Appendix 1

Barium values fluctuate in the area from 480 ppm to 1670 ppm. They are probably due to mineralisation and the presence of barytes and other barium-rich minerals as veins and then as detrital veins. Fig 1 shows the mean and standard deviation of the Barium values measured in the 62 samples, relative to Aluminium. Those groups which contain coarse sand or gravel inclusions have both a higher Barium content and a wider range, both of which are consistent with Barium-rich clasts being present in the samples.

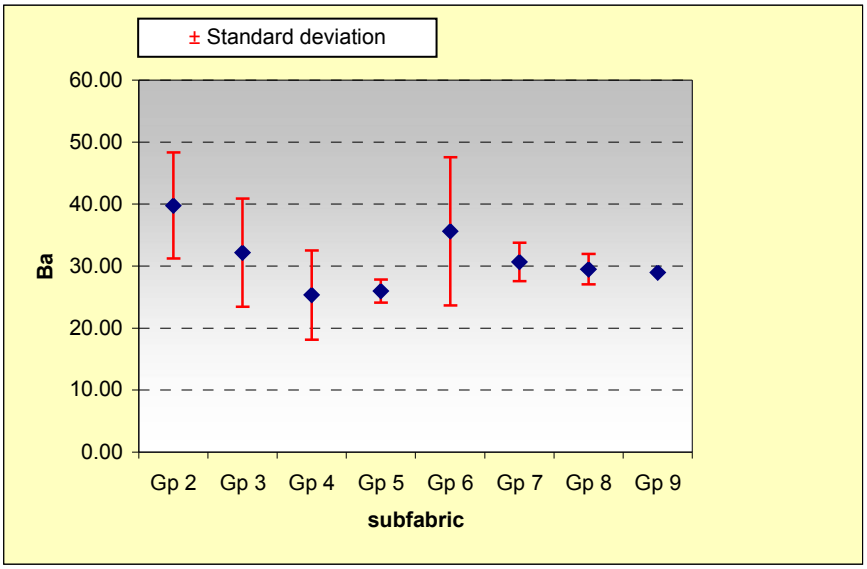


Figure 1

Calcium content is mainly determined by the presence of limestone and in the Newcastle area varies from 1.5% to 3.6% of sediments. Calcic feldspars are probably also responsible for some calcium content, especially in acidic sediments where limestone does not survive. Fig 2 shows the frequency of Calcium

in the pottery samples, relative to Aluminium. It shows a high, but widely variable, content in Group 2 with the lowest and least variable frequencies being present in the finest fabrics (Groups 8 and 9).

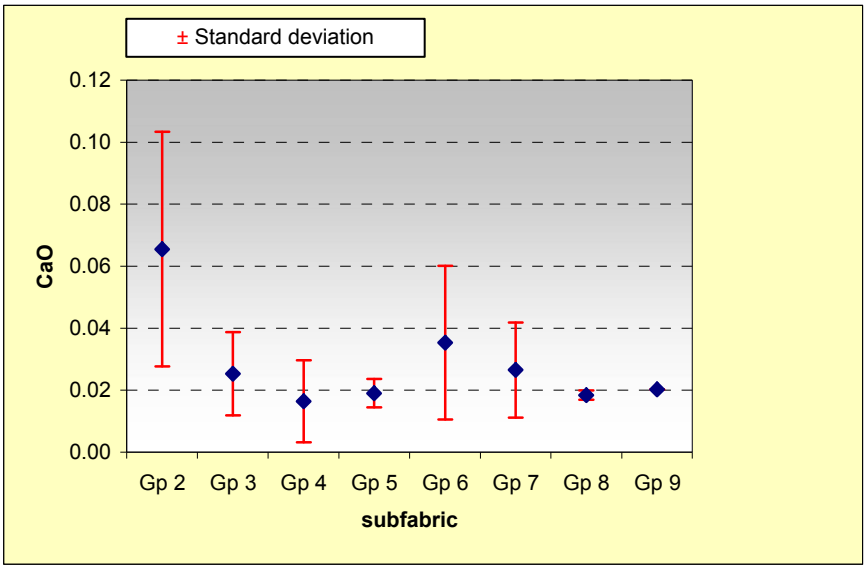


Figure 2

Chromium values in local sediments vary from c.121 ppm to 216 ppm. It is mainly present in resistate minerals (such as Ilmenite, Magnetite and Chromite), and in association with iron compounds, clays and organic matter. It is therefore likely to occur both in iron-rich detrital grains and in the clay groundmass and mudstone inclusions (especially, perhaps organic shales). Fig 3 shows the distribution of Chromium in the pottery samples and indicates that the fine-textured fabrics contain as much or more Chromium as the coarser-textured ones.

