Petrological Report on Neolithic/Early Bronze Age Pottery from Willington, Derbyshire. Accession No: 1998-46

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Introduction

Thirteen sherds of Neolithic and Early Bronze Age pottery were selected for petrographic analysis with an additional two sherds included for hand specimen examination of specific large inclusions. The questions to be addressed during analysis are summarised as follows:

1. What is the petrography of the fabrics?
2. What is the source of material found in the fabrics?
3. Have the inclusions been deliberately added?
4. Do the worn edges of the large inclusions in the two sherds not included in the petrographic sample reveal information relating to their source?
5. To compare the fabrics in this sample with Neolithic and Bronze Age fabrics from three other sites.

Methodology

Thin sections were made at the Geology Department of the University of Leicester from the thirteen sherds selected for petrographic analysis. The samples were examined using a Nikon Eclipse E600 polarising microscope. Sections showing similarities in terms of matrix and inclusions were grouped together, resulting in the identification of eight fabric groups as set out in the table below.

Group No.	Fabric Class	TSNo	Context	SfNo	Hand Spec. Fabric Dating
1	Quartz	P1	1000		Qu2; Peterborough Ware: Fengate: Middle Neolithic
2	Packed Quartz	P5		587	IEBA: Biconical urn or LBA
3	Angular Chert	P6	1004		Fl2IPeterborough Ware: Middle Neolithic
4	Grog/Sandstone	P2	151		Beaker: Late Neolithic/EBA
5	Quartzite/Sandstone	P4	3070	604	Qu1; Peterborough Ware: Middle Neolithic
	Quartzite/Sandstone	P9	114	10	Qu2; Peterborough Ware: Fengate: Middle Neolithic
	Quartzite/Sandstone	P10	225		Qu1; Peterborough Ware: Middle Neolithic
6	Igneous Rock/Sandstone	P3	486	118	Ro1; Peterborough Ware: Middle Neolithic
	Igneous Rock/Sandstone	P8	U/S		Ro2; ?Middle Neolithic
7	Granitic (fine matrix)	P7	1850		Ro3; Peterborough Ware: Middle Neolithic
	Granitic (fine matrix)	P11	2063		Ro3; Peterborough Ware: Middle Neolithic
	Granitic (fine matrix)	P12	1799		Ro3; Peterborough Ware: Middle Neolithic
8	Granitic (sandy matrix)	P13	291	532	Ro3; Peterborough Ware: Middle Neolithic

Fabric Descriptions

The following fabric descriptions give a summary of characteristic features of each group and a photomicrograph of each sample within the group. All photomicrographs were taken using a Nikon digital camera and the x2 microscope objective. Definition of the terminology used is as follows:

Inclusion proportions:		**Void descriptions:**	
Predominant:	>70%	Vughs:	Relatively large, irregular voids.
Dominant:	50-70%		
Frequent:	30-50%	Channels/	May be linear in thin section, but
Common:	15-30%	Micro-channels:	are cylindrical in three dimensions.
Few:	5-15%		
Very few:	2-5%		
Rare:	0.5-2%		
Very rare:	<0.5%		(Whitbread 1995: 379-380).

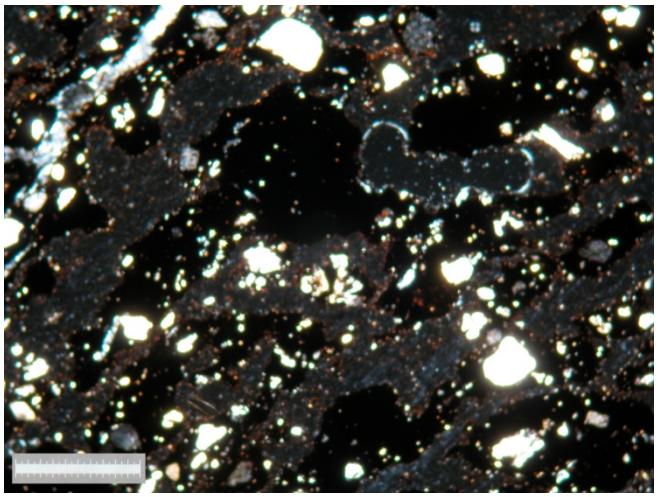
Fabric 1: Quartz

Sample Number: P1.

This fabric is characterised by moderately sorted mono and polycrystalline quartz inclusions.

Micromass: Red-brown, optically inactive (xpl)
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 20% coarse: 70% fine: 10% voids

Composition:
Predominant: QUARTZ, sub-angular to sub-rounded, mono and polycrystalline, 0.03mm to 0.5mm range
Very Rare: MUSCOVITE laths, 0.1mm.
Very Rare: BIOTITE, angular, 0.1mm.
Very Rare: CHLORITE within polycrystalline quartz.



