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Petrology of Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds from Northton, South Harris

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Petrology of Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds from Northton, South Harris

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Foreword

This report is the published product of a study by the British Geological Survey (BGS) for Dr E. Murphy and Professor D. Simpson of the School of Archaeology and Palaeoecology, Queen's University of Belfast. The work forms part of a project undertaken by Dr Murphy to publish an excavation report on the prehistoric settlement at Northton in Harris on behalf of Historic Scotland.

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Glossary

Grain Size – **(a)** clay < 0.0039 mm in size; **(b)** silt, 0.0039 to 0.0625 mm in size; **(c)** fine sand, 0.0625 to 0.25 mm in size; **(d)** medium sand, 0.25 to 0.5 mm in size; **(e)** coarse sand, 0.5 to 1.0 mm in size; **(f)** very coarse sand, 1.0 to 2.0 mm in size; **(g)** granules 2.0 to 4.0 mm in size; **(h)** pebbles 4.0 to 64.0 mm in size.

Rounded – Describes the smoothness of the surface of a grain. The terms well-rounded, rounded, subrounded, subangular, angular, very angular are used to describe the increasingly angular/irregular/rough nature of the surface of detrital grains.

Sphericity – Describes the how closely a detrital grain approximates to a sphere. The terms low sphericity, moderate sphericity and high sphericity are used to describe how spherical (ball-like) the detrital grains are.

Sorting – Well sorted describes a deposit in which all the detrital grains are of approximately uniform size. In reality most fragmentary deposits contain a range of grain sizes and can be described as moderately sorted, poorly sorted or in extreme cases unsorted.

Packing – Describes, as the term suggests, how closely the individual detrital grains are packed together within a fragmentary deposit. The term closely packed is used where all the grains are in contact and there is very little obvious matrix or cement; moderately packed and open packed are used with an increase in the porosity, matrix and/or cement.

Clast supported – Describes a fragmentary deposit where all the detrital grains are in contact.

Cement supported – Describes a fragmentary deposit where the detrital grains are, to varying degrees, isolated/supported within the cement.

Cement – The material bonding the fragments of clastic sedimentary rocks together and which was precipitated between the grains after deposition.

Porosity – The volume of voids expressed as a percentage of the total volume of the sediment or sedimentary rock.

Matrix – Material, usually clay minerals or micas, forming a bonding substance to grains in a clastic sedimentary rock. The matrix material was deposited with the other grains or developed authogenically by diagenesis or slight metamorphism. Also used more generally for finer grained material in any rock in which large components are set.

Matrix supported – Describes a fragmentary deposit where the detrital grains are, to varying degrees, isolated/supported within the matrix.

Detritus – A general term for fragmentary material, such as gravel, sand, clay, worn from rock by disintegration. Detrital grains in clastic sedimentary rocks may be composed of single mineral grains (e.g. monocrystalline quartz, plagioclase), polycrystalline mineral grains (e.g. polycrystalline quartz) or lithic fragments including sedimentary, igneous and metamorphic rock fragments.

Summary

This report describes the mineralogy and petrology of a number of thin sections Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds collected from the Prehistoric settlement at Northton in South Harris. The work forms part of a multidisciplinary study being undertaken by Dr E. Murphy and Professor D. Simpson of the School of Archaeology and Palaeoecology, Queen's University of Belfast on behalf of Historic Scotland.

1 Introduction

This report describes the mineralogy and petrology of a number of thin sections Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds collected from the Prehistoric settlement at Northton in South Harris. The work forms part of a multidisciplinary study being undertaken by Dr E. Murphy and Professor D. Simpson of the School of Archaeology and Palaeoecology, Queen's University of Belfast on behalf of Historic Scotland.

1.1 THE PREHISTORIC NORTHTON SETTLEMENT

The complex stratified settlement site of Northton [NF 976 913] is situated on Toe Head, South Harris approximately 0.75 miles west of Northton Village which gives the site its name. The archaeology of the Northton site was described by Simpson (1976) and is briefly summarised here.

The Northton site lies beneath a thick deposit of windblown calcareous sand and was initially exposed in 1964 by wind and sea erosion. Six occupation horizons were recognised which are in general separated by a deposit of sterile, wind blown sand. The occupation levels consist of two later Neolithic, two Beaker and two Iron Age/Historic middens; the latter being associated with a series of grass covered enclosures on top of the dune. The earlier Neolithic occupation rests directly upon a deposit of glacial diamicton.

1.2 GEOLOGICAL BACKGROUND

The bedrock geology of the Outer Hebrides (Dearnley 1963; Fettes *et al*., 1992) is dominated by a suite of high-grade metamorphosed igneous and subordinate sedimentary rocks known as gneisses. These coarse-grained, crystalline basement rocks are Precambrian (Archean, 3000 to 1500 million years old) in age and collectively referred to as the Lewisian Gneiss Complex. The Outer Hebrides occupy a unique geological position in Europe, in that they represent a mere fragment of a much larger ancient craton, which was only finally broken up by the formation of the North Atlantic Ocean in Jurassic to recent times. Hence there nearest geological relatives are found in Greenland and eastern Canada, except for parts of the foundered continental material that make up the Rockall Plateau.

More recent, glacial and Holocene features and deposits recognised on the Outer Hebrides (Peacock 1984), are also dominated by Atlantic effects. On Uist, Bara and South Harris the main ice shed lay on the western side of the islands and ice movement took place from west to east into the Minches. The sand dune-machair system, which is commonly developed of the western seaboard, also results from the onshore movement of calcareous, shelly sand and fluvioglacial materials from the west by the prevailing westerly and southwesterly winds. The result is that these outermost islands of Scotland have a distinctive geology, dominated by Archean Lewisian Gneiss basement, and a peat- and sand-dominated cover.

The Northton settlement occurs within the south-western extremity of a belt of high-grade of metasedimentary rocks (The Leverburgh Belt, Dearnley 1963) intruded by a metabasic igneous intrusion and coarse-grained, granite pegmatites (see Fettes *et al*., 1992). The metasedimentary rocks include foliated quartz-feldspar-biotite (± garnet) gneisses and a suite of foliated metapelitic gneisses which contain the assemblage: garnet + kyanite + sillimanite + biotite + quartz + feldspar. The adjacent dark grey coloured metanorite (a metamorphosed variety of gabbro) crops out along the south-west coast of South Harris, and is well exposed at Rudh' an Teampuill, where it is relatively massive and locally retrogressed to feldspar-pyroxene-hornblende assemblage. On the western side of Rudh' an Teampuill, the metanorite is intruded by a dark grey porphyritic basalt dyke.

The metasedimentary gneisses and metanorite are separated by a prominent Laxfordian shear zone, which passes through the eastern end of Traigh an Teampuill about 270 metres to the west of the Northton site. Adjacent to this ductile fault zone the metanorite and metasedimentary rocks are highly deformed and bands of mylonite are locally developed within both lithologies. The Shear zone also contains a lenticular body of deformed garnet-bearing metagabbro.

For a more detailed description of the geology of the site the reader is referred to the accompanying report by Phillips (2001).

2 Analytical techniques

A total of sixteen samples of Neolithic (three samples), Beaker (four samples), Bronze Age (three samples), Iron Age (four samples) and Medieval (two samples) pottery sherds from the Northton settlement were submitted by Dr E. Murphy of the School of Archaeology and Palaeoecology, Queen's University of Belfast with a request for petrographic analysis. The objective of the study was to describe the mineralogy and petrology of the pottery shards.

A blue-dyed resin impregnated thin section was prepared from each of the seven samples, and examined using standard transmitted polarising light optical microscopy. The mineralogy and texture of the pottery has been described using standard geological terminology used for the description of sedimentary rocks and unconsolidated glacial materials in thin section. A glossary of the terminology used is provided at the beginning of this report.

The modal proportion of the various components present within the pottery sherds, i.e. the clay matrix, voids and various included components (temper), were determined using a Swift Automatic Point Counter. This technique is widely used by petrologists to determine the modal compositions of igneous, metamorphic and, in particular, sedimentary rocks. In the case of the sedimentary rocks modal/compositional analytical techniques are used as part of provenance studies. In these studies the data are used to establish the nature, composition and tectonic setting of the sedimentary source area.

A total of 500 counts per thin section were made to determine the overall composition of the pottery sherds. Modal compositions of the pottery sherds were calculated as volumetric proportions of the following categories: clay to fine-silt-grade matrix (**M**); voids (**V**); stable quartzose grains (**Q**) including both monocrystalline (**Qm**) and polycrystalline quartz (**Qp**); amphibole (**Hb**); monocrystalline feldspar grains including plagioclase (**Pl**) and K-feldspar (**Ksp**); unstable polycrystalline lithic fragments (**L**) of three main kinds, namely fine-grained igneous (**Lv**), amphibolite/metabasic (**La**) and metasedimentary and granitic (**Lm**) rock fragments. The total lithic component (**Lt**) of the sandstones was taken as the sum of the unstable lithic fragments (**L**) plus stable polycrystalline quartz lithic fragments (**Qp**). Other minor components include muscovite (**Mu**), biotite (**Bio**), garnet (**Gt**), opaque minerals (**Op**), chlorite (**Chl**), pyroxene (**Hb**) and epidote (**Ep**).

The 'raw' compositional data are recalculated to 100% (Table 1) and plotted on a series of bivariant and log-ratio diagrams (Figures 1 to 6) using a commercial spreadsheet package (Microsoft Excel V97).

3 Petrology of the pottery sherds

The following sections describe the mineralogy and petrology of the Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds collected from the Northton site. The terminology employed by geologists to describe unconsolidated sediments and sedimentary rocks (see Glossary) has been used to describe the pottery sherds. This approach was used due to the fragmentary nature of the pottery sherds in thin section

3.1 NEOLITHIC

Sample Number: 7.A.8 **Pottery Type:** Neolithic II, Hebridean Ware (rigid bowl)

Description: In thin section the matrix to this pottery sherd possesses a streaky colour banding ranging from olive-green to brown (under plane polarised light). The sherd has an open packed, poorly sorted and matrix supported texture (Plate 1a and b). Included fragments range from silt (<0.1 mm in size) up to granule in size (up to 2.7 mm across). These included clasts are angular to rarely subrounded in shape with a low to occasionally moderate sphericity. The grains, or clasts, are composed of a mixed assemblage of broken crystal fragments and subordinate rock fragments (lithics).

