# Characterisation of Iron Age Pottery from the A4146 Stoke Hammond and Linslade Western Bypass, Buckinghamshire

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The Iron Age pottery from the A4146 Stoke Hammond and Linslade Western Bypass has been studied by Ed McSloy who divided it into fabric groups. Samples of some of these fabrics were selected for characterisation with the intention of establishing whether or not the pottery was made locally and the relationships between the various visually-defined fabrics.

Twelve samples were taken and each was analysed using thin section and chemical analysis using Inductively-Coupled Plasma Spectroscopy. The results suggest that half of the sampled sherds were made from a similar fabric, which contrasts in thin section and chemical analysis with the boulder clay which underlies the A4146 sites but whose sand inclusions were derived from the Lower Cretaceous Woburn Sands, which outcrop in the Leighton Buzzard area. Two samples of flint-tempered ware share several characteristics with this fabric and may come from a similar, but different, source. The four remaining, sand-tempered, samples each has slightly different petrological characteristics and these may all come from different sources. However, all of these samples contain inclusions which could be obtained locally. Chemical analysis confirms the fabric divisions observed in thin section and indicates that two of the Iron Age sandy fabrics, including the most common, IASANDY1, are chemically distinct from both samples of Iron Age and medieval fired clay from the A4146 sites and from medieval pottery and tile.

## Methodology

The samples were given record numbers within the AVAC system (Table 1). Thin sections of each sherd were prepared by Steve Caldwell, University of Manchester, and stained using Dickson's method (Dickson 1965). Sub-samples were cut from the remaining part of the sample and the outer surfaces were removed mechanically and the remainder crushed to a fine powder. This powder was then submitted to Dr J N Walsh, Department of Geology, Royal Holloway College, London, where it was analysed using Inductively-Coupled Plasma Spectroscopy.

*Table 1*

| TSNO | Context | Sample | AVAC Fabric | Comments | McSloy Fabric Code |
|---|---|---|---|---|---|
| V3547 | 32201 | TS01 | IASANDY1 | | Q2 |
| V3548 | 32202 | TS02 | IASANDY1 | | Q2 |
| V3549 | 32205 | TS03 | IASANDY2 | | Q1 |
| V3550 | 32117 | TS04 | IASANDY3 | | Q4 |
| V3551 | 32202 | TS05 | IASANDY1 | | Q1 |
| V3552 | 32125 | TS06 | IASANDY1 | | Q1 |

| | | | | | |
|---|---|---|---|---|---|
| V3553 | 32214 | TS07 | IASANDY4 | | Q1 |
| V3554 | 70023 | TS08 | IASANDY5 | SCORED WARE | Q1 |
| V3555 | 22015 | TS09 | IASANDY1 | | Q2 |
| V3556 | 22041 | TS10 | IASANDY1 | | Q2 |
| V3557 | 12184 | TS11 | IAFLINTY | | F2 |
| V3558 | 12172 | TS12 | IAFLINTY | | F2 |

## Thin Section Analysis

The samples were first examined at x20 magnification and a note made of the principal inclusions. The thin sections were then examined and a record made of the inclusion types present. The results of these two studies were then compared and the samples assigned to six fabric groups (Table 1 AVAC Fabric), coded IASANDY1 to IASANDY5 and IAFLINTY.

### IASANDY1

Six of the samples were assigned to this group. In the hand specimen, the defining characteristic was the presence of abundant, well-rounded, polished quartz grains, mostly coated with a red/brown material, probably haematite. In thin section it was additionally noted that the fabric contains abundant rounded opaque grains.

The following inclusion types were noted in thin section:

- Rounded quartz. Abundant grains up to 1.5mm across. Most are monocrystalline and unstrained but strained, polycrystalline grains occur. Several grains have an opaque coating and/or red/brown veins.
- Rounded opaques. Abundant grains up to 1.0mm across. Most are well-rounded and have an ovoid outline. Some grains are translucent and dark red/brown in transmitted light.
- Angular opaques. Sparse fragments, up to 1.5mm across, some containing subangular quartz inclusions, whose outline suggests that they originally cemented rounded quartz grains.
- Altered glauconite. Abundant grains ranging from c.0.2mm up to 1.0mm across. All are similar in colour and there does not appear to be a gradation from the opaque grains to the altered glauconite. There are, however, some grains in which opaque material has replaced the glauconite.
- Rounded chert. Rare grains up to 0.5mm across. In one case, a chert grain was heavily stained by opaque/red brown material along the crystal boundaries.
- Organics. Sparse irregular voids up to 2.0mm across surrounded with a darkened halo.

