	23	5	1	2	2	10	49	9
V4072	389	68	21	53	34	9	208	67	18	43	31	59	29	7	1	3	2	12	57	10
V4073	335	50	19	33	24	6	229	47	16	42	25	43	26	5	1	3	2	16	54	8
V4074	482	55	18	40	29	8	160	51	16	45	28	48	29	5	1	3	2	16	63	10
V4075	483	57	17	38	29	8	174	57	17	43	29	52	30	6	1	3	2	13	60	10
V4076	355	57	19	38	28	8	221	65	18	63	30	54	31	5	1	3	2	15	54	10

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V4077	447	54	18	39	32	8	215	59	17	49	28	48	29	5	1	3	2	15	55	11
V4078	468	55	19	42	31	9	208	62	17	51	29	50	30	5	1	3	2	17	61	10
V4079	589	129	28	59	93	17	144	171	25	69	44	72	46	7	2	5	3	21	134	26
V4080	388	68	22	39	37	10	132	77	23	62	39	61	40	7	1	4	2	16	70	12
V4081	477	96	28	42	43	13	133	102	26	52	44	74	45	9	2	4	2	25	80	16
V4082	676	115	25	80	60	17	162	133	28	72	50	87	52	9	2	5	3	30	95	21
V4083	459	106	27	72	53	16	228	125	23	57	47	79	48	8	2	4	3	24	91	18
V4084	819	97	28	82	54	14	243	115	23	68	43	78	45	8	2	5	3	19	87	21
V4497	527	145	33	83	61	18	80	135	25	103	42	78	44	6	1	4	3	17	78	20
V4498	618	181	32	52	73	20	97	165	27	132	47	88	49	8	1	5	3	28	158	20
V4551	464	111	34	139	46	19	135	118	18	61	42	73	41	6	1	2	2	23	111	15
V4552	532	93	24	126	85	15	106	146	20	56	42	101	44	8	2	4	3	21	129	25
V4553	391	80	29	52	23	15	99	152	13	58	37	66	37	5	1	2	2	21	58	10
V4554	377	76	30	32	23	15	86	143	22	52	40	67	39	5	1	2	2	21	59	10
V4555	433	74	21	67	56	13	98	179	20	45	34	80	35	7	1	3	2	19	96	15
V4556	464	86	29	85	62	17	95	132	32	46	41	86	42	9	2	4	3	19	87	19