The crystal fragments are dominated by monocrystalline quartz, monocrystalline and polycrystalline plagioclase, as well as subordinate amphibole (hornblende and actinolite). Minor to accessory components include biotite, muscovite, chlorite, opaque minerals (e.g. Fe-oxide), pyroxene and K-feldspar (microcline). Rock fragments present within the sherd are, in general larger in size than the crystal fragments (Plate 1a and b). They are composed of a range of locally derived rock types including: fine-grained biotite granite, polycrystalline quartz (Plate 1a and b), quartzofeldspathic mylonite (Plate 2a), deformed very fine-grained basaltic rock and amphibolite/metanorite. All the ferromagnesian minerals (amphibole, pyroxene) are fresh and lack any signs of alteration. It is possible that some of the included opaque material may be carbonaceous in nature and, therefore, represent plant fragments being used as temper. A number of the voids are also rimmed/coated by opaque, possibly carbonaceous, material.

Elongate included grains are variably shape-aligned parallel to the margins of the sherd. These margins are sharp, with the outer convex surface being coated in a thin opaque, probably carbonaceous, film. No obvious glaze has been recognised. The decoration on the surface of the pot can also be recognised in thin section and is formed by asymmetrical tool marks on the outer surface of the sherd. Also present within the clay matrix of the sherd is a moderately well-developed foliation defined by a preferred optical alignment of the clay plasma (observed under crossed polarised light) and included mica flakes. This foliation occurs parallel to the margins of the sherd and wraps around the larger included grains. These grains are enclosed with poorly developed pressure shadows. These pressure shadows develop due to the included grains forming rigid bodies in the deforming clay matrix. The foliation is also deflected by the carved ornamentation on the surface of the sherd indication that the foliation developed during manufacture, prior to decoration.

Sample Number: 4.A.7 **Pottery Type:** Neolithic II, Unston Bowl

Description: In thin section the matrix to this pottery sherd possesses a streaky colour banding ranging from green-brown, to olive-green to red-brown (under plane polarised light). The sherd has a open packed, poorly sorted and matrix supported texture (Plate 1c to f). Included fragments typically range from coarse silt to fine-sand grade (≤ 0.25 mm) in size. However, occasional larger fragments are present, up to *c*. 2.8 mm in length. These included clasts are angular to subangular in shape with a low to moderate sphericity (Plate 1c and d). Rare subrounded clasts were also noted. The clast assemblage is mainly composed of broken crystal fragments with subordinate to minor rock fragments.

The crystal fragments are mainly composed of monocrystalline quartz, plagioclase and amphibole (hornblende). Amphibole is green in colour with a moderate to well developed pleochroism and typically forms euhedral crystals. Other minor to accessory components include biotite, epidote, microcline and titanite. The lithic fragments are largely composed of metamorphic rocks including fine-grained metabasic rock, biotite-quartz-gneiss, amphibolite (Plate 1c and d), metanorite, meta-granodiorite or dioritic rock, zoisite-bearing metamorphic rock and quartz mylonite and ultramylonite. No obvious alteration of the included grains has been recorded.

Occasional voids present within the matrix of the pottery sherd are lined by an opaque or carbonaceous material. These voids are interpreted as representing moulds after organic (plant) fragments. Rounded 'bubble' like voids are also present. The included grains exhibit a well developed preferred shape alignment parallel to the foliation present within the matrix and margins of the sherd. Clustering and a crude circular arrangement of medium to coarse sand-grade fragments has also been noted.

The foliation within the matrix of the sherd is defined by a length and optical alignment of the clay plasma (observed under crossed polarised light), included phyllosilicate minerals and elongate, wispy looking fractures or voids. The latter may represent shrinkage cracks formed in response to volume changes during water loss in response to either initial drying or subsequent firing of the pot. This matrix foliation was observed wrapping around the larger included grains and is distorted by the tool marks forming the decoration on the outside of the sherd (Plate 1e and f). This relationship suggests that the foliation developed early in the manufacture of the pot. The tool marks are symmetrical in shape and take the form of a flat bottomed 'V' shape (Plate 1e and f). The outer surface of the sherd is coated by traces of a thin opaque or carbonaceous film.

Sample Number: 6.A.2 **Pottery Type:** Neolithic II, Hebridean Ware, large bowl

Description: In thin section the matrix of this sherd is colour banded, grading from dark red-brown to pale olive-green(under plane polarised light). The dark colour of the matrix largely obscures any fine-scale textures or fabrics (Plate 2b). However, a well developed foliation defined by optically aligned clay plasma (observed under crossed polarised light) can be recognised at one end of the sherd (Plate 2c and d). This fabric occurs parallel to the margins of the sherd and in the more turbid areas of the thin section can be recognised by the presence of thin, wispy looking fractures or voids. The foliation wraps around included grains. The latter locally are enclosed within weakly developed pressure shadows. This relationship indicates that these included fragments acted as rigid objects within the weaker clay matrix which actively 'deformed' during manufacture of the sherd. The foliation is distorted and more 'wavy' in form than the planar foliation present within the matrix of the previously described sherd.

In general, the sherd has a open packed and matrix supported texture and contains poorly sorted include grains (Plate 2c to d). The included grains are a common component within the sherd and range up to *c*. 2.7 mm in size. They are mainly composed of crystal fragments with subordinate to minor rock fragments. The included grains are typically angular to subangular in shape with a low sphericity. However, rare subrounded grains are also present. The crystal fragments are mainly composed of monocrystalline quartz, green amphibole and plagioclase. Other minor to accessory crystal fragments include microcline, biotite, opaque minerals, epidote, titanite and brown hornblende. Rock fragments include amphibolite (Plate 2b) or metanorite, polycrystalline quartz, deformed biotite-granitic rock, two-feldspar granite and epidote-bearing quartzofeldspathic rock. No obvious alteration of the included ferromagnesian minerals or plagioclase feldspar has been noted within this sample. However, included biotite flakes are locally distorted and are 'split' along their basal (010) cleavage.

Shrinkage cracks were noted developed around the larger included grains. The outer margin of the sherd is irregular and poorly preserved in thin section. However, it appears to have been decorated by cuspate to truncated 'U' shaped tool marks. The inner surface of the sherd is smooth and coated by a very thin carbonaceous o opaque coating. Rare voids with a thin carbonaceous/opaque lining have also been recorded within this sherd.

3.2 BEAKER

Sample Number: B1.F.27 **Pottery Type:** Beaker I

Description: In thin section the matrix to this sherd ranges from dark brown to olive green (under plane polarised light) has a mottled or patchy appearance. The darker coloured areas are turbid to almost opaque. The matrix is massive with no obvious foliation, but does contain rounded to irregular voids. In general the sherd has a moderately sorted, silty appearance and contains occasional larger sand-grade included grains (Plate 2e). This sherd is clearly finer grained than the previously described Neolithic sherds.

Included grains, in general, range from medium to coarse silt in size (< 0.1 mm in size). However, occasional sand-grade clasts, up to c. 1.5 mm in diameter, are also present. In general, the included grains are angular to subangular in shape with a low to occasionally moderate sphericity. The larger included grains are mainly composed of sericitised plagioclase with subordinate monocrystalline and polycrystalline quartz, as well as minor amphibole. The finer grained clasts are composed of monocrystalline quartz, polycrystalline to cryptocrystalline quartz, hornblende, plagioclase, biotite, chlorite, white mica or muscovite, opaque minerals and very fine-grained schistose rock. A weakly developed circular arrangement and clustering of included grains was noted. Rare seed-shaped, elongate and rounded voids are also present and may contain carbonaceous/opaque remnants of possible organic temper.

The fine-scale, wispy looking fractures which are a common feature within the matrix of the Neolithic pottery sherds, are absent within this thin section. This may be a reflection of the reduced volume of included grains and higher matrix component within this sherd resulting in a more uniformly distributed volume change during drying/firing. The outer surface of the sherd is smooth and decorated by open 'U'-shaped tool marks. The outer and inner surfaces of the sherd are coated in a thin film of carbonaceous or opaque material.

This thin section of Beaker I pottery is compositionally similar to the Neolithic sherds but is distinguished by: (a) the lack of any obvious matrix foliation; (b) finer grained silty appearance; (c) higher degree of sorting of included grains; (d) finer grains size of included fragments; (e) darker coloured matrix; and (f) absence of fine-scale shrinkage cracks within the matrix.

Sample Number: B1.F.76 **Pottery Type:** Beaker I

Description: In thin section the matrix to this sherd is dark red-brown in colour (under plane polarised light) and possesses a massive, silty appearance (Plate 2f). No obvious foliation is developed within the matrix. In general, the sherd has a moderately to poorly sorted, open packed and matrix supported texture.

Included grains are typically coarse silt to fine sand-grade in size (< 0.2 mm in diameter). But larger clasts, up to *c*. 2.6 mm in length, are also present. The included grains are angular to subangular in shape with a low sphericity. However, rare subrounded grains have also been recorded.

The clasts are mainly composed of broken crystals with minor rock fragments. These lithic clasts typically form the larger included grains and are composed of amphibolite or metanorite, polycrystalline quartz, epidote-bearing mylonitic rock and deformed granite. Unlike, the previously described thin sections, this ample also contains rare shell fragments and possible echinoderm spines. Crystal fragments are mainly composed of monocrystalline quartz, plagioclase and amphibole. Other minor to accessory components include garnet, pyroxene, biotite, muscovite or white mica and microcline. Garnet forms a distinctive relatively common minor to accessory component within this sample. Some discolouration and/or oxidation of included biotite flakes was noted. In general, however, the crystal and rock fragments are fresh and show little evidence of alteration.

Rounded to irregular voids are a common feature within this thin section (Plate 2f). These voids do not show any signs of deformation (e.g. stretching) and may represent an artefact of the thin section making process. However, a small number of these rounded voids are lined by a thin film of opaque or carbonaceous material and, therefore, may represent moulds after organic temper.

Sample Number: B2.M.10.6 **Pottery Type:** Beaker II

Description: In thin section the matrix of this sherd is very dark red-brown in colour (under plane polarised light), possibly due to hematitic staining. Adjacent to the outer margin of the sherd the matrix is a slightly paler red-brown. In contrast to the Beaker I sherds, this sample is rich in included grains (Plate 3a) which exhibit a preferred shape alignment parallel to a matrix foliation defined by fine-scale, wispy looking fractures. However, no obvious optical alignment of the clay plasma within this sherd has been recognised, possibly due to the turbid nature of the matrix.

Included grains are angular to occasionally subangular in shape with a low sphericity. However, rare well rounded grains are also present. The clastic grains are typically less than 0.2 mm in size, but occasional larger grains range up to *c*. 2.5 mm in length. They are mainly composed of crystal fragments with minor lithic clasts (Plate 3a and b). The broken crystals are typically fresh and largely composed of monocrystalline quartz, plagioclase and amphibole (Plate 3b). Minor to accessory components include epidote, garnet (Plate 3b), pyroxene, altered feldspar, biotite and opaque minerals. The rock fragments comprise amphibolite or metanorite, sieve textured amphibole with quartz/feldspar inclusions, deformed quartzofeldspathic metamorphic rock and polycrystalline quartz. Biotite shows some discolouration and/or replaced by hematitic oxide.