The groundmass consists of optically anisotropic baked clay minerals with sparse angular quartz, muscovite and moderate opaque grains. In some sections the opaque grains are surrounded by shrinkage cracks and the resulting void is filled with brown-stained phosphate.

### Interpretation

The fabric was probably made from a glauconitic clay and tempered with an iron-cemented quartz sand. The lack of feldspars and the low quantity of chert indicates that this was a mature sand in which all but the most resistant grains have been chemically eroded. The organic inclusions are most likely accidental rootlet inclusions, indicating that the clay was taken from a surface deposit rather than a clay pit deeper than roots could penetrate. However, it may be that the clay contained sparse detrital organic matter.

Locally, glauconitic clays occur in the Lower Cretaceous and the base of the Upper Cretaceous. In the Leighton Buzzard area the Lower Gault outcrops and the lower metre or two of this outcrop are described as being glauconitic, silty and sandy, being succeeded by dark grey pyritic mudstones (1996, 72). These overlie the Silver Sands of the Woburn Sands formation which are a coarse-grained, unconsolidated quartz sand with lenses of secondary iron pan and some plant remains (Sumbler 1996, 68-9). It seems very likely that these two deposits were exploited to produce IASANDY1. However, similar Cretaceous deposits occur from Wiltshire through to Hertfordshire and a more distant source cannot be excluded.

## IASANDY2

A single sample was assigned to this fabric group. At x20 magnification, similar polished quartz grains to those in IASANDY1 were the most common inclusion type noted although they were less common than in IASANDY1. In thin section the range of inclusions was seen to differ from that in IASANDY1.

The following inclusion types were noted in thin section:

- Rounded quartz. Abundant subangular and rounded quartz, up to 1.0mm across. Some grains are well-rounded and spherical.
- Rounded chert. Sparse subangular and rounded grains up to 1.0mm across.
- Subangular flint. Sparse subangular brown-stained grains up to 1.5mm across.
- Rounded Sandstone. Sparse rounded grains up to 0.5mm across. The sandstone is composed of interlocking subangular quartz grains up to 0.2mm across.
- Organics. Sparse subangular voids up to 1.0mm across containing carbonised organics and with a darkened halo.
- Rounded clay pellets. Sparse pellets, some of similar colour and texture to the groundmass, up to 1.5mm across and others light-coloured with rounded opaque inclusions, up to 1.0mm across.
- Rounded opaques. Sparse rounded grains up to 0.3mm across.

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

### Interpretation

By contrast with IASANDY1, this fabric appears to be tempered with a mixed, quaternary or recent sand, which includes material of Carboniferous (chert), Triassic (quartz and fine-grained sandstone) and Cretaceous origin (polished quartz grains, rounded opaques and flint). The groundmass is not sufficiently distinct to attribute to any particular geological formation.

## IASANDY3

A single sample was assigned to this fabric group. At x20 magnification, the proportion of polished to other quartz grains was lower than in fabrics IASANDY1 and IASANDY2 and the groundmass was noticeably more silty and micaceous.

The following inclusion types were noted in thin section:

- Subangular quartz. Abundant grains up to 0.2mm across.
- Altered Glauconite. Moderate grains up to 0.2mm across.
- Rounded quartz. Sparse grains up to 0.5mm across, some definitely of lower Cretaceous character.
- Rounded opaques. Sparse rounded grains up to 1.5mm long.
- Organics. Sparse voids, some subangular and others elongate, containing carbonised material and surrounded by a darkened halo.
- Muscovite. Moderate laths up to 0.2mm long.
- Microcline Feldspar. Sparse rounded grains up to 0.3mm across.
- Rounded chert. Sparse rounded grains up to 0.3mm across.

The groundmass consists of optically anisotropic baked clay minerals, angular quartz, muscovite, rounded opaque grains and altered glauconite up to 0.1mm long.

### Interpretation

The majority of the inclusions in this fabric were probably present in the parent clay, which is almost certainly a silty facies of the Gault clay. The few larger inclusions could have been present in the clay (which occurs lenses of sand derived from winnowing of earlier deposits) and appear to be too sparse to have been added as temper.

## IASANDY4

A single sample was assigned to this fabric group. At x20 magnification it was seen to contain similar quartz sand inclusions to those in IASANDY3 but with a finer-textured groundmass. In thin section, the distinguishing feature is that the groundmass is variegated with lenses of light-coloured clay.