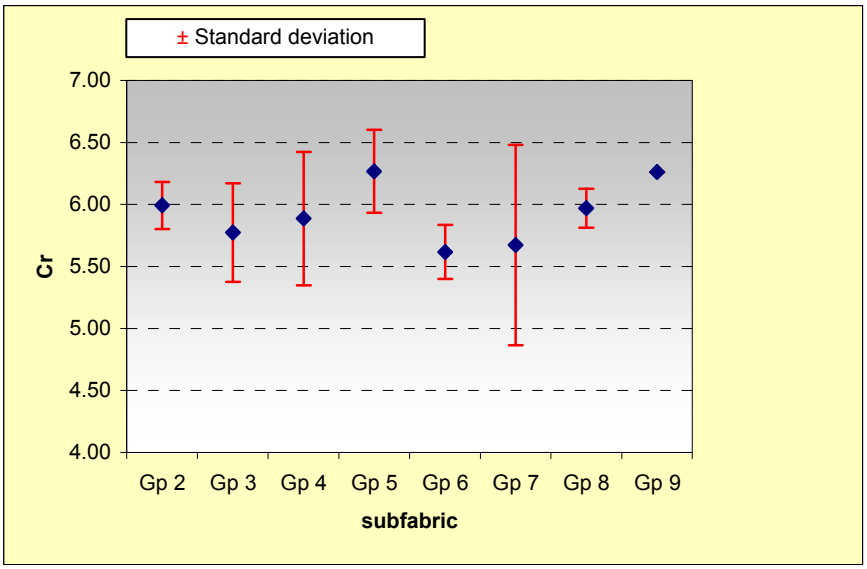


Figure 3

Copper is present in local sediments between 29 ppm and 172 ppm. Regionally, the Durham Coalfield is an area of copper enrichment, although the BGS suggest that this might be partially due to the presence of colliery and industrial waste. However, the coal itself is enriched, as a result of concentration with organic matter. The copper values found in the pottery samples are mainly low (Fig 4) with the highest value, relative to Aluminium, being a single sample of Group 9. This is possibly the result of contamination with copper-stained lead glaze which is certainly present in that same (and others). In the main, however, copper is present at a constant, low level, consistent with it being concentrated in the clay groundmass.

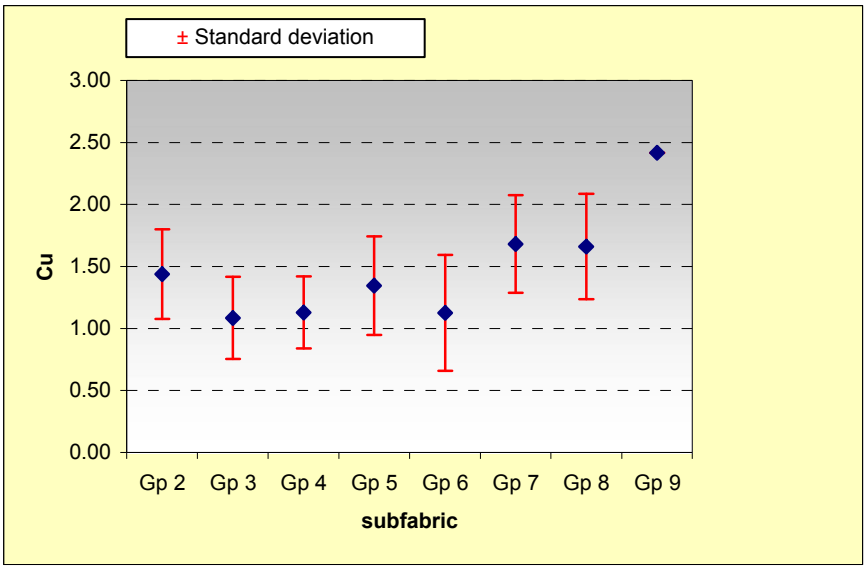


Figure 4

Iron (Fe2O3) forms between 4.9% and 12.0% of sediments in the Newcastle area. It arrives through many routes and is particularly high over parts of the Durham Coalfield, where it can account for up to 74% of the sediment. It also concentrates in low-lying organic deposits as bog iron. In the pottery samples, the frequency is relatively low, due in part to the selection of seat earth and seat earth-derived clays for the light-firing properties. There is a variation in iron content between the fabric groups (Fig 5) with groups 4 and 6 in particular having low iron contents and groups 5, 7, 8 and 9 having high ones (which, because of the small standard deviation, are probably due to finely-divided iron in the groundmass.