Sample P1 showing moderately sorted quartz inclusions. Scale bar represents 1.0mm.

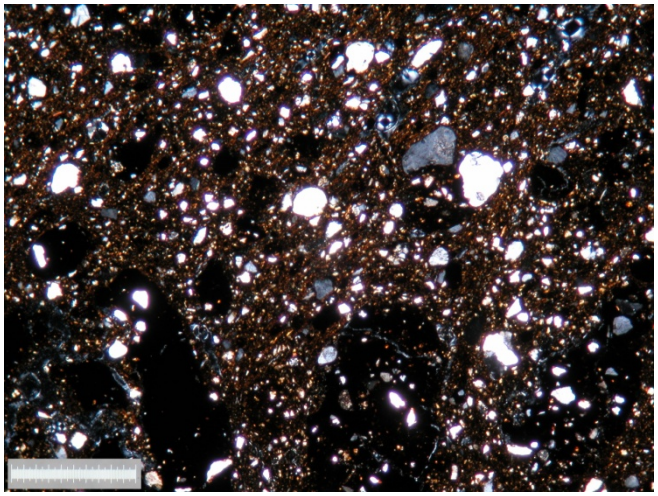
Fabric 2: Packed Quartz

Sample Number: P5

This fabric is characterised by packed, moderately sorted quartz in a silty matrix.

Micromass: yellowish-brown, optically slightly active (xpl).
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 30% coarse: 65% fine: 5% voids

Composition:
Dominant: QUARTZ, rounded/sub-rounded, 0.1mm (mode), 0.03mm to 0.65mm range, moderately sorted.
Common: OPAQUE "AMORPHOUS" CONCENTRATION FEATURES (acfs), rounded/sub-rounded, strongly impregnated, sharp to clear boundaries, 1.0mm (mode), c.2.0mm largest.
Rare: ORTHOCLASE FELDSPAR? sub-rounded, 0.25mm-0.5mm, cloudy.
Rare: CHERT, sub-rounded, 0.368mm.
Very Rare: MUSCOVITE, laths, 0.125mm-0.25mm.
Very Rare: PLAGIOCLASE FELDSPAR, rounded, 0.25mm.



Sample P5 (xpl) Packed quartz in a silty matrix. The darker areas of the matrix are opaque "amorphous" concentration features. Scale bar represents 1.0mm.

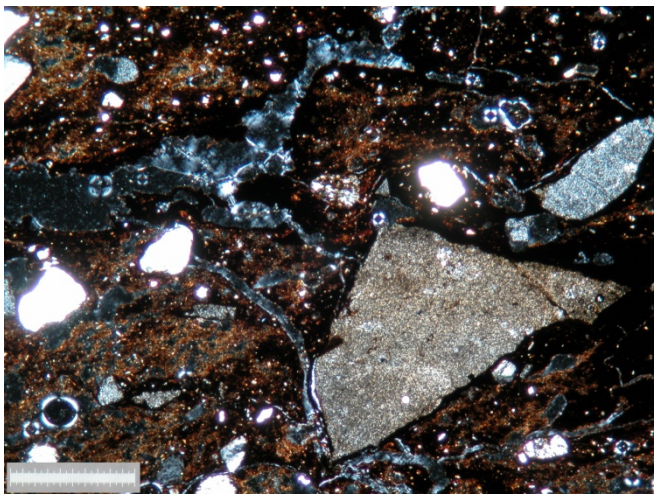
Fabric 3: Angular Chert.

Sample Number: P6

The characteristic components of this fabric are poorly sorted, angular chert and well sorted, rounded quartz grains in a moderately sorted quartz silt matrix. The angularity of the chert compared to the other inclusions could suggest its addition to the clay. The presence of siltstone may indicate a source for the angular quartz silt grains in the matrix.

Micromass: red/brown, optically active (xpl).
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 25% coarse: 65% fine: 10% voids

Composition:
Dominant: CHERT, angular, very poorly sorted, 0.1-0.125mm to 2.5mm plus occasional larger fragments up to 5.0mm.
Common: QUARTZ, (mono and polycrystalline) rounded/sub-rounded, 0.25mm-0.5mm plus one larger grain c.1.0mm.
Very Rare: CHLORITE? (green, non-pleochroic), 0.1mm.
Very Rare: MUSCOVITE laths 0.1mm.
Very Rare: SILTSTONE, 0.5mm, sub-rounded/rounded grains containing well sorted angular quartz, 0.1mm mode.



Sample P6 (xpl) showing large angular chert and smaller, rounded quartz inclusions. Scale bar represents 1.0mm.