The following inclusion types were noted in thin section:

- Rounded Quartz. Abundant, poorly sorted grains ranging from c.0.2mm to 1.5mm across. Some of the grains are of lower Cretaceous origin.
- Rounded Opaques. Sparse grains up to 1.5mm across. These are concentrated in the darker clay laminae.
- Basic igneous rock. A single rounded fragment, c.1.0mm across, composed of altered laths of feldspar up to 0.1mm long in a cryptocrystalline groundmass.
- Organics. Sparse elongate voids up to 1.5mm long, some containing carbonised organic matter, surrounded by a darkened halo.
- Flint. Sparse subangular, unstained fragment up to 2.0mm across.
- Plagioclase feldspar. Sparse rounded grains up to 0.3mm across.
- Rounded chert. Sparse rounded grains up to 0.4mm across.

The groundmass consists of poorly mixed variegated laminae of optically anisotropic baked clay minerals, varying in colour from dark red/brown to light brown. The darker clays contain moderate angular quartz, sparse muscovite and sparse rounded opaques. The lighter colour clays contain fewer inclusions.

### Interpretation

The fabric is composed of clays with two different sets of characteristics, one a light-firing, inclusionless clay and the other red-firing with rounded opaque inclusions. The former is probably of Jurassic origin, although seatearths also occur in the Lower Cretaceous Whitchurch Sand formation, which outcrops locally in isolated patches, as at Brill (Sumbler 1996, 63-5) and the latter is probably a Lower Cretaceous clay, similar to that used to produce IASANDY1. The remaining inclusions are probably a mixed detrital sand, similar to that found in IASANDY2. The mixed nature of the inclusions and groundmass and the lack of sorting suggests the use of a boulder clay and all of the characteristics of this fabric can be matched with samples of fired clay from the A4146 sites.

## IASANDY5

A single sample was assigned to this fabric group. At x20 magnification no polished quartz grains were noted and red/brown clay/iron pellets absent from the other sandy fabrics were present. In thin section these were identified as being relict clay and both they and the groundmass were seen to contain grains of altered glauconite.

The following inclusion types were noted:

- Subangular Quartz. Moderate subangular and rounded grains up to 0.3mm across. Some are well-rounded and spherical.
- Clay pellets. Abundant subangular pellets of red/brown clay, similar in colour to the groundmass but varying in their colour and texture. A few contain sparse rounded quartz grains or abundant angular quartz grains. Some are isotropic and thus either fired at a higher temperature than the remainder (i.e. grog) or perhaps have a higher phosphate content.
- Angular chert. Sparse fragments up to 2.0mm across with a chalcedonic structure.
- Flint. Sparse angular unstained fragments up to 1.0mm across.

The groundmass consists of poorly-mixed optically anisotropic baked clay minerals containing rare angular quartz grains and clay pellets up to 0.1mm across.

### Interpretation

The groundmass of this fabric suggests that the vessel was made from a clay that was insufficiently prepared, so that the clay was not fully plastic. The clay pellets sometimes contain similar quartz inclusions to those observed in the rest of the section. The chert and flint fragments originated in an area of Cretaceous rocks and the quartz grains include some of probably Triassic origin. Both of these inclusion types have a wide distribution in the south-east midlands whilst the chert and flint preclude a source to the northwest of the A4146.

## IAFLINTY

Two samples were assigned to this fabric group. At x20 magnification both samples were seen to contain abundant angular flint fragments but were distinguished by one sample (V3557) having rounded quartz sand, including red-coated polished grains as in IASANDY1 to 4, and a silty, micaceous groundmass similar to that in IASANDY3. In thin section, however, the different between the two samples appeared less clear and therefore both were assigned to the same fabric group.

The following inclusion types were noted:

- Flint. Abundant angular fragments whose outlines suggest that they were formed by heat-shattering (dousing heated flints with water), up to 2.0mm across. A single subangular brown-stained flint fragment 1.5mm long was also present.
- Opaques. Abundant rounded grains up to 1.0mm across.

- Subangular Quartz. Moderate grains of subangular quartz up to 0.4mm across and sparse rounded grains up to 0.5mm across, some of which are definitely of Lower Cretaceous origin.

The groundmass consists of optically anisotropic baked clay minerals with sparse angular quartz grains, rounded opaque grains and muscovite laths up to 0.1mm long.

## Interpretation

The flint fragments in this fabric are clearly deliberately prepared and added to the clay. With their exception, the inclusions are similar to those found in the sandy fabrics (IASANDY1 to 4) whilst the groundmass is similar to that of IASANDY2.