Rounded to irregular voids are locally lined by a thin film of opaque or carbonaceous material.

Sample Number: B2.H.93 **Pottery Type:** Beaker II

Description: In thin section is texturally similar to the previously described Neolithic II pottery sherds, rather than the finer grained, darker coloured Beaker sherds. This clast-rich sample possesses a coarse-grained, poorly sorted, matrix supported texture. The matrix displays a distinct colour banding (under plane polarised light) ranging from olive-green to brown.

Included grains are angular to subangular in shape with a low to occasionally moderate sphericity. They are mainly composed of broken crystals with subordinate rock fragments; the latter tending to form the coarser grains clasts. The crystals are largely composed of monocrystalline quartz, green hornblende and plagioclase. Minor to accessory components include garnet, epidote, sericitised feldspar, titanite, microcline, pyroxene and opaque minerals. Although the crystal fragments are typically fresh, some oxidation of biotite flakes and sericitisation of plagioclase feldspar were noted. The lithic clasts present within this sherd include amphibolite or metanorite, polycrystalline quartz, fine-grained quartzofeldspathic metamorphic rock, polycrystalline clinozoisite, biotite-muscovite-granitic rock and altered amphibolite. The alteration of feldspar and amphibolite lithic clasts appears to have been a primary feature of these clasts, i.e. did not occur as a result of the firing process. Biotite is variably altered to or replaced by hematitic oxide and shows signs of expansion, resulting in splitting along its basal (010) cleavage.

A foliation within this sherd is defined by a preferred shape alignment of elongate grains and fine-scale, wispy looking fractures developed in the matrix. Any optical orientation of the clay plasma, if developed, is masked by the dark coloured, turbid nature of the matrix. The foliation was observed wrapping around the larger included grains. Both surfaces of the sherd are smooth. However, slight irregularities on one side may represent very shallow tool marks.

3.3 BRONZE AGE

Sample Number: 17.SF.47 **Pottery Type:** Bronze Age, clipped from larger rim sherd

Description: In thin section this sherd has a medium- to coarse-grained, poorly sorted, matrix supported texture. The matrix is colour banded ranging from dark, turbid red-brown to olive-green (under plane polarised light). Importantly there is no obvious compositional difference between these two areas of the thin section. The change in colour is relatively sharp, with very little obvious gradation between the two bands. The dark red-brown to brown colour appears to be a product of the staining of the matrix either during firing, domestic use or subsequent burial. The matrix is massive and lacks any obvious foliation.

Included grains range from coarse silt to medium/coarse sand grade. However, occasional larger included grains which range from 2.0 mm up to 6.0 mm in length, are also present. These larger clasts are composed of basalt rock fragments and are angular to subangular in shape with a low sphericity (Plate 3c and d). These large basaltic lithic clasts form a distinctive feature of this Bronze Age sherd. The finer grained clasts are angular to subangular in shape with a low to occasionally moderate sphericity. These finer included grains are mainly composed of plagioclase, amphibole and monocrystalline quartz. Other minor to accessory components include amphibolite or metanorite, biotite, opaque minerals, polycrystalline quartz, epidote and garnet. No basalt rock fragments have been observed within the finer grained included components within this sherd. A slight alteration or discolouration of amphibole crystal fragments was noted associated with the dark brown coloured/stained matrix.

Occasional rounded to elongate voids are lined by an opaque or carbonaceous coating. These voids are surrounded by a haloe of brown (?hematitic) stained matrix. Shrinkage cracks and open fractures are developed enclosing larger included grains. These fractures probably developed due to volume loss during the shrinkage of the clay matrix to the sherd in response to firing.

Sample Number: 23.SF.118 **Pottery Type:** Bronze Age, small rim sherd from cordoned urn

Description: In thin section this sherd has a medium-grained, poorly sorted, matrix supported texture. The matrix is dark brown and contains a relatively high proportion of open voids, the latter forming *c*. 15 to 20% of the total matrix component.

Included grains, in general, range from coarse silt to medium sand-grade in size and are angular to subangular in shape with a low to moderate sphericity. However, occasional subrounded clasts are also present. The sherd is characterised by the presence of larger (1.5 to 6.0 mm in length), angular to subangular, low sphericity basalt rock fragments. These basaltic lithic clasts are weakly altered to hematitic oxide. In contrast, the finer grained included clasts are mainly composed of plagioclase and monocrystalline quartz, with minor to accessory pyroxene. Other minor to accessory components include opaque minerals and biotite. Basaltic lithic clasts are absent from this finer grained assemblage. Biotite and the other included ferromagnesian minerals show some alteration to hematitic oxide.

A weak clustering and circular arrangement of the finer grained included grains is locally developed within this sherd. One large, approximately 3.5 mm long, curved void containing minor amounts of carbonaceous/opaque material may represent a fragment of included organic material.

Sample Number: 39.SF.61 **Pottery Type:** Bronze Age, small sherd clipped from larger base

Description: In thin section this sherd has a coarse-grained, poorly sorted, matrix supported texture. Two distinct colour bands have been noted within the matrix. The ‘inner’ part of the sherd is green to olive-green in colour (under plane polarised light). In contrast, in the ‘outer’ part of the sherd is red-brown to dark brown in colour. The margin of this part of the sherd is coated by a thin film of carbonaceous or opaque material. There is no obvious compositional differences between these two colour bands. The colour difference appears to be a secondary feature as a result of staining and/or firing. The matrix is massive with no obvious alignment of clay plasma.

Included grains range from coarse silt up to very coarse sand, or even granule, size. These grains are angular to subangular in shape with a low to occasionally moderate sphericity. The grains are mainly composed of monocrystalline quartz, plagioclase and amphibole. Amphibolite or metanorite lithic fragments are also a common minor component within this sherd. Other minor to accessory components include pyroxene, garnet, garnet-bearing gneiss, hornfels, kyanite- or sillimanite-bearing metasedimentary rock, granitic rock and opaque minerals. Garnet is a relatively common minor/accessory component within this sherd.

A small number of fractures within the sherd are filled by a fine-grained carbonate mineral. This carbonate mineralisation is probably secondary in nature and occurred after burial. Occasional rounded, irregular and rare arcuate voids are locally lined by carbonaceous/opaque material. The outer edge of the sherd is smooth, which contrasts with the irregular inner margin. A weakly developed circular arrangement of small, silt-grade clasts was noted enclosing the larger included grains.

3.4 IRON AGE

Sample Number: 51.SF.403 **Pottery Type:** Early to Mid Iron Age, small everted neck sherd

Description: In thin section this sherd possesses a fine-grained, moderately sorted, matrix supported texture. The matrix once again possesses a distinct colour banding (Plate 3e) with approximately 75% of the matrix being green to olive green in colour (under plane polarised light). The outer part of the sherd is dark brown in colour with a thin film of opaque or carbonaceous material coating the surface. No obvious compositional differences have been recognised between these two areas of the sherd. The colour variation, therefore, appears to be a secondary staining effect.

Included grains are angular to subangular in shape with a low to moderate sphericity (Plate 3e). Rare subrounded clasts have also been recorded. The included grains are mainly composed of monocrystalline quartz, plagioclase and subordinate to minor amphibole. Amphibole is, in general, fresh and exhibits a moderately developed pleochroism from green to green-brown. It does, however, locally show a slight discolouration/alteration to a honey brown colour; in particular within the stained portion of the sherd. Minor to accessory included components include opaque minerals, variably oxidised biotite, polycrystalline plagioclase, amphibolite or metanorite rock fragments, epidote and polycrystalline quartz.

Elongate voids are lined, or partially filled by carbonaceous or opaque material and are interpreted as being the remnants of organic temper. A well developed foliation is defined by the preferred shape alignment of included grains and small-scale, elongate voids or cracks within the matrix. This fabric occurs parallel to the margins of the sherd and was also observed wrapping around the larger included grains. The intensity of the foliation apparently decreases in the outer stained portion of the sherd. This is primary due to a marked decrease in the modal volume of voids within the matrix, these where probably filled by secondary opaque oxides.

Sample Number: 55.SF.58 **Pottery Type:** Early to Mid Iron Age, small sherd clipped from a larger decorated sherd

Description: In thin section this sherd is distinct and possess a fine-grained, poorly sorted, matrix-rich texture. Unlike the previous described pottery fragments, this sample is relatively poor in included grains which occur scattered throughout the sherd (Plate 3f). The matrix is very dark brown in colour to almost opaque (Plate 3f). An original, possibly well-developed foliation may have been present within the matrix defined by optical alignment of the clay plasma (observed under crossed polarised light).

Included grains are angular to subangular in shape with a low sphericity. Occasional rounded grains are also present. Elongate grains are aligned parallel to the margins of the sherd and the poorly preserved foliation present within the matrix. The included grains are mainly composed of plagioclase, amphibole and monocrystalline quartz. Amphibole is fresh with a moderately developed green to green-brown pleochroism. Other minor to accessory components include amphibolite or metanorite rock fragments, polycrystalline quartz, variably oxidised biotite and epidote. No obvious garnet and/or pyroxene have been recognised within the clast assemblage. Carbon/opaque lined voids after included organic fragments have also been recognised within this sherd.

Sample Number: 64.SF.100 **Pottery Type:** Late Iron Age, small sherd clipped from a larger rim sherd

Description: In thin section this sherd possesses a coarse-grained, very poorly sorted, matrix supported texture and is compositionally similar to the Bronze Age sherds (samples 17 and 23). This Iron Age sample possesses a distinct bimodal grain size with larger 0.5 to 5.5 mm long lithic clasts set within a finer grained sandy textured ground (Plate 4a). The large included grains are angular to subangular in shape with a low sphericity. These clasts are mainly composed of olivine microporphyritic basalt and subordinate amphibolite. These elongate lithic fragments are aligned parallel to the margins of the sherd.

The finer grained clasts range from coarse silt to medium sand in size. They are angular to subangular in shape with a low to moderate sphericity. The clasts are mainly composed of monocrystalline quartz, plagioclase and amphibole. Amphibole is fresh and ranges from green to green-brown in colour. The basaltic lithic fragments are apparently restricted to the coarse grain fraction. Other minor to accessory components include polycrystalline quartz, biotite, epidote-amphibolite, pseudomorphs after olivine and epidote. Biotite is variably altered to, or pseudomorphed by opaque oxide.

The matrix to the sherd is dark brown in colour with a thin carbonaceous/opaque coating upon both margins of the sherd. A weak shape alignment of the included grains defines a crudely developed foliation which occurs parallel to the margins of the sherd.