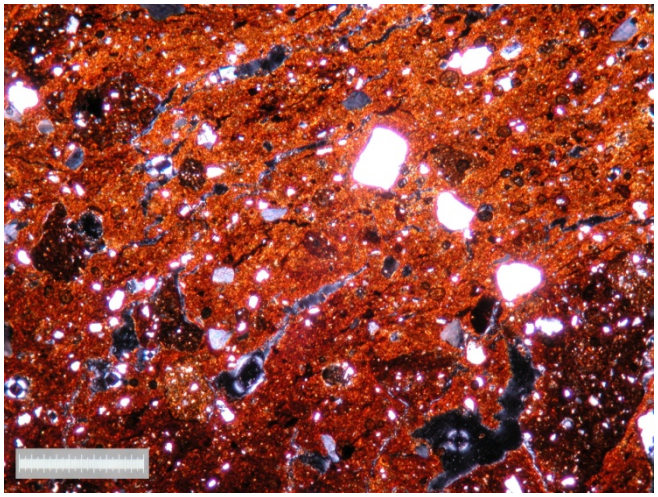
Fabric 4: Grog/Sandstone

Sample Number: P2

This fabric is characterised by the presence of well sorted quartz with a few sandstone rock fragments and possibly grog inclusions. Quartz is the main visible inclusion. The grog could be related to the host fabric as it also contains mostly quartz inclusions and a few voids, perhaps indicating the same type of pottery fabric is being recycled in the manufacture of new vessels. Quartz silt is present in the matrix.

Micromass: reddish-brown, optically active (xpl)
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 20% coarse: 70% fine: 10% voids

Composition:
Frequent: QUARTZ, rounded/sub-rounded, moderate to well sorted, 0.03mm-0.5mm range, most within 0.125mm-0.25mm range.
Common: GROG, sub-angular to sub-rounded, 0.5-0.75mm range, plus occasional larger 1.0mm-2.0mm pieces. Some voids can be detected within the structure, which suggests these inclusions are grog rather than clay pellets or mudstone.
Few: SANDSTONE ROCK FRAGMENTS, sub-angular to rounded, 0.5mm plus one larger fragment c.3.0mm. The sandstone is composed of predominantly well sorted quartz with grain sizes in the range of 0.125mm-0.375mm.
Very Rare: ORTHOCLASE FELDSPAR, rounded/sub-rounded, 0.25-0.5mm, cloudy.



Sample P2 (xpl) the darker red inclusions are grog fragments. Scale bar represents 1.0mm.

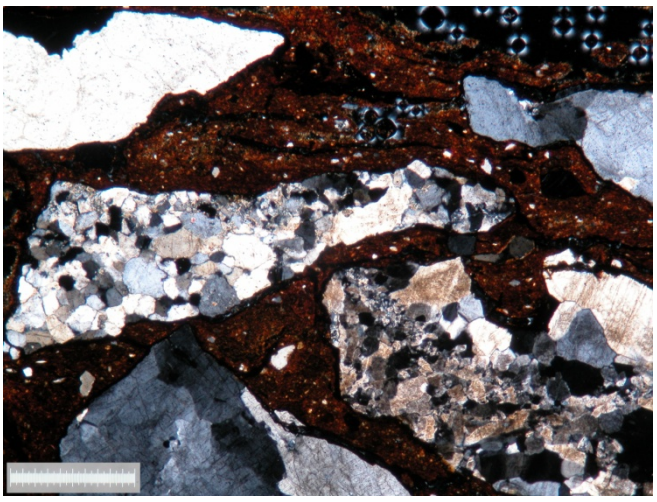
Fabric 5: Quartzite/Sandstone

Sample Numbers: P4, P9, P10

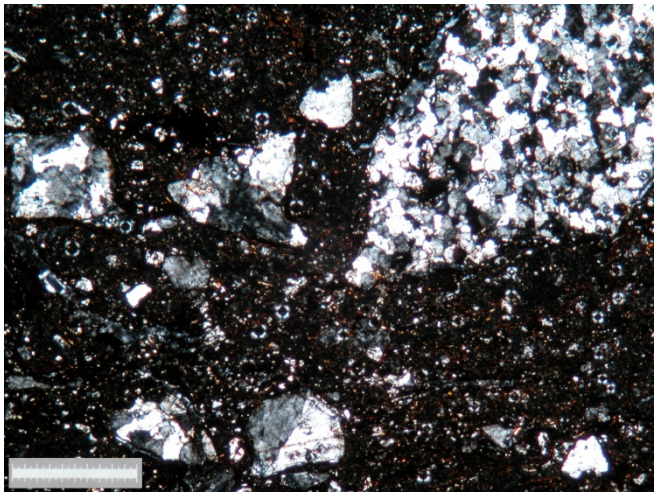
This fabric is characterised by large moderately sorted quartzite and sandstone inclusions. The sandstone is similar to that found in the grog/sandstone group (sample P2).