## Chemical Analysis

The ICPS data consisted of the frequency of a range of major elements, measured as percent oxides (App 1) and a range of minor and trace elements measured in parts per million (App 2).

Silica was not measured and in several fabrics was probably added as temper in the form of quartzose sand. Variations in silica content therefore have the effect of diluting the frequencies of all other elements, except for those co-varying with quartz, such as, potentially, zirconium. The data were therefore normalised to aluminium to minimise the dilution effect.

The normalised chemical data were analysed using the factor analysis module of Winstat for Excel (Fitch 2001). Five significant factors were found (Table 2) of which Factor 1 was by far the most important, accounting for 55% of the variability in the dataset.

*Table 2*

| Factor | Eigenvalue | Variance (percent) | Percent cumulative |
|---|---|---|---|
| **1** | 14.85095592 | 55.00354044 | 55.00354044 |
| **2** | 4.581806846 | 16.96965498 | 71.97319543 |
| **3** | 2.941941046 | 10.89607795 | 82.86927337 |
| **4** | 1.624092428 | 6.015157141 | 88.88443051 |
| **5** | 1.09441653 | 4.053394554 | 92.93782507 |

A plot of the F1 against F2 scores indicates that IASANDY1 can be differentiated from the remainder by its F1 scores whilst IASANDY5 can be differentiated from the remainder by its F2 score. The IAFLINTY samples have similar scores to the remaining sandy ware fabrics. The weightings generated for each element by the factor analysis indicate that high F1 scores are mainly due to chromium, iron, vanadium, cobalt and nickel, all of which are presumably present in the opaque grains which define this fabric, as well as high weightings for zirconium and a number of rare earth elements (cerium, samarium, neodymium, lanthanum and europium). The zirconium values for IASANDY1 are well above those for the other fabrics and this indicates a higher zircon frequency in the fabric. However, if the an estimate of the added quartz sand is made, by subtracting the total measured oxides from 100%, and plotted against the zirconium values then it can be seen that there is an inverse relationship, and that therefore the zircon grains are actually present in the silt or clay fraction (Fig 2). There is a correlation between the rare earth elements and iron in the dataset which indicates that these elements too are probably concentrated in the opaque pellets. This is illustrated by a plot of lanthanum against iron content (Fig 3). The IASANDY5 sample stands out in this graph as it has a different iron to lanthanum ratio from the remainder, which all differ mostly in frequency alone.