Sample Number: 81.SF.58 **Pottery Type:** Late Iron Age, small sherd clipped from a larger rim sherd

Description: In thin section this clast-rich sherd possesses a coarse-grained, poorly to very poorly sorted, matrix supported, open packed texture (Pate 4b). A weakly developed staining of the matrix is present along one margin of the sherd. However, in general the chloritic/clay matrix is green in colour.

Included grains range from coarse silt to very coarse sand in size and are angular to subangular in shape with a low to occasionally moderate sphericity. Rare subrounded clasts are also present. The included grains are mainly composed of plagioclase, monocrystalline quartz and amphibole. Amphibole is fresh, with a moderately developed green to green-brown pleochroism. Other minor to accessory components include amphibolite or metanorite lithic fragments, pyroxene, opaque minerals, epidote, epidote-bearing metamorphic rock, biotite, garnet, polycrystalline quartz, granitic rock, rutile and titanite.

The sherd is massive with no obvious foliation developed within the matrix. Rounded to elliptical voids are a distinctive minor feature within this sample (Plate 4b). Rare very thin, arcuate voids, representing moulds after included organic temper, have been recognised.

3.5 MEDIEVAL OR LATER

Sample Number: 91.SF.40 **Pottery Type:** Medieval or later, small sherd clipped from larger rim sherd

Description: In thin section this sherd possesses a medium-grained, poorly sorted, open packed, matrix supported texture (Plate 4c). The matrix is colour banded with two distinct bands, one green, the other dark brown. No obvious compositional differences have been recognised between these two parts of the sherd. A foliation is developed and defined by elongate, small-scale, wispy looking voids or fractures and a preferred shape alignment of included grains. This fabric occurs parallel to the margins of the sherd and wraps around the larger included grains.

Included grains are angular to subangular with a low to moderate sphericity. Occasional subrounded grains have also been recorded. The fragments are mainly composed of plagioclase, monocrystalline quartz and amphibole. Amphibole is green to green-brown in colour with a weakly to moderately well-developed pleochroism. Minor to accessory components include amphibolite or metanorite rock fragments, pyroxene, polycrystalline quartz, opaque minerals, epidote, garnet, biotite and titanite. Amphibole and pyroxene are both fresh and show no evidence of alteration during the firing process.

Arcuate voids after possible included organic fragments are more common within this sherd and are lined by a carbonaceous or opaque material (Plate 4c). The margins of the sherd are both planar and coated by a thin carbonaceous or opaque film. A weakly developed clustering and crude circular arrangement of the finer included grains was noted within this sherd.

Sample Number: 93.SF.40 **Pottery Type:** Medieval or later, small rim sherd

Description: In thin section this sherd possesses a fine- to medium-grained, poorly sorted, open packed, matrix supported texture and contains occasional very coarse sand-grade included fragments (Plate 4d). This sherd is compositionally and texturally very similar to the previously described thin section. A foliation present within the matrix of this sample is defined by small-scale, wispy looking fractures and a variably developed preferred shape alignment of included grains. This foliation occurs parallel to the margins of the sherd which are coated by a thin film of opaque or carbonaceous material. The matrix is dark brown to brown in colour.

Included grains are angular, subangular to occasionally subrounded in shape with a low sphericity. They are mainly composed of plagioclase, monocrystalline quartz and amphibole crystal fragments. Amphibole is fresh and ranges from green to green-brown in colour. Minor to accessory detrital components include amphibolite or metanorite rock fragments, polycrystalline quartz, epidote, biotite, opaque minerals, pyroxene, polycrystalline plagioclase, granitic rock fragments, microcline, clinozoisite, muscovite and garnet.

Elongate to irregular voids (Plate 4d), which are locally lined by a thin film of carbonaceous or opaque material, are interpreted as moulds after included organic fragments. The presence of organic fragments (temper) within the Medieval pottery sherds is more obvious than the other sherds examined during this study.

4 Compositional Analysis of Pottery Sherds

The modal proportion of the various components present within the Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds have been determined using a Swift Automatic Point Counter (Table 1). The composition of the sherds are described in terms of volumetric proportions of the matrix, voids, crystal fragments and rock fragments The resultant compositional data can be used to establish the likely source or provenance of the clay and/or temper used in the manufacture of the sherds.

A number of observations can be made with respect to the variation in modal compositions of the pottery sherds:

- All the sherds are similar in composition and in general plot in the same area on Figures 1 and 2. This may be used to suggest that they were derived from the same or very similar source.

- Although compositionally similar minor variations in modal composition can be recognised with sherds from a particular age plotting in a cluster on Figures 1 and 2.

- The early to Mid Iron Age and Beaker 1 pottery sherds in general have a higher matrix content that the other sherds examined during this study (Figures 1 and 2, and Table 1). In contrast, the Late Iron Age samples possess the lowest matrix content.

- Neolithic II pottery sherds are distinguished by their higher polycrystalline quartz (Figure 1a) and biotite (Figure 2c) contents. These sherds also, in general, contain a higher proportion of other metamorphic rock fragments (Plate 2a), including metasedimentary rock and quartzofeldspathic mylonite.

- The Bronze Age, Beaker I and Early to Mid Iron Age sherds typically contain a lower proportion of included amphibolite rock fragments (Figure 1d). These sherds, along with two of the Neolithic II sherds, also exhibit and overall lower amphibole content (Figure 2b).

The compositional differences highlighted using the bivariant plots can also be seen when the data is plotted on a series of log-ratio diagrams (Figure 3). In Figure 3 the matrix component of the sherds has been used as a normalising factor.

Compositional data obtained for the various sherds have been plotted on a series of histograms and variation diagrams to highlight any variation in composition with age (Figures 4 and 5, respectively). These diagrams show that in general over 50% of the sherd is composed of fine-grained clay matrix (Figures 4a and 5a, also see Table 1). However, overall the modal proportion of the matrix component decreases within the progressively younger sherds (Figure 5a). The proportion of voids within the sherds remains relatively constant (Figure 5a).

The included grains present within the sherds are mainly composed of monocrystalline quartz and plagioclase crystal fragments (Figures 4b and 5b). However, overall the included grains present within all the sherds is dominated by mineral (plagioclase, amphibole) and rock fragments (amphibolite) derived from metamorphosed basic igneous rocks. The variation in amphibole crystal fragments present within the sherds clearly mimics that of amphibolite rock fragments (Figure 5c). Metasedimentary and granitic rock fragments (Lm) occur in all the sherds but form a greater proportion of the mode of the Neolithic and Beaker I sherds (Figures 4b and 5c). Polycrystalline quartz, biotite and, to a lesser extent garnet show a similar pattern of variation as these metamorphic and granitic lithic fragments (Figure 5).

Two of the Bronze Age and one of the Late Iron Age sherds are distinguished by the presence of basalt rock fragments (Figures 4b and 5c). It is possible that the one Late Iron Age sherd may be in fact Bronze Age. The basaltic lithic clasts are absent in all the other sherds. Pyroxene, although present in small proportions in most of the sherds, shows a marked rise in concentration within the Bronze Age pottery (Figure 5d). Pyroxene within these sherds may have been derived from basalt. In the pottery sherds from the other time periods the pyroxene component may have been derived from the a high-grade meta-igneous rock (e.g. metanorite).

5 Provenance of the pottery sherds

It is clear from the petrological descriptions and compositional analysis of the pottery sherds from the Northton site that they are compositionally very similar (Figure 6). This similarity in composition suggests that the clay used in the manufacture of all the pottery, irrespective of age, was derived from the same or a very similar source. The range in mineral and rock fragments present within these sherds clearly reflect the geology of the area around the Northton settlement.

The metasedimentary and granitic rock fragments, and associated mineral components (biotite, polycrystalline quartz, garnet) were probably derived from the Lewisian Complex exposed in the immediate area of the site. The Northton settlement occurs within the south-western extremity of a belt of high-grade of metasedimentary rocks (The Leverburgh Belt, Dearnley 1963) which are intruded by coarse-grained, granite pegmatites (see Fettes *et al.*, 1992). These metasedimentary rocks include foliated quartzofeldspathic gneisses and metapelitic gneisses which locally contain garnet.

The included grains present within the pottery sherds are, however, dominated by mineral (plagioclase, amphibole, epidote, pyroxene) and rock fragments (amphibolite, metagabbroic rock) derived from a metamorphosed basic igneous rocks. Such rocks are well exposed immediately to the north of the Northton Site at Rudh' an Teampuill. In this area the relatively massive metanorite (a metamorphosed variety of gabbro) is locally retrogressed to feldspar-hornblende-dominated assemblage (amphibolite).

The two Bronze Age and one of the Late Iron Age pottery sherds which contain basalt rock fragments are compositionally very distinctive. Basaltic intrusions are not common in the Northton site area. However, on the western side of Rudh' an Teampuill, the metanorite of the Lewisian Complex is intruded by a dark grey porphyritic basalt dyke. Basalt rock fragments are absent in all the other sherds examined, probably reflecting the uncommon nature of these intrusions and small size of the basalt dyke exposed at Rudh' an Teampuill. Consequently, it is likely that these basaltic rock fragments were specifically collected from this small intrusion.

Also present in some of the sherds are fragments of highly deformed mylonitic rocks. These rock fragments may have been derived from a ductile fault zone (shear zone) which passes through the eastern end of Traigh an Teampuill about 270 metres to the west of the Northton site and separates the metasedimentary gneisses from the metanorite.

The green colouration of the matrix of the matrix of the pottery sherds suggests that it is rich in chlorite minerals. The dark brown staining of the matrix probably results from the firing process which was carried out using a peat fired kiln (M. Johnson 2001 personal communication). The potentially chlorite-rich nature of the matrix to the sherds is considered to also reflect the predominantly basic igneous metamorphic provenance of the clay. Chlorite is a common alteration of ferromagnesian minerals such as pyroxene and amphibole, both of which occur within the minerals assemblage of the metanorite and associated amphibolites.

It is concluded, therefore, that the clay used for the manufacture of the pottery sherds was locally derived, possibly within only a few hundred metres of the Northton settlement. The most likely source for the clay is the till deposited during the last glaciation. On Uist, Bara and South Harris the main ice movement took place from west to east into the Minches. Consequently, the till in the Northton area is likely to be dominated by fragments of basic meta-igneous material which crops out to the northwest of the settlement.

The more recent deposits of calcareous, shelly sand was not used in the manufacture of the pottery as all the sherds lack any obvious evidence of shell fragments being used as temper; a conclusion supported during detailed visual examination of the sherds (M. Johnson 2001 personal communication). The only organic temper used appears to have been plant material. In the majority of the sherds the plant material may have been included accidentally. However, voids lined by carbonaceous material are a common feature within the Medieval pottery sherds. The used of grass and/or other plant material during the manufacture of Medieval pottery was a common practice in the Outer Hebrides (M. Johnson 2001 personal communication).