Micromass: Red-brown, optically inactive (xpl) though P4 is active.
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 25% coarse: 65% fine: 10% voids

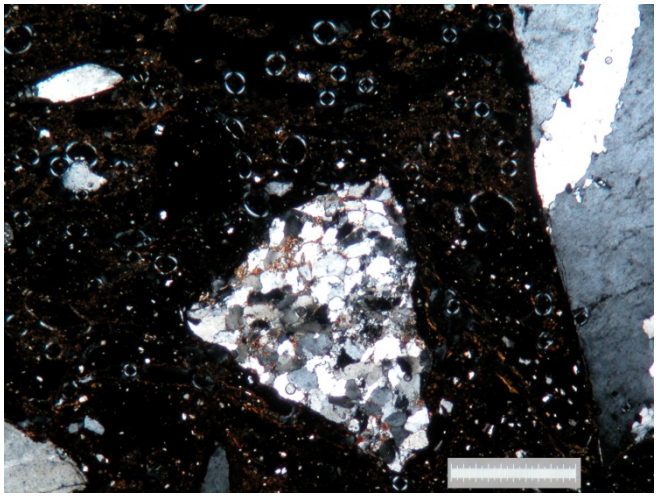
Composition:
Frequent: QUARTZITE, sub-angular, mostly large fragments 2.0-3.0mm, some smaller (0.5-1.0mm range) plus one very large 6.75mm fragment. Some grains show signs of cement and could be sandstone. Grain sizes range from 0.125mm-0.5mm with occasional grains up to 1.25mm.
Frequent: QUARTZ, sub-angular, mono and polycrystalline, 1.0-2.0mm range with larger 3.25-4.5mm polycrystalline fragments.
Very Rare: MUSCOVITE laths, 0.35mm.
Very Rare: ZIRCON.
Very Rare: TOURMALINE.



Sample P4 showing large quartzite and quartz inclusions. Scale bar represents 1.0mm.



Sample P9 has large quartzite inclusions and a siltier matrix than the other sections in this fabric group. Scale bar represents 1.0mm.



Sample P10 showing large quartzite and quartz inclusions. Scale bar represents 1.0mm.

Fabric 6: Igneous Rock/Sandstone

Sample Numbers: P3, P8.

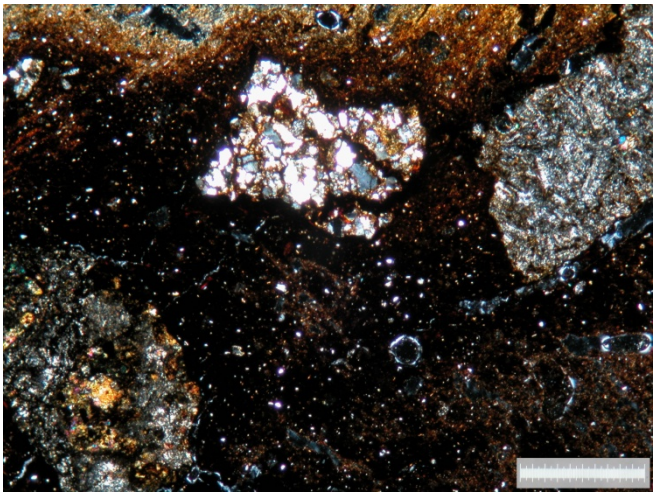
This group is characterised by the presence of poorly sorted altered igneous rock and well sorted sandstone inclusions, with quartz silt in the matrix. Sample P3 contains more sandstone than P8, whilst gabbroic rock fragments comprise additional igneous rock inclusions in P8.

Micromass: yellowish-brown/brown, P3 optically slightly active (xpl), P8 optically active (xpl).
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 20% coarse: 70% fine: 10% voids

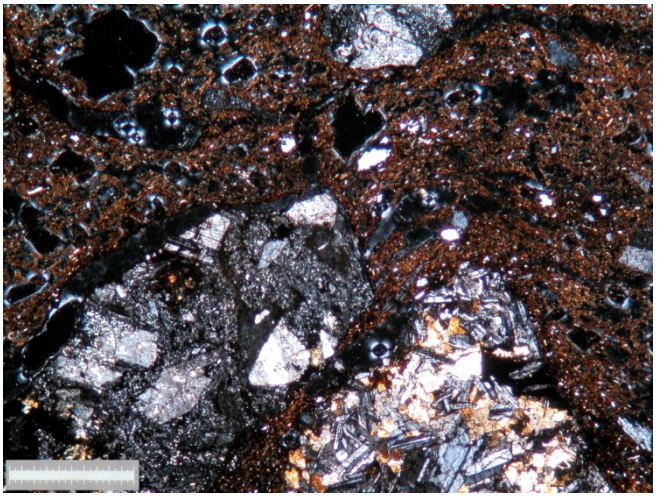
Composition:

P3:
Dominant: ALTERED IGNEOUS? ROCK, sub-angular to sub-rounded, poorly sorted, large inclusions 2.0-4.0mm, some small 0.5mm. Rock is composed of microcrystalline quartz, epidote and traces of plagioclase feldspar. The presence of relic plagioclase laths suggests an altered igneous rock.
Common: SANDSTONE ROCK FRAGMENTS, angular to sub-rounded, 0.75-1.25mm range plus occasional larger 2.75mm inclusions. Sandstone is composed of very well sorted quartz, plagioclase feldspar, muscovite and biotite mica. Grain size 0.125mm (mode).
Rare: QUARTZ, very fine (less than 0.125mm) to silt.

P8:
Common: ALTERED IGNEOUS? ROCK, sub-angular to sub-rounded, 0.75-1.0mm range, similar to the rock in P3.
Common: QUARTZ, sub-angular to sub-rounded, 0.5mm, well sorted.
Few: SANDSTONE, sub-rounded, 0.5-1.5mm range.
Few: ORTHCLASE FELDSPAR, sub-rounded, 0.5mm median.
Very Rare: GABBROIC ROCK FRAGMENTS Sub-rounded, 2.5mm.
Very Rare: MUSCOVITE, laths, 0.1mm.



Sample P3 (xpl) showing sandstone (centre) and altered igneous rock fragment at the right of the section. Scale bar represents 1.0mm.



Sample P8 (xpl) showing large gabbroic rock fragment at the bottom right of the section. Scale bar represents 1.0mm.

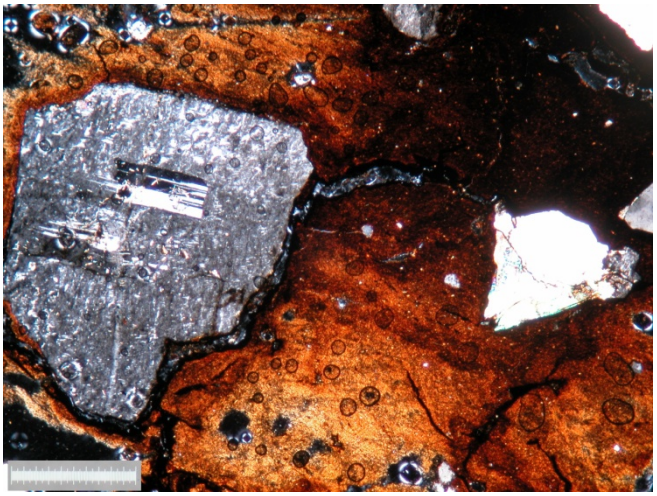
Fabric 7: Granitic (fine matrix)

Sample Numbers: P7, P11, P12

This fabric is characterised by the presence of moderately sorted granitoid rock fragments and orthoclase feldspar in a very fine matrix with rare silt grains. The lack of other sedimentary material such as sandstone or quartzite may indicate a source other than the local gravel beds.

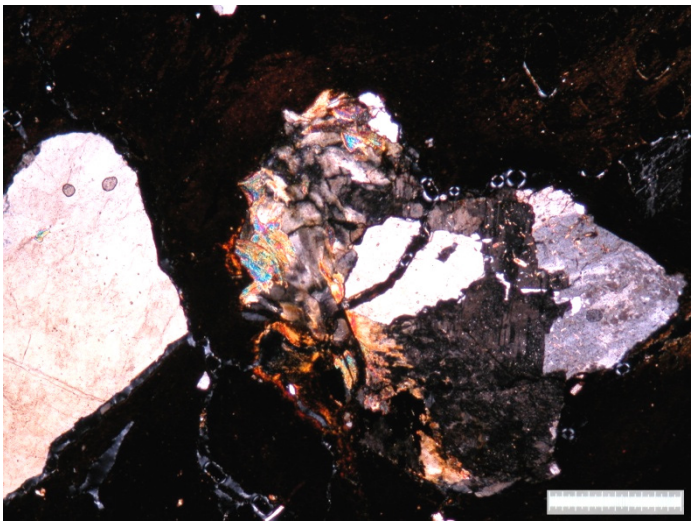
Micromass: pale brown-brown, optically active (xpl).
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 20% coarse: 70% fine: 10% voids

Composition:
Frequent: GRANITIC ROCK FRAGMENTS (quartz, orthoclase and plagioclase feldspar, muscovite mica), angular to sub-angular, moderately sorted, 0.75-3.25mm range. Orthoclase is cloudy. Most fragments are angular to sub-angular and relatively fresh; a few are more rounded and altered, perhaps indicating a different generation of debris.
Frequent: ORTHOCLASE FELDSPAR, sub-angular, moderately sorted, 0.5-2.25mm range, cloudy and perthitic.
Few: QUARTZ, 0.03mm to 0.25mm, sub-rounded. Occasional larger sub-angular fragment c.2.5mm



P7 (xpl) showing granitic rock fragment (left hand side of section) in a very fine clay matrix. Scale bar represents 1.0mm.