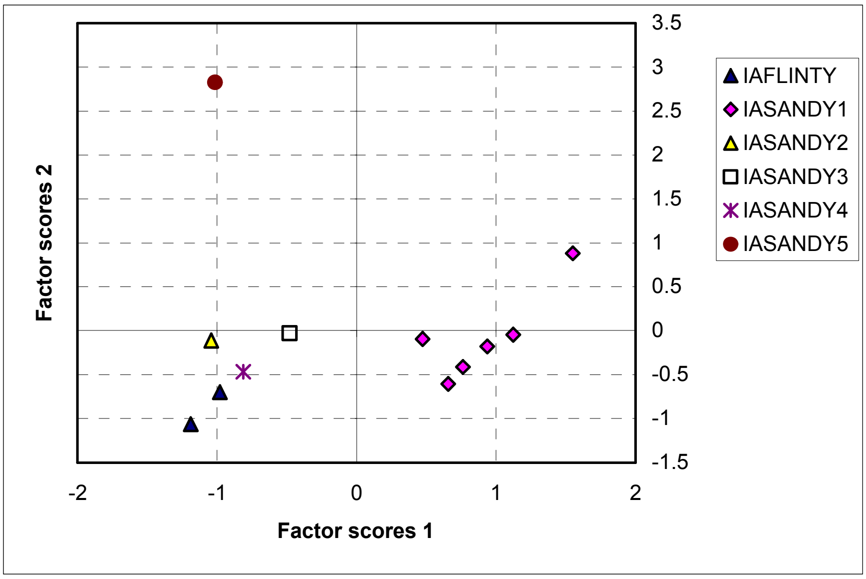


*Figure 1*

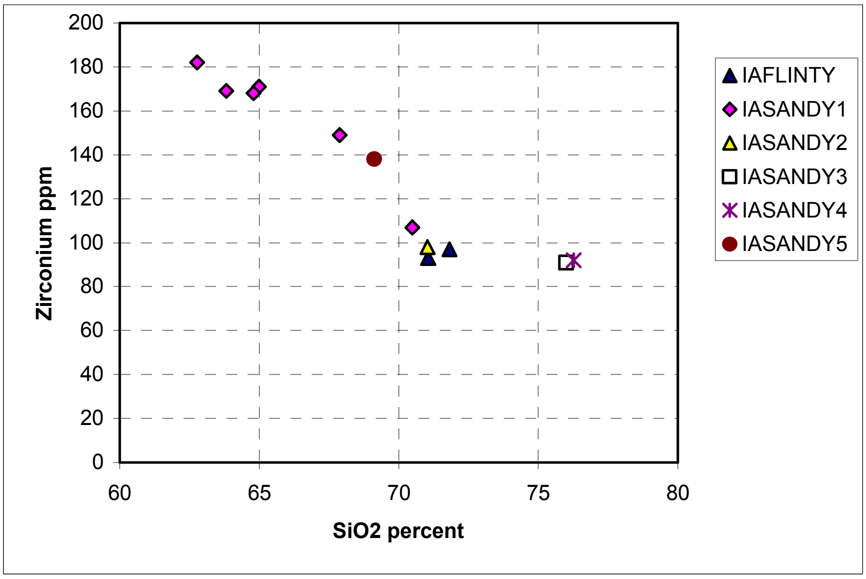


*Figure 2*

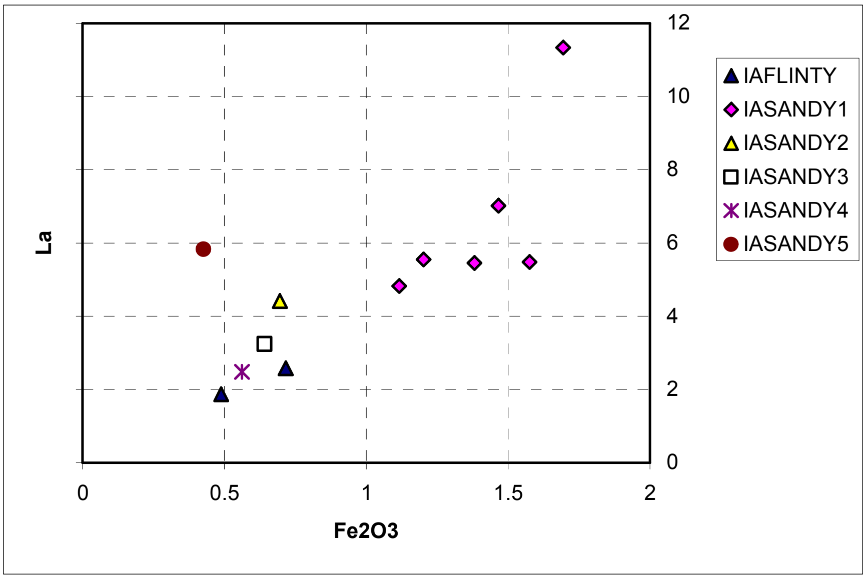


*Figure 3*

The ICPS data was then compared with that from the analysis of Iron Age and medieval fired clay from the A4146 sites. This analysis also found that the IASANDY1 samples form a separate group from the remainder, which all formed a single cluster. The analysis was therefore repeated omitting the elements responsible for the high F1 scores, as noted above. This second factor analysis found two significant factors (Fig 4). Whilst in general all of the samples are similar in this analysis, the IASANDY1 samples, together with the IASANDY5 and IASANDY3 samples tend to have higher F2 scores than the fired clay and remaining pot fabrics. Interestingly, the medieval daub is distinguishable from the Iron Age fired clay (some of which may be daub and other samples from loom weights) and the remaining pot fabrics (IASANDY3 and IASANDY4). Examination of the weightings for F2 indicates that the main contributing elements were zinc, copper and scandium. A plot of zinc against scandium indicates that four of the pottery fabrics have either zinc or scandium values outside the range found in the local fired clay (IASANDY1, IASANDY2, IASANDY3 AND IASANDY5). The remaining two fabrics, IASANDY4 and IAFLINTY, have scandium and zinc values within the range of the fired clay.