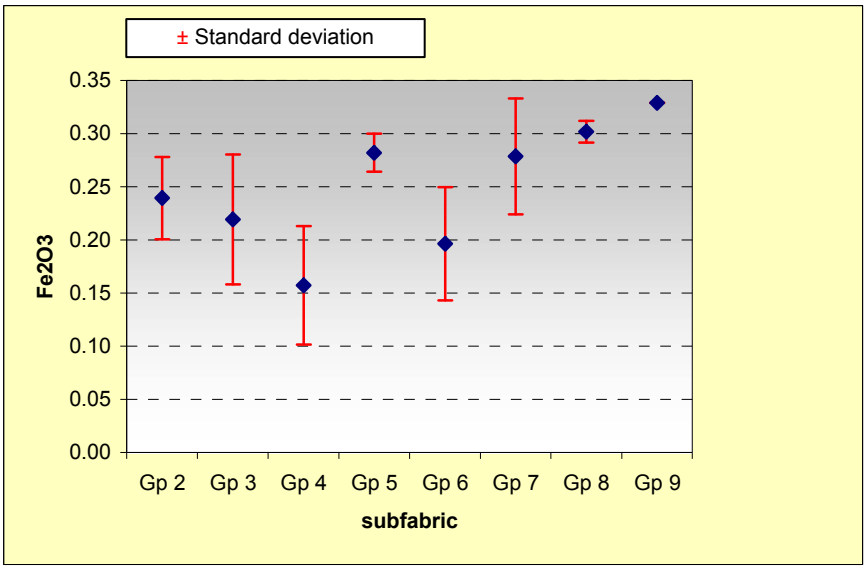


Figure 5

Lanthanum (La) occurs at between 25 and 86 ppm in the Newcastle area. It is one of the light Rare Earth Elements and has a similar distribution to Cerium (Ce). Both are most common either in clay-rich deposits or as resistate detrital grains, such as monazite. Such grains can be concentrated by water or wind, for example possibly in the Vale of Pickering. In the pottery samples there is a very similar concentration of Lanthanum in all the samples, with more variation in groups 3, 4 and 6 than in the others. In the ICPS data there is a strong correlation between La values and those of the remaining REEs, no correlation at all between La and phosphorus and a negative correlation with Titanium and Zirconium, both present in resistate minerals. Therefore, the Lanthanum, and other Rare Earth Elements, are present mostly in the clay mineral fraction, probably being bound to clay minerals.

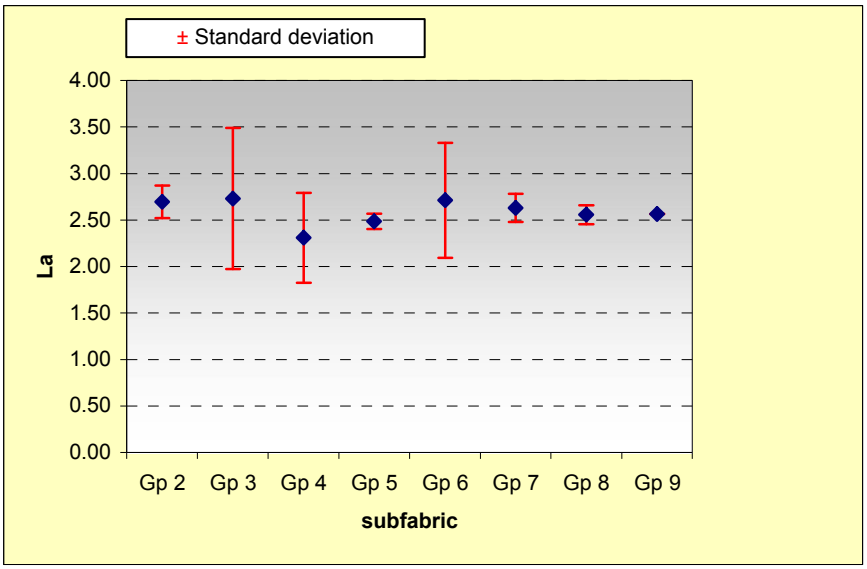


Figure 6

Lead is present at between 42 and 591 ppm in the Newcastle area, mostly as a result of underlying mineralisation. In the pottery samples there is a strong suspicion that some of the lead present is contamination from glaze. Lead concentrations range from 60 ppm to over 21000 ppm un-normalised (i.e. over 2% by weight). No contamination was noted in samples of groups 2 or 3 but was present in every other group.

Lithium (Li) is present at between 72 and 130 ppm in the Newcastle area where it is usually associated with fine-grained sedimentary rocks, and especially those deposited in shallow marine conditions (the highest natural frequencies of Lithium in the north east occur over Millstone Grit shales in the Alston Block). In the pottery samples, Lithium has a variable distribution but with no correspondence with the fabric groups, nor any strong correlation (positive or negative) with other measured elements.