6 Conclusions

A number of conclusions can be made concerning the composition and texture of the Northton pottery sherds in thin section:

- The Neolithic pottery is coarse-grained with an open packed, poorly sorted and matrix supported texture. Angular, low to occasionally moderate sphericity included grains are composed of a mixed assemblage of broken crystal fragments and subordinate rock fragments (lithics).

- The Beaker I pottery sherds are, in general, moderately sorted, fine-grained with an overall silty texture. They are differentiated from the Neolithic pottery by a lack of any obvious matrix foliation, finer grained silty appearance, higher degree of sorting of included grains, finer grain size of included fragments and overall darker colour of the matrix.

- The younger Beaker II pottery are richer in included grains than the Beaker I sherds and are medium- to coarse-grained with a poorly sorted, matrix supported texture.

- The Bronze Age pottery sherds are medium- to coarse-grained with poorly sorted, matrix supported texture. But are distinguished by the presence of large (2.0 to 6.0 mm) basalt rock fragments.

- The Early to Mid Iron Age sherds are matrix-rich and possesses a fine-grained, moderately to poorly sorted, matrix supported texture. They may possess a well developed foliation defined by the preferred shape alignment of included grains and small-scale, elongate voids or cracks within the matrix.

- The Late Iron Age sherds are coarse-grained, very poorly to very poorly sorted, open packed, matrix supported texture. One of these sherds is compositionally similar to the Bronze Age pottery, containing large basalt rock fragments.

- The younger Medieval pottery sherds possesses a medium-grained, poorly sorted, open packed, matrix supported texture. They are matrix rich and distinguished by the presence of arcuate voids lined by carbonaceous material.

- The crystal fragments present within the sherds are dominated by monocrystalline quartz, plagioclase, as well as amphibole. Rock fragments present are, in general, larger in size than the crystal fragments and composed of a range of amphibolite, metanorite, metasedimentary gniess and granite. However, the bulk of the included are dominated by mineral (plagioclase, amphibole, epidote, pyroxene) and rock fragments (amphibolite, metagabbroic rock) derived from a metamorphosed basic igneous rocks. All the ferromagnesian minerals (amphibole, pyroxene) are fresh and lack any signs of alteration; possibly reflecting the low temperature of firing of the pottery.

- Tool marks which form the decoration on the surface of pottery has also be recognised in thin section. The shape of this carved indentation varies probably reflecting the shape ('V', 'U' shaped indentations noted) of the tools used.

- The matrix of the pottery sherds may possess a weakly to moderately well-developed foliation defined by a preferred optical alignment of the clay plasma (observed under crossed polarised light). Elongate included grains and wispy looking fractures (probably shrinkage cracks formed during drying or firing) may also be aligned parallel to this foliation. The foliation typically occurs parallel to the margins of the sherd and may wrap around the larger included grains. The foliation is also deflected by the carved ornamentation on the surface of the sherd indication that the foliation developed during manufacture, prior to decoration.

- All the pottery sherds from the Northton site are compositionally very similar. However, minor variations in modal composition have been recognised which can be used to discriminate between sherds of different ages. The similarity in composition suggests that the clay used in the manufacture of all the pottery, irrespective of age, was derived from the same or a very similar source. The range in mineral and rock fragments present within these sherds clearly reflect the geology of the Northton Site area. Particular rock fragments identified in thin section can, with care, be related to specific lithological units exposed within the immediate area around the Northton Site.

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Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

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Figures

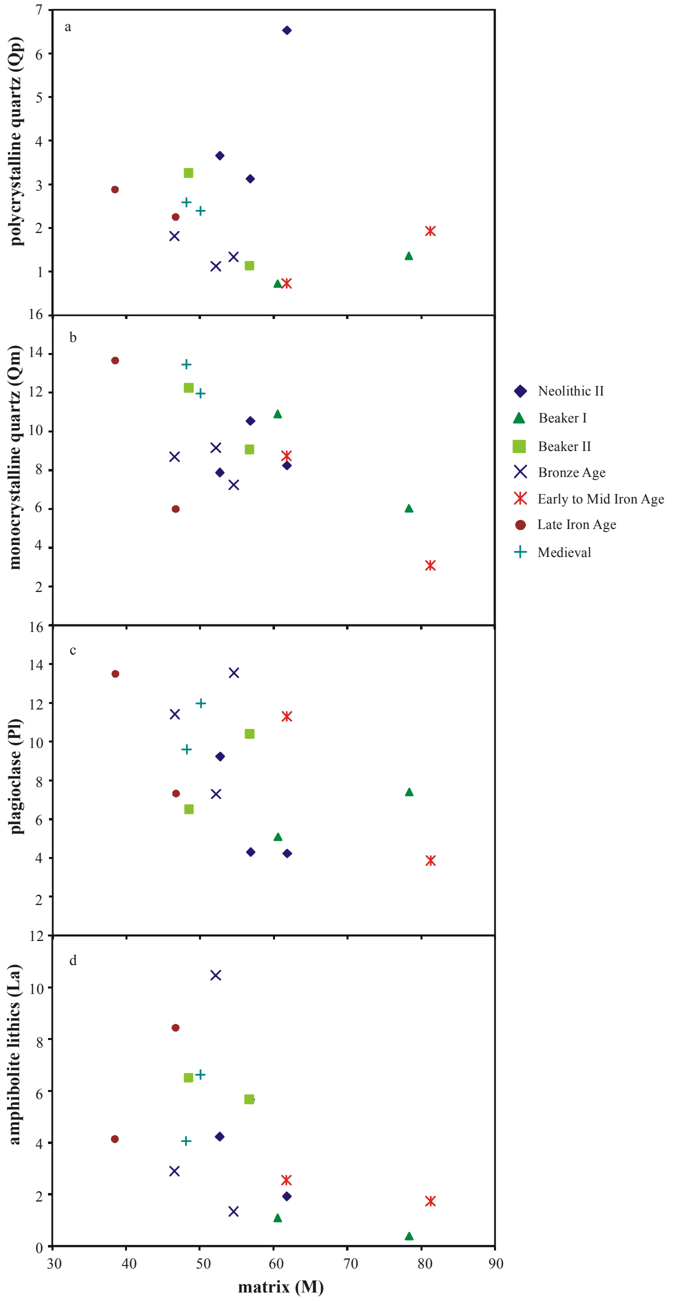

Figure 1. Bivariant plots showing the variation in modal composition of Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds with respect to the matrix component. **(a)** polycrystalline quartz (Qp); **(b)** monocrystalline quartz (Qm); **(c)** plagioclase (Pl); **(d)** amphibolite lithic fragments (La).

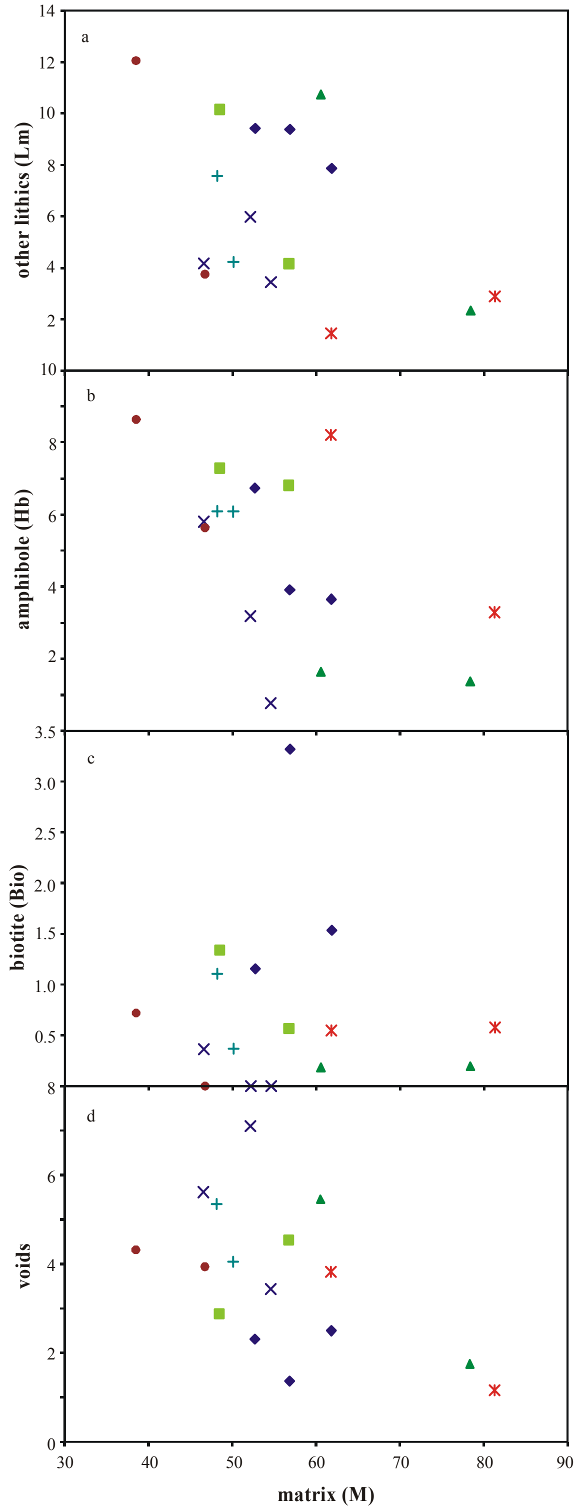

Figure 2. Bivariant plots showing the variation in modal composition of Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds with respect to the matrix component. **(a)** other metamorphic lithic clasts (Lm); **(b)** amphibole (Hb); **(c)** biotite (Bio); **(d)** voids (V).