P11 (xpl) showing granitic rock fragment (right hand side of section) with mica in a very fine clay matrix. Scale bar represents 1.0mm.



P12 (xpl) showing granitic rock fragment. The matrix is darker than the other samples within this group, perhaps as a result of higher firing. Scale bar represents 1.0mm.

Fabric 8: Granitic (sandy matrix)

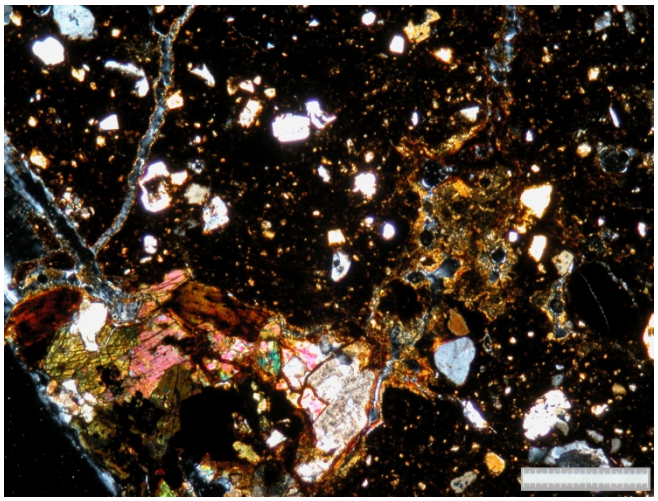
Sample Number: P13

This fabric is characterised by the presence of moderately sorted granitoid rock fragments and orthoclase feldspar in a matrix of well sorted angular to sub-angular quartz sand. This sample is distinguished from fabric 7 above by the presence of amphibole and biotite within the granitic rock fragments and the sandy nature of the background matrix.

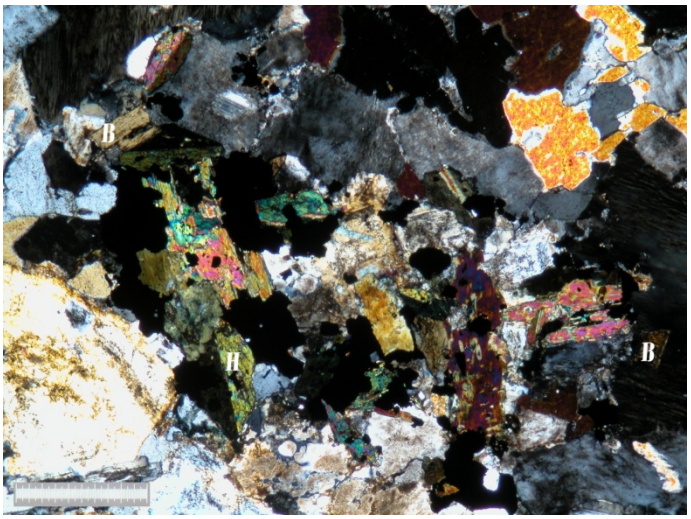
Micromass: pale brown-brown, optically active (xpl).
Voids: vughs and microchannels.
Proportion of inclusions to matrix and voids: 25% coarse: 65% fine: 10% voids

Composition:
Frequent: GRANITIC ROCK FRAGMENTS (quartz, orthoclase and plagioclase feldspar, biotite mica, amphibole), mostly sub-angular, moderately sorted, 2.5mm. Feldspars are generally cloudy.
Frequent: ORTHOCLASE FELDSPAR, sub-rounded, moderately sorted, 0.5-1.25mm range, generally cloudy and perthitic.
Few: QUARTZ, 0.03mm to 0.25mm, sub-rounded.

The second image below is a reference sample labelled “Mountsorrel granodiorite” from the Geology Department at the University of Leicester. The rock does show similarities with the rock fragments in this fabric and highlights the difference between the granitic fragments here and within fabric 7. The rock fragments in fabric 7 do not exhibit amphibole or biotite mica.



P13 (xpl) showing amphibole (hornblende) and biotite (bottom left of section) in a sandy matrix. Scale bar represents 1.0mm.



"Mountsorrel granodiorite" (xpl) reference sample (thick section) showing biotite (B) and hornblende (H). Scale bar represents 1.0mm.