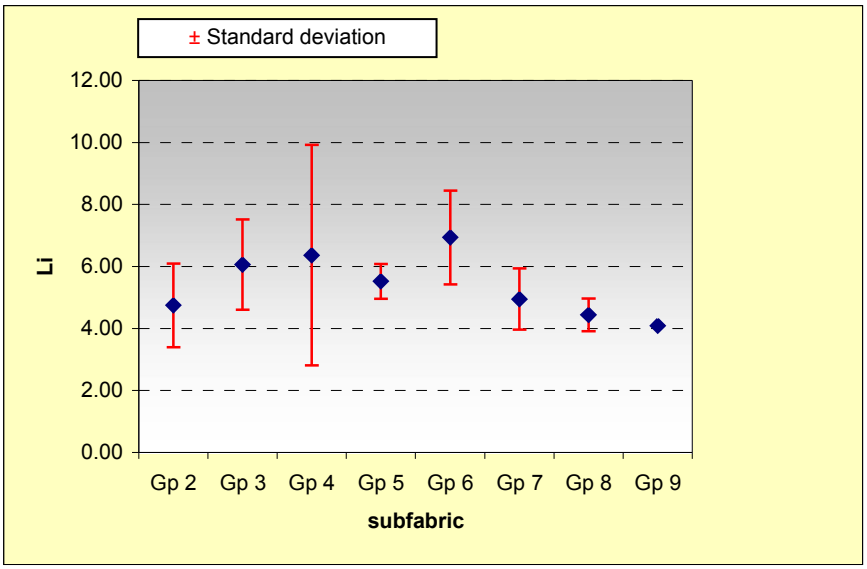


Figure 7

Magnesium (MgO) is present at between 1% and 2.1% in the Newcastle area, rising sharply to the southeast of the City as one moves onto Permian deposits. In the pottery samples, the frequency of Magnesium is also low but shows variation between fabric groups. Fine textured fabric groups have less variation in Magnesium content than coarser ones, but the Magnesium content of these fine-textured groups is higher than that of some of the coarse groups, which implies that the clay groundmass of those groups is lower in Magnesium, presumably because the coarser-textured groups include samples with a kaolinitic clay (Magnesium is one of the elements which is depleted in seat earth clays).

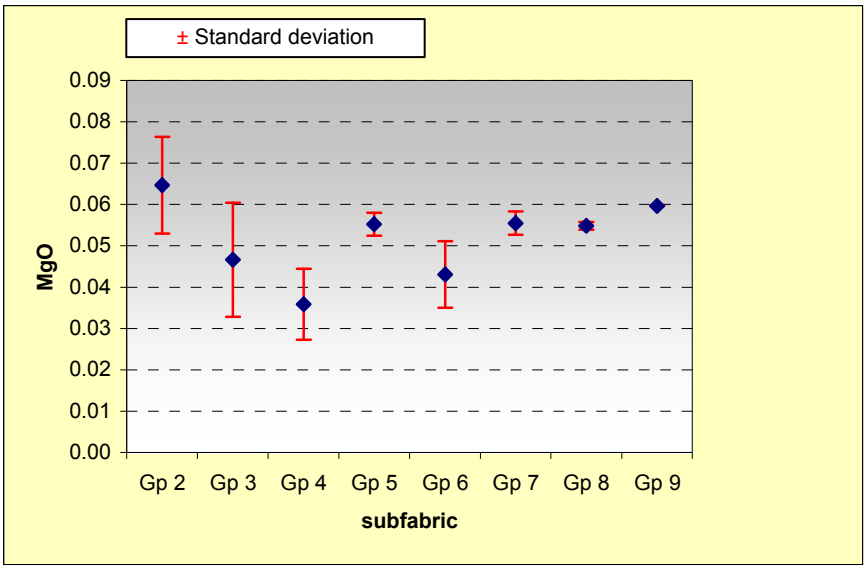


Figure 8

Manganese (MnO) is present at between 0.4% and 7.2% in sediments in the Newcastle area. It is much more common over the Durham Coalfield than over the neighbouring Permian deposits. In the pottery samples it has a higher, but more variable frequency in coarse-textured fabrics than in the finer ones, although the lowest frequencies in the coarse fabrics (groups 6 and 7) are lower than in the fine textured groups 8 and 9 (Fig 9). It is likely that the majority of the Manganese in the pottery samples comes from ferromagnesian nodules, although there is only a weak correlation of Iron and Manganese frequencies.