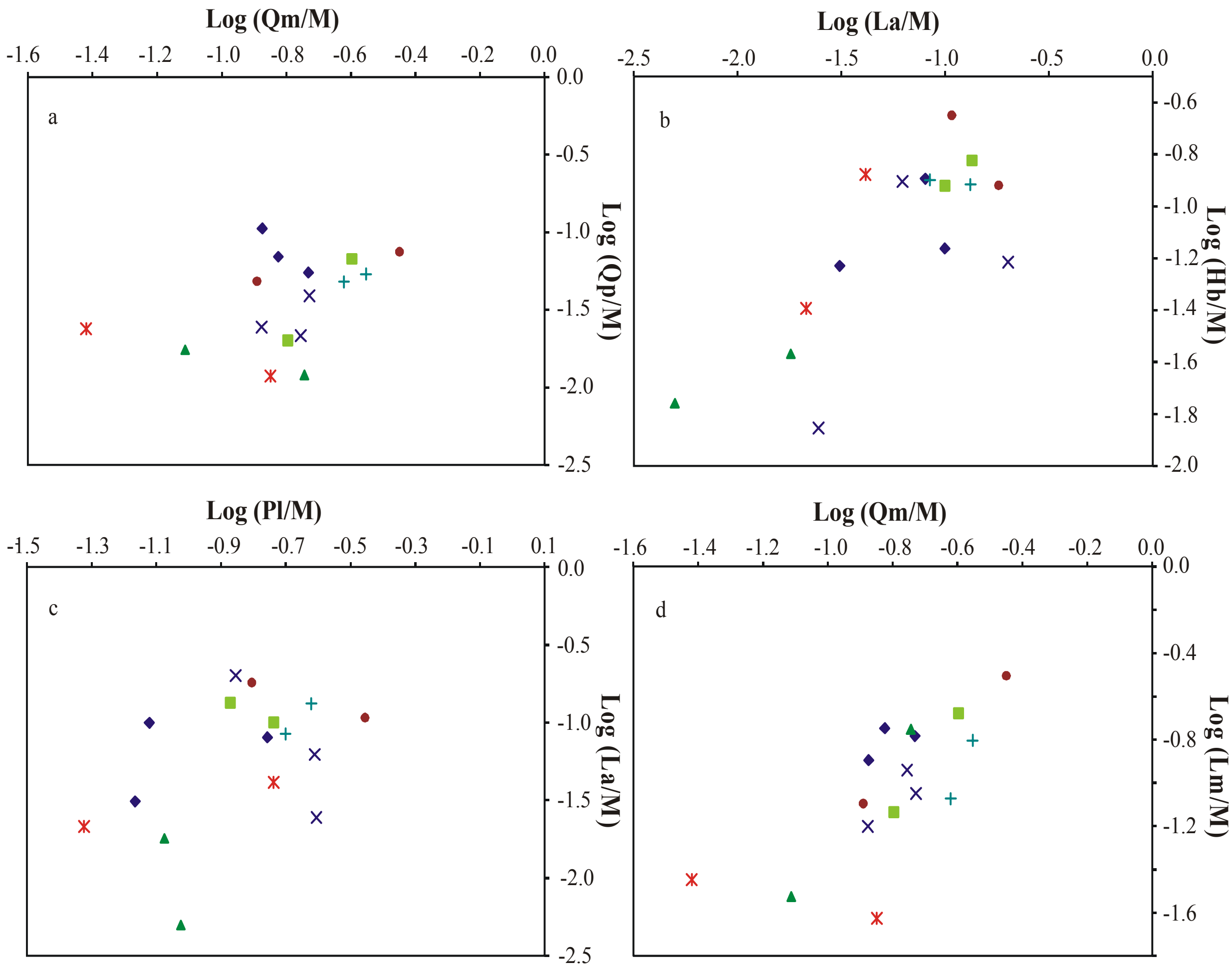

Figure 3. Log-ratio plots showing the variation in modal composition of Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds. **(a)** Log (Qm/M) versus Log (Qp/M); **(b)** Log (La/M) versus Log (Hb/M); **(c)** Log (Pl/M) versus Log (La/M); **(d)** Log (Qm/M) versus Log (Lm/M).

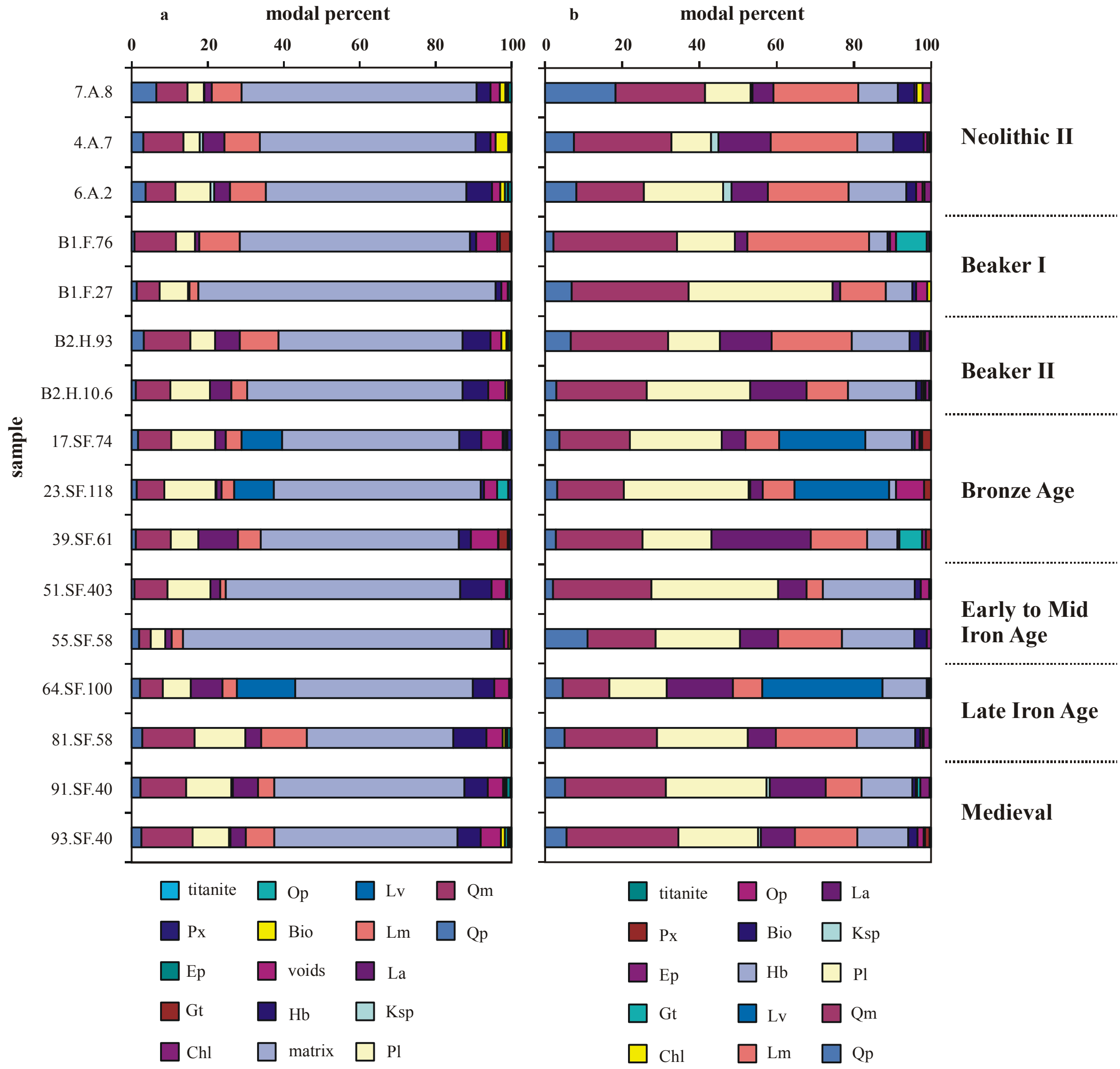

Figure 4. Histograms showing the variation in modal composition of Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds. **(a)** Modal percent including matrix. **(b)** Modal percent of total included grains.

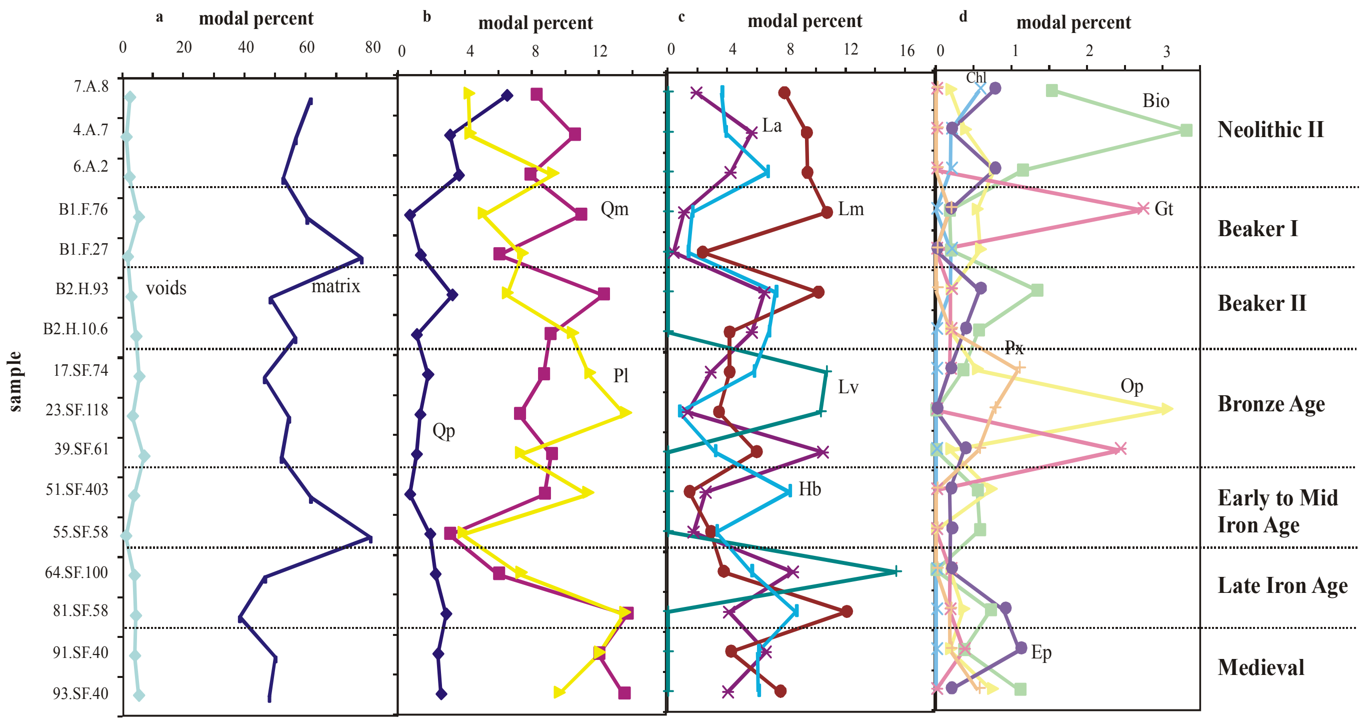

Figure 5. Diagrams showing variation in selected components within Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds. **(a)** voids, matrix; **(b)** polycrystalline quartz (Qp), monocrystalline quartz (Qm), plagioclase (Pl); **(c)** amphibole (Hb), basalt lithic fragments (Lv), amphibolite lithic fragments (La), other metamorphic lithic clasts (Lm); **(d)** chlorite (Chl), biotite (Bio), pyroxene (Px), garnet (Gt), opaque minerals (Op) and epidote (Ep).