Discussion

The Willington site is approximately 3km north of Burton upon Trent, lying on alluvium, river terrace sand and gravel, and Triassic Mercia Mudstone (British Geological Survey Map Sheet 141). The river terrace deposits are rich in quartz, quartzite and sandstone, and there are also outcrops of Bunter Pebble Beds near Repton slightly south of the Willington site (Fox-Strangeways 1905: 30-31). The most common rocks found in these Pebble Beds are local quartzite, sandstone and carboniferous limestone, but pebbles of metamorphic and igneous rocks are also present (Hains & Horton 1969: 63-66). Mercia Mudstone (also known as Keuper Marl) (Worssam & Old 1988: 65) mostly comprises beds of mudstone and siltstone with bands of sandstone, quartz, feldspar and other detrital minerals. Dolomite and gypsum are also scattered throughout (Fox-Strangeways 1905: 33-34; Hains & Horton 1969: 69-71).

Referring to question two in the introduction, analysis of the fabrics reveals quartz/quartz silt, quartzite and sandstone as the most frequently occurring inclusions in the samples which, given the background geology, are likely to derive from local gravel beds. The sandstone in fabric 5 (quartzite/sandstone) and fabric 4 (grog/sandstone) is very similar, composed predominantly of well sorted quartz. The sandstone in fabric 6 (igneous rock/sandstone) is micaceous and may be different from that in the other two groups however the source could still be local. The chert inclusions in fabric 3 (angular chert) may also be from local gravel beds. Other fabric classes in the sample contain traces of chert, and this fabric contains sedimentary material (sandstone and quartz) alongside the dominant chert inclusions, which could suggest a local source.

Three fabric classes contain igneous material. Fabric 6 contains gabbroic rock and altered igneous material, possibly a granodiorite. Granitic material, possibly granodiorite, is also found within fabrics 7 and 8. Fabric 7 is characterised by the lack of sedimentary rocks such as quartz and sandstone as much as by the presence of granitoid material, which might suggest a non-local source for the inclusions. Fabric 8 is characterised by a sandy matrix and the presence of amphibole and biotite mica within the rock fragments.

A possible source may be the Mountsorrel complex in Leicestershire, as a variety of igneous rocks including gabbro, granodiorite and diorite are found in this region (Le Bas 1968: 47-48). Apart from quartz, plagioclase and orthoclase feldspar, the other common minerals found within a granodiorite are biotite and hornblende (amphibole) (Knight *et al* 2003: 111), both of which are absent from the rock fragments in fabric 7, but present in fabric 8.

John Carney from the British Geological Survey has been involved in recent research relating to the presence of granodiorite rock within prehistoric (largely Iron Age) pottery in the East Midlands (Knight *et al* 2003) and in view of this his opinion was sought regarding the nature of the igneous inclusions in fabrics 6, 7 and 8. Carney concludes that the igneous inclusions in fabric 6 are atypical of material from Charnwood or Mountsorrel/South Leicestershire. He suggests two samples in fabric 7 (P11 and P12) include granodiorite, possibly from Mountsorrel, but that sample P7 in this group would be atypical of the Mountsorrel/South Leicestershire suites. However, samples P7 and P11 are from sherds belonging to the same pot, therefore this pot contains granodiorite, possibly from Mountsorrel, but also some atypical material, the significance of which cannot be determined without further sampling. Finally, Carney suggests the igneous

inclusions in fabric 8 could be a hornblende diorite or even possibly a hornblende gabbro, adding that hornblende gabbro does form a very small outcrop in Swithland Reservoir which, though now submerged was once accessible (Carney *pers. comm.*). It must be noted that these observations were made on the basis of viewing photomicrograph images of the samples and not the actual thin sections.

Determining sources of rock fragments within pottery sherds is difficult at times, as the constituent minerals can result in a variety of granitoid rocks depending on the different proportions of each mineral type present. This characteristic is not always identifiable within a pottery thin section where only a small fragment of the rock is present. The presence of granitic and gabbroic rocks within the pottery fabrics may be a reflection of the variety of igneous rocks found within the Mountsorrel complex as mentioned above, however it is not possible to positively attribute a source based on the small amount of information currently available.

In considering question three, a number of the fabric groups in this sample probably have had inclusions deliberately added to the clay during pottery production, though it is not possible to positively determine this in all cases as detailed below.

Fabric 1, quartz: it is not possible to determine whether or not the quartz has been deliberately added. The quartz grains in this fabric are small and rounded in sub-angular quartz silt and may be naturally occurring.

Fabric 2, packed quartz: as with the quartz group, it is not possible to determine whether or not any inclusions were deliberately added.

Fabric 3, angular chert: the angularity and size of the chert grains compared with rest of the inclusions suggests this could have been added, though angular material can be naturally occurring in sediments.

Fabric 4, grog/sandstone: as grog is crushed pottery, its presence does indicate deliberate inclusion of additional material. The sandstone may have been added, but could also be naturally occurring in the clay. The well sorted rounded quartz is unlikely to have been added.