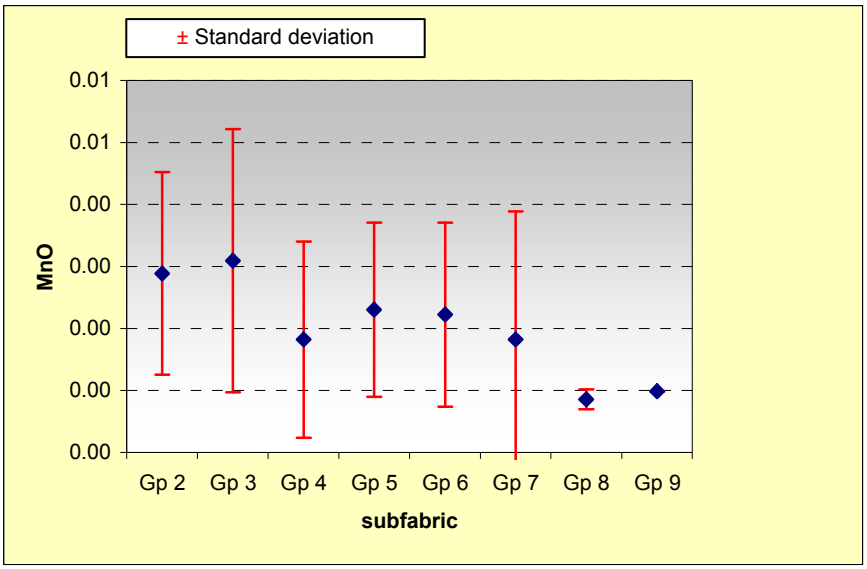


Figure 9

Nickel (Ni) ranges from 45 ppm to 1434 ppm in the Newcastle area and is particularly high over the Durham Coalfield in general. It is present in shales and clays, and in ferromagnesian compounds. In the pottery samples it more common in group 2 than in other groups.

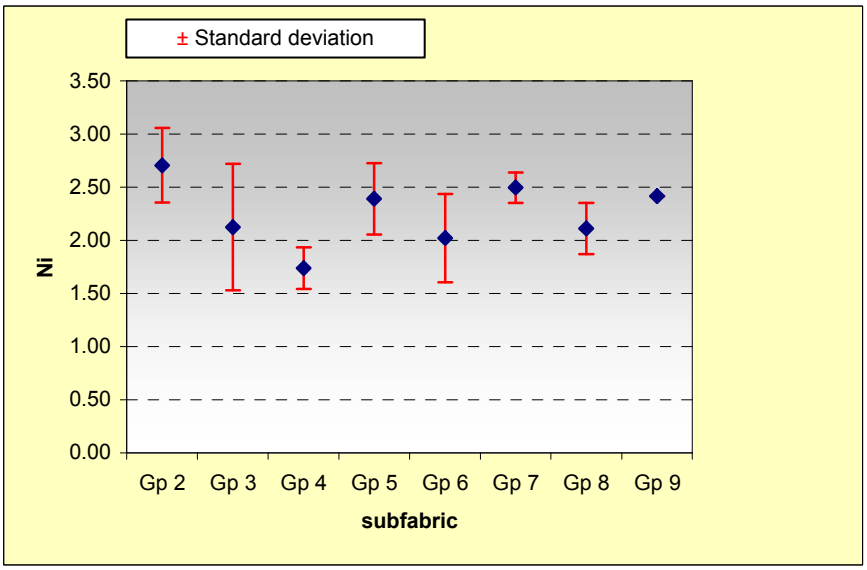


Figure 10

Potassium (K2O) forms between 1.5% and 3.8% of sediments in the Newcastle area. It is present in potassium-feldspars, micas

and clay minerals, especially illite. In the pottery samples the highest frequency occurs in group 2, whilst the groups with the most kaolinitic clays have low but variable frequencies, suggesting that in these instances the main source of potassium is feldspar or coarse-grained micas, whilst the fine-textured samples of groups 5, 7, 8 and 9 have moderate frequencies of potassium but with less variability, suggesting that in these groups the element is mostly present in the clay groundmass (Fig 11).