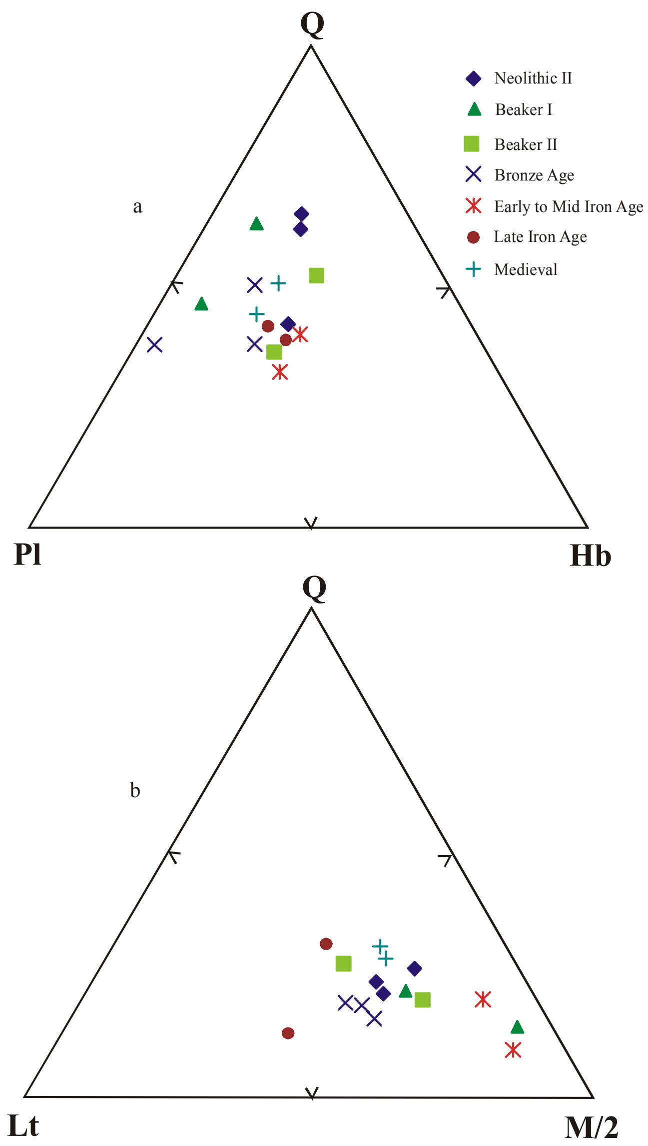

Figure 6. Ternary plots showing variation in modal composition of Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds. **(a)** quartz-plagioclase-amphibole; **(b)** quartz-total lithic clasts-(matrix/2).

Tables

Table 1. Modal compositional data obtained for Neolithic, Beaker, Bronze Age, Iron Age and Medieval pottery sherds.

		Recalculated as percentage of total								
Sample	**Age**	**N**	**Qp**	**Qm**	**Pl**	**Ksp**	**La**	**Lm**	**Lv**	**matrix**
7.A.8	Neolithic II	521.00	6.53	8.25	4.22	0.19	1.92	7.87	0.00	61.80
4.A.7	Neolithic II	512.00	3.13	10.55	4.30	0.78	5.66	9.38	0.00	56.84
6.A.2	Neolithic II	520.00	3.65	7.88	9.23	0.96	4.23	9.42	0.00	52.69
B1.F.76	Beaker I	550.00	0.73	10.91	5.09	0.00	1.09	10.73	0.00	60.55
B1.F.27	Beaker I	513.00	1.36	6.04	7.41	0.00	0.39	2.34	0.00	78.36
B2.H.93	Beaker II	522.00	3.26	12.26	6.51	0.00	6.51	10.15	0.00	48.47
B2.H.10.6	Beaker II	529.00	1.13	9.07	10.40	0.00	5.67	4.16	0.00	56.71
17.SF.74	Bronze Age	552.00	1.81	8.70	11.41	0.00	2.90	4.17	10.69	46.56
23.SF.118	Bronze Age	524.00	1.34	7.25	13.55	0.19	1.34	3.44	10.31	54.58
39.SF.61	Bronze Age	535.00	1.12	9.16	7.29	0.00	10.47	5.98	0.00	52.15
51.SF.403	Early Iron Age	549.00	0.73	8.74	11.29	0.00	2.55	1.46	0.00	61.75
55.SF.58	Early Iron Age	518.00	1.93	3.09	3.86	0.00	1.74	2.90	0.00	81.27
64.SF.100	Late Iron Age	533.00	2.25	6.00	7.32	0.00	8.44	3.75	15.38	46.72
81.SF.58	Late Iron Age	556.00	2.88	13.67	13.49	0.00	4.14	12.05	0.00	38.49
91.SF.40	Medieval	543.00	2.39	11.97	11.97	0.37	6.63	4.24	0.00	50.09
93.SF.40	Medieval	542.00	2.58	13.47	9.59	0.37	4.06	7.56	0.00	48.15
		Recalculated as percentage of total								
Sample	**Age**	**Hb**	**voids**	**Bio**	**Op**	**Chl**	**Gt**	**Ep**	**Px**	**Sphene**
7.A.8	Neolithic II	3.65	2.50	1.54	0.19	0.58	0.00	0.77	0.00	0.00
4.A.7	Neolithic II	3.91	1.37	3.32	0.39	0.20	0.00	0.20	0.00	0.00
6.A.2	Neolithic II	6.73	2.31	1.15	0.77	0.19	0.00	0.77	0.00	0.00
B1.F.76	Beaker I	1.64	5.45	0.18	0.55	0.00	2.73	0.18	0.18	0.00
B1.F.27	Beaker I	1.36	1.75	0.19	0.58	0.19	0.00	0.00	0.00	0.00
B2.H.93	Beaker II	7.28	2.87	1.34	0.19	0.19	0.19	0.57	0.00	0.19
B2.H.10.6	Beaker II	6.81	4.54	0.57	0.19	0.00	0.19	0.38	0.19	0.00
17.SF.74	Bronze Age	5.80	5.62	0.36	0.54	0.00	0.18	0.18	1.09	0.00
23.SF.118	Bronze Age	0.76	3.44	0.00	3.05	0.00	0.00	0.00	0.76	0.00
39.SF.61	Bronze Age	3.18	7.10	0.00	0.19	0.00	2.43	0.37	0.56	0.00
51.SF.403	Early Iron Age	8.20	3.83	0.55	0.73	0.00	0.00	0.18	0.00	0.00
55.SF.58	Early Iron Age	3.28	1.16	0.58	0.00	0.00	0.00	0.19	0.00	0.00
64.SF.100	Late Iron Age	5.63	3.94	0.00	0.19	0.00	0.19	0.19	0.00	0.00
81.SF.58	Late Iron Age	8.63	4.32	0.72	0.36	0.00	0.18	0.90	0.18	0.00
91.SF.40	Medieval	6.08	4.05	0.37	0.18	0.00	0.37	1.10	0.18	0.00
93.SF.40	Medieval	6.09	5.35	1.11	0.74	0.00	0.00	0.18	0.55	0.18

Plates

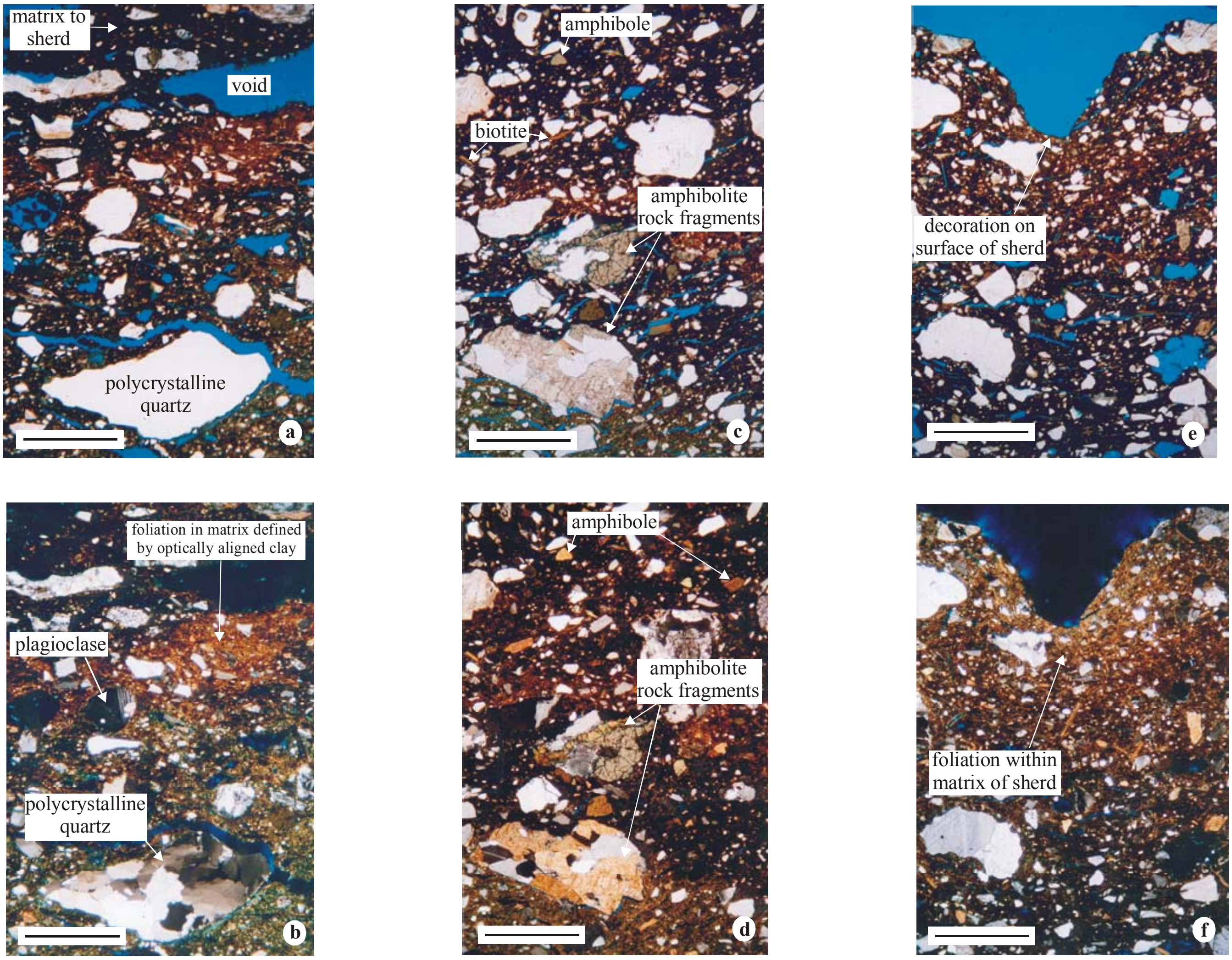

Plate 1. Photomicrographs **(a)** Neolithic II pottery sherd containing a large fragment of polycrystalline colourless quartz (plane polarised light, sample 7.A.8). **(b)** Neolithic II pottery sherd containing a large fragment of polycrystalline quartz and brightly coloured foliation in the matrix defined by optically aligned clay plasma (crossed polarised light, sample 7.A.8). **(c)** Neolithic II pottery sherd containing fragments of amphibolite (metamorphosed basic igneous rock) (plane polarised light, sample 4.A.7). **(d)** Neolithic II pottery sherd containing fragments of amphibolite (crossed polarised light, sample 4.A.7). **(e)** Neolithic II pottery sherd with pronounced 'V' shaped tool mark forming decoration on outer surface (plane polarised light, sample 4.A.7). **(f)** Neolithic II pottery sherd in which the well-developed foliation within the matrix is deflected around the pronounced 'V' shaped tool mark on outer surface (crossed polarised light, sample 4.A.7). Scale Bar = 1.0 mm.