Fabric 5, quartzite/sandstone: the large size and frequency of the quartzite and sandstone fragments suggests they have probably been deliberately added. The bimodal distribution of the inclusions, particularly in sample P4 would indicate this.

Fabric 6, igneous rock/sandstone: the igneous rock and sandstone inclusions have probably been added, though the well sorted sub-rounded quartz is likely to be naturally occurring in the clay.

Fabric 7, granitic (fine matrix): the granitoid rock fragments within this fabric were most likely added. The matrix is very fine and the absence of other inclusions suggests selection of the rock fragments.

Fabric 8, granitic (sandy matrix): although the matrix is not as fine as group 7 above, rock fragments are the dominant inclusion suggesting they were most likely added.

Fabric 4 (grog/sandstone) and fabric 3 (angular chert) display some similarities. A medium range of well sorted sand is the underlying characteristic of both fabrics, however one has chert inclusions, the other probably grog. This may indicate a single clay source with types of coarse inclusions chosen by the potter. The chert fabric is Middle Neolithic and the grog fabric Early Bronze Age. This could indicate exploitation of the same clays for pottery production during both periods, though not necessarily continuous use.

Question four concerned the two sherds of pottery not included in the petrographic sample. These sherds contain large pebbles of quartzite with smooth surfaces as well as more angular rock inclusions. Whilst it is not possible to positively provenance a source for these inclusions, it is likely they are from the local gravel beds described above.

Comparison of fabric groups with other sites

Three other sites from which Neolithic and Bronze Age pottery had been recovered and analysed petrographically were selected for comparison with the fabric groups identified in this sample.

Hill Farm Willington (Williams forthcoming).
Sample size: twelve sherds.

Four fabric groups were identified by Williams as containing grog, large quartz grains, smaller quartz and calcite inclusions (Williams forthcoming). The most notable difference is that none of our fabrics analysed above match Williams' calcite group. Williams' grog and large quartz grains fabrics could be similar to our fabric 4 (grog/sandstone) and fabric 5 (quartzite/sandstone). Williams' smaller quartz fabric may or may not be related to our fabric 1 (quartz) or fabric 2 (packed quartz) described above, as they are all quartz based. It should be noted that the samples from Hill Farm were from Mildenhall Ware dating to the Middle Neolithic and, although some Mildenhall Ware was recovered from the Willington quarry site, the Neolithic pottery samples in this study are all Later Neolithic Peterborough Ware. In this respect the Hill Farm assemblage is slightly earlier in date.

Lockington (Williams 2000: 60-61).
Sample size: eighteen sherds

The material from this site was mainly Bronze and Iron Age in date. Williams' four fabric groups were identified as containing grog, quartz, sandstone and igneous inclusions (Williams 2000: 60-61). Again, Williams' Early Bronze Age grog tempered fabric could be similar to our Late Neolithic/Early Bronze Age fabric 4 (grog/sandstone), although there may be differences in inclusion angularity. Williams' quartz group sample number 7, a ?Neolithic pottery sherd, could be similar to our fabric 1 (quartz).

Lockington lies on the same river terraces and Mercia Mudstone beds as Willington, which might explain the similarities between the quartz and sandstone inclusions. However Lockington is nearer the Charnwood Forest Precambrian outcrop than Willington. The river systems could flow along the River Trent into gravel beds more local to Willington or the igneous rock inclusions found at Willington could derive from a different source such as the Bunter Pebble Beds.

Whitemoor Haye (Ixer 2002: 94-97 and forthcoming)
Sample size: nine sherds.

Sample A Middle Neolithic and sample fabric 11 Peterborough Ware show some similarities with our fabric 5 (quartzite/sandstone), as both have large quartzite inclusions. Ixer also reports the presence of tourmaline, zircon and mudstone (Ixer 2002: 95 and forthcoming). Very small amounts of zircon and tourmaline were present in our quartzite/sandstone fabric, but no mudstone was identified. The local geology of Whitemoor Haye is also Triassic Mercian Mudstone, sandstones and Bunter Beds (Coates 2002: 1), which do contain tourmaline and zircon (Hain & Horton 1969: 66). Tourmaline and zircon are both common detrital minerals within sediments (Kerr 1977: 394-395, 425; Cox *et al* 1988: 156). Ixer's fabric 9 (a grog tempered beaker) could be related to our fabric 4 (grog/sandstone) beaker, although there are differences in the angularity of the quartz inclusions and the proportion of grog present in the two fabrics. Larger sample sizes are required to fully appreciate variances within fabric groups and it is not possible to determine how closely related these fabrics may be at this time.

Bibliography

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Acknowledgements

The authors would like to thank John Carney from the East Midlands District of the British Geological Survey for taking the time to view images of the samples and for his valuable comments.