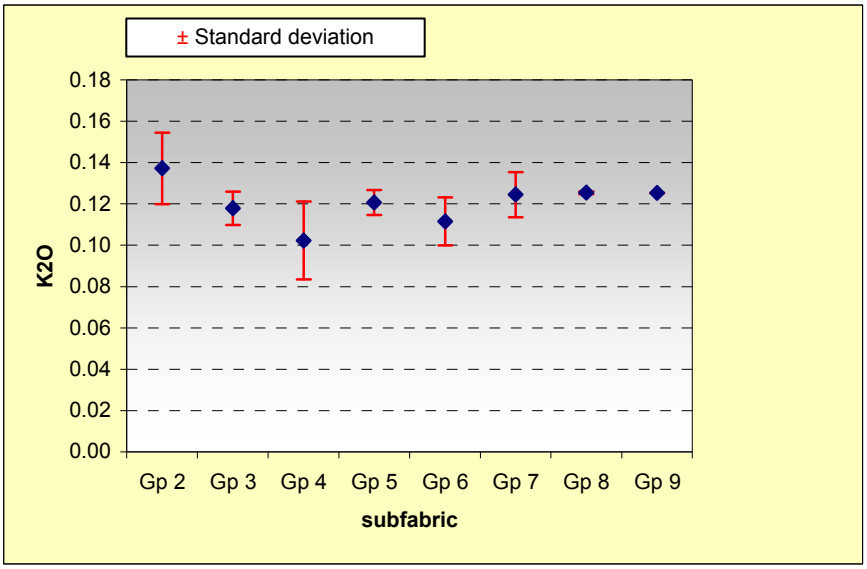


Figure 11

Strontium (Sr) occurs at between 104 ppm to over 454 ppm in the Newcastle area. The element is often strongly correlated with calcium, and thus is often affected by post-burial leaching and concretion, but in this instance is probably present in addition as a result of baryte mineralisation. In the pottery samples it occurs most frequently in samples of group 2 and has a wide variability in occurrence in all samples, consistent with it being present in clasts rather than the groundmass, even in fine-textured fabrics (Fig 12). There is a stronger correlation of Strontium to Calcium frequency in the pottery sample data and given the much higher

frequency of calcium to barium in the samples it is likely that most of the strontium is present in calcium-rich minerals.

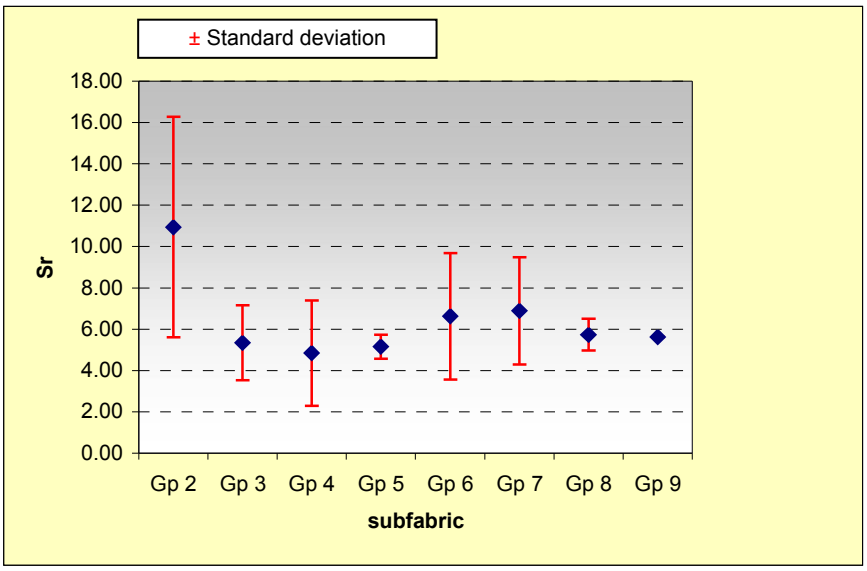


Figure 12

Titanium (TiO) accounts for between 0.86 and 1.9% of sediments in the Newcastle area. It is mostly present in resistate minerals, such as Rutile, Ilmenite and Sphene, and given the presence of fine-grained basic igneous dykes in the area it is possible that some is present in fragments of these rocks. In the pottery samples, it has a low variability within each group and is higher in frequency in the fine-textured groups than the coarser ones, although even in these groups the standard deviation suggests that the Titanium is present in discrete clasts rather than the clay groundmass. This is consistent with the interpretation above. There is a correlation of Titanium and Iron in the samples, which suggests that the minerals in which it occurs include Iron- and Iron-Titanium oxides such as Ilmenite and magnetite.