Plate 2. Photomicrographs **(a)** Neolithic II pottery sherd containing a large fragment of quartz-rich mylonite (crossed polarised light, sample 4.A.7). **(b)** Neolithic II pottery sherd containing a large fragment of amphibolite (crossed polarised light, sample 6.A.2). **(c)** Neolithic II pottery sherd which possesses a well developed foliation within the matrix defined by aligned clay plasma (plane polarised light, sample 6.A.2). **(d)** Neolithic II pottery sherd which possesses a well developed foliation within the matrix defined by aligned clay plasma (crossed polarised light, sample 6.A.2). (e) Beaker I pottery showing an overall fine-grained texture (plane polarised light, sample B1.F.27). **(f)** Beaker I pottery sherd which contains rounded voids plane polarised light, sample B1.F.76). Scale Bar = 1.0 mm.

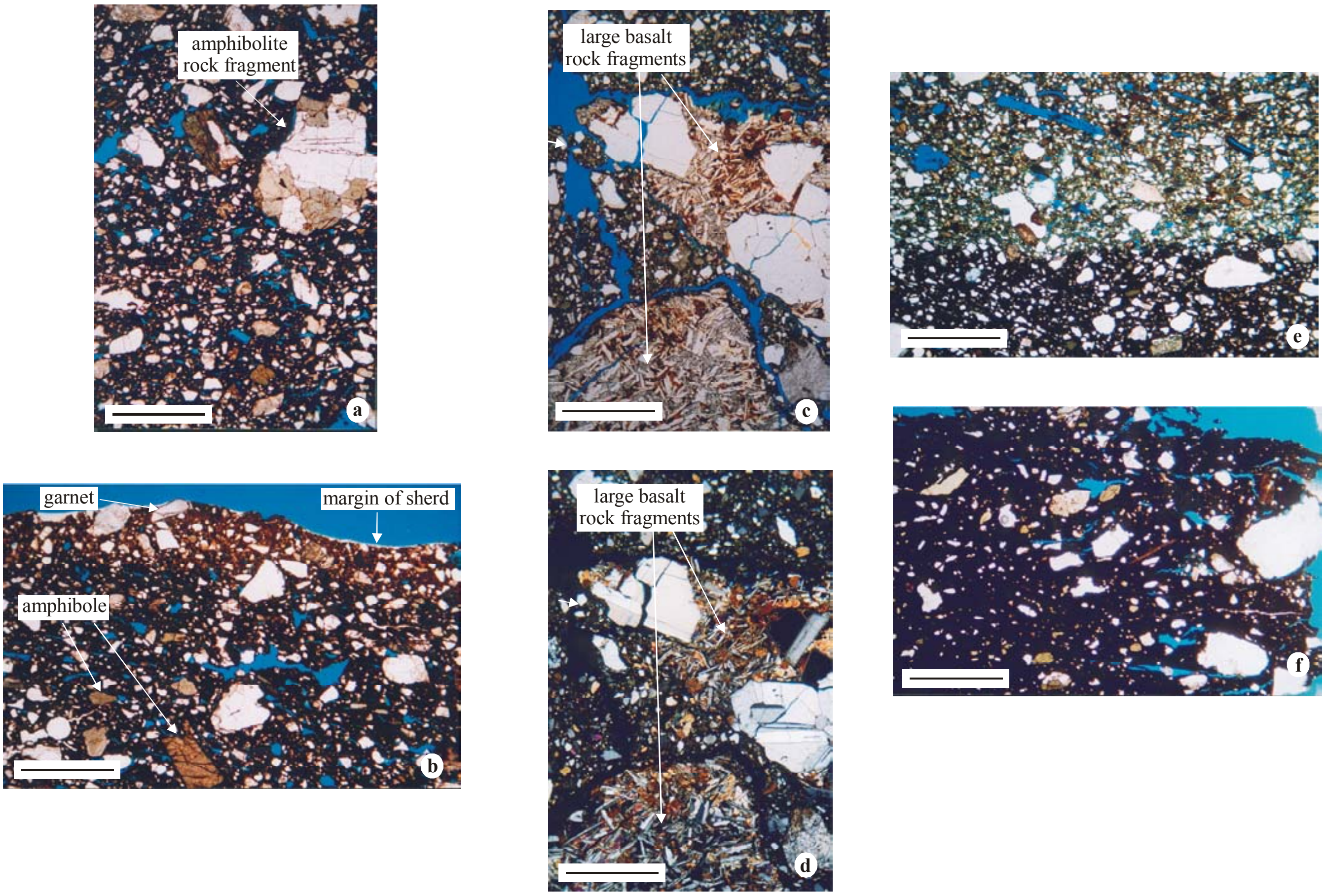

Plate 3. Photomicrographs **(a)** Beaker II pottery sherd containing a large fragment of amphibolite and smaller crystal fragments of amphibole (plane polarised light, sample B2.M10.6). **(b)** Beaker II pottery sherd containing numerous small crystal fragments (crossed polarised light, sample B2. M.10.6). **(c)** Bronze Age pottery sherd which contains large fragments of plagioclase porphyritic basalt (plane polarised light, sample 17.SF.47). **(d)** Bronze Age pottery sherd which contains large fragments of plagioclase porphyritic basalt (crossed polarised light, sample 17.SF.47). **(e)** Early to Mid Iron Age pottery sherd showing well developed colour banding in matrix (plane polarised light, sample 51.SF.403). **(f)** Early to Mid Iron Age pottery with an overall fine-grained texture and dark brown turbid matrix plane (polarised light, sample 55.SF.58). Scale Bar = 1.0 mm.

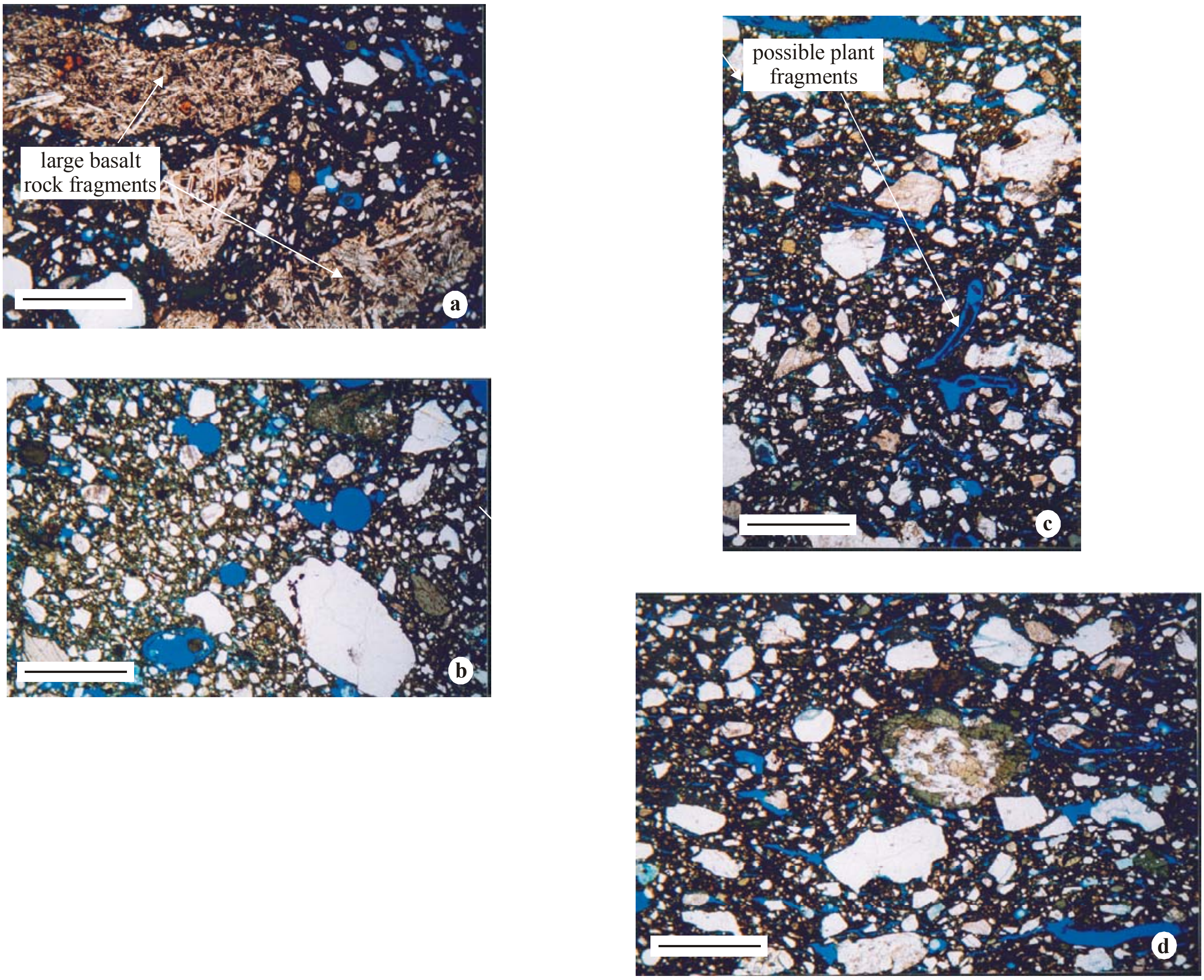

Plate 4. Photomicrographs **(a)** Late Iron Age pottery sherd containing large fragments of basalt (plane polarised light, sample 64.SF.100). **(b)** Late Iron Age pottery sherd lacking basalt fragments but containing round voids (plane polarised light, sample 81.SF.58). **(c)** Medieval pottery sherd containing voids after possible plant fragments (temper) (plane polarised light, sample 91.SF.40). **(d)** Medieval pottery sherd containing numerous included fragments (plane polarised light, sample 93.SF.40). Scale Bar = 1.0 mm.