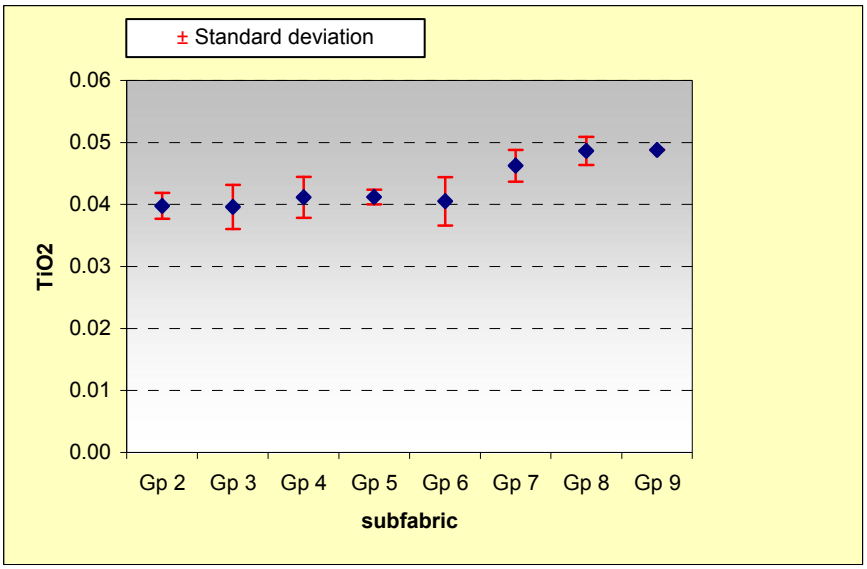


Figure 13

Vanadium occurs at between 78 ppm and 114 ppm in the Newcastle area. It is usually associated with iron, reducing conditions and organic matter, and is therefore high in coals and black shales. In the pottery samples there is little variation in its distribution between groups but has a notably high variability in the finer-textured groups, such as Group 8, suggesting that it is present in clasts rather than the groundmass.

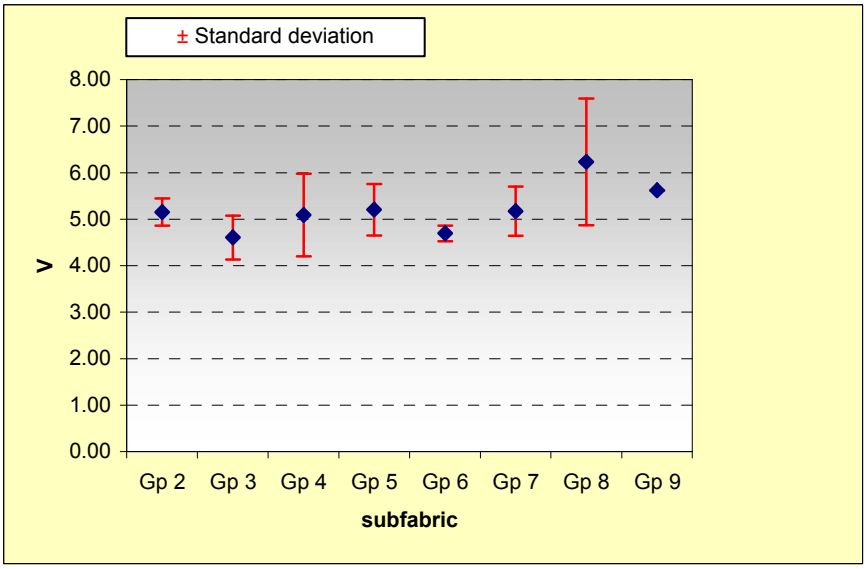


Figure 14

Yttrium (Y) occurs at between 27 and 48 ppm in the Newcastle area. It is concentrated in ferromagnesian minerals such as hornblende and biotite as well as resistate minerals such as apatite, sphene, monazite and zircon. In the pottery samples there is considerable variation in frequency within groups and little between groups. The pattern of distribution suggests that it is present in clasts, even in the finer-textured groups. Correlation with phosphate is poor, which suggests that apatite and monazite are unlikely sources, but there is a better correlation with Zirconium, albeit with some samples having anomalously high Yttrium values. Therefore, most of the Yttrium present in the samples is probably present in Zircon grains but there is also a contribution from other sources.

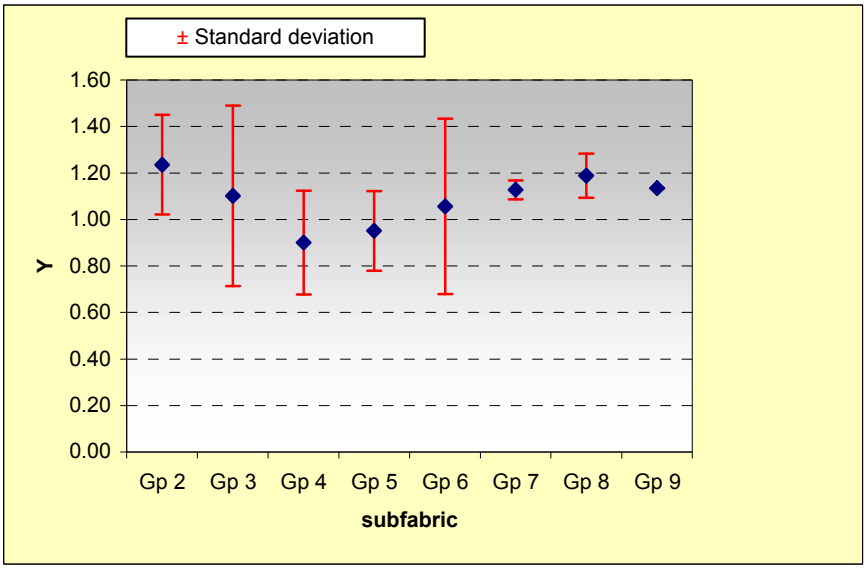


Figure 15

Zinc (Zn) occurs between 142 ppm and 4027 ppm in the Newcastle area. It occurs together with iron in ferromagnesian minerals, particularly biotite, but also has an affinity for clay minerals and organic matter. It is therefore also enriched in shales and organic shales. In the pottery samples, there is a reasonable

correlation of zinc with iron values, but with some anomalously high zinc values. There is little variation in zinc frequency between groups and considerable variation in zinc content within groups, suggesting that it is present in clasts rather than the groundmass.

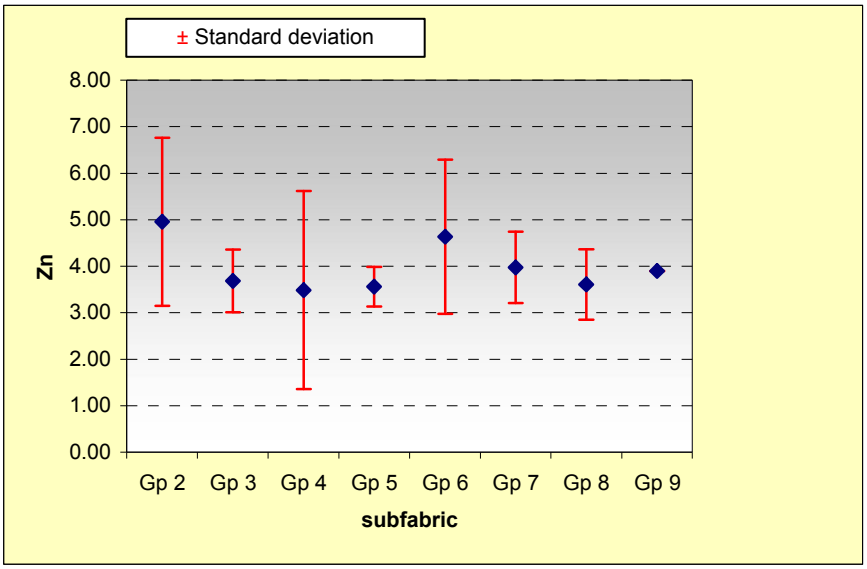
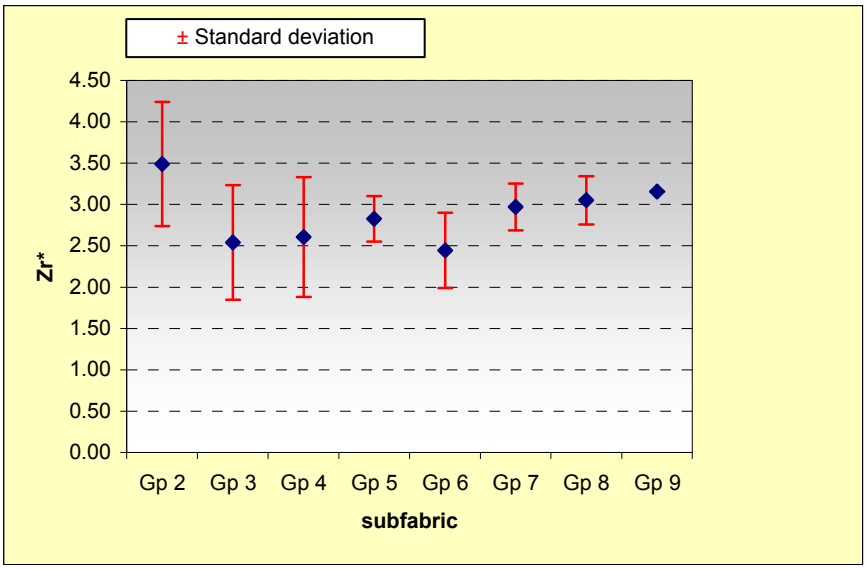


Figure 16

Zirconium (Zr) ranges from c.449 to 1343 ppm in the Newcastle area. Most is likely to have been present in zircon. In the pottery samples, there is a higher frequency of zirconium in group 2 samples and higher variation in frequency in coarse-textured than fine-textured groups, but with a higher mean frequency in the fine-textured samples than the coarse ones (Fig 17).


± Standard deviation
4.50
4.00
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3.00
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2.00
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0.50
0.00
Zr*
Gp 2
Gp 3
Gp 4
Gp 5
Gp 6
Gp 7
Gp 8
Gp 9
subfabric

Figure 17