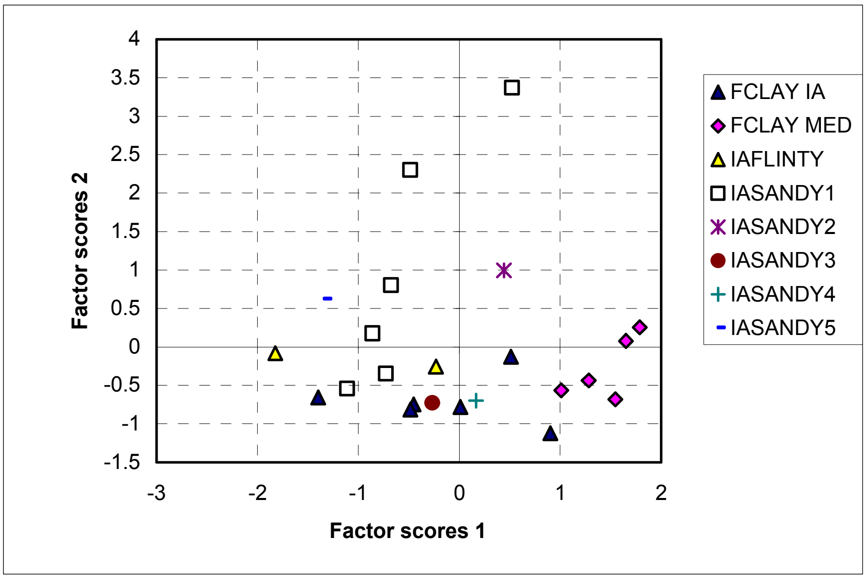


*Figure 4*

## Conclusions

The Iron Age pottery from the A4146 sites can be grouped into six fabric groups. Of these, one, IASANDY1, is clearly distinguishable in thin section and chemical composition from the remainder and was made from raw materials not used in other sampled ceramics from the A4146 excavations. However, the thin section analysis demonstrates that the fabric could have been made locally, using lower Cretaceous clays and sands.

The flint tempered ware, IAFLINTY, was also made from raw materials which were potentially available locally and the flint inclusions appear to have been deliberately prepared by heating the flint and then immersing the nodules in water by thermal shock. Since heating stones and throwing them into water was a known activity in the Bronze Age and perhaps continued to be so in the Iron Age it is possible that this flint was itself the by-product of some other activity. Excluding the added flint, there was little in the fabric, either in thin section or chemical composition, to distinguish it from the remaining fabrics.

The remaining sandy fabrics all have characteristics in thin section which suggest a local origin although only one  of these (IASANDY4) cannot be distinguished chemically from local fired clay samples. This is in agreement with the thin section analysis which also points to the use of a boulder clay, similar to that available on site, for the production of this fabric.

## Bibliography

Dickson, J. A. D.  (1965)  "A modified staining technique for carbonates in thin section." *Nature*, 205, 587.

Sumbler, M. G.  (1996)  *London and the Thames Valley*, HMSO, London.

*Appendix 1*

| TSNO | Al2O3 | Fe2O3 | MgO | CaO | Na2O | K2O | TiO2 | P2O5 | MnO |
|---|---|---|---|---|---|---|---|---|---|
| V3547 | 11.38 | 19.28 | 1.03 | 0.95 | 0.18 | 1.43 | 0.48 | 2.22 | 0.284 |
| V3548 | 12.69 | 18.6 | 0.67 | 0.5 | 0.13 | 1.22 | 0.52 | 1.7 | 0.155 |
| V3549 | 13.38 | 9.31 | 0.91 | 0.79 | 0.25 | 1.76 | 0.56 | 1.83 | 0.175 |
| V3550 | 12.04 | 7.74 | 0.55 | 0.46 | 0.23 | 1.6 | 0.55 | 0.79 | 0.032 |
| V3551 | 10.58 | 16.67 | 0.76 | 0.64 | 0.12 | 1.05 | 0.43 | 1.75 | 0.117 |
| V3552 | 12.24 | 13.67 | 0.39 | 0.35 | 0.16 | 1.04 | 0.5 | 1.12 | 0.04 |
| V3553 | 12.08 | 6.79 | 0.69 | 0.36 | 0.3 | 1.88 | 0.58 | 1.02 | 0.029 |
| V3554 | 18.36 | 7.83 | 1.16 | 1.01 | 0.17 | 1.2 | 0.65 | 0.39 | 0.11 |
| V3555 | 13.21 | 18.24 | 0.8 | 0.71 | 0.12 | 1.06 | 0.52 | 0.49 | 0.059 |
| V3556 | 14.05 | 16.89 | 0.62 | 1.35 | 0.16 | 1.13 | 0.55 | 0.23 | 0.027 |
| V3557 | 13.59 | 9.73 | 0.93 | 0.58 | 0.3 | 1.69 | 0.52 | 0.73 | 0.114 |
| V3558 | 17.14 | 8.38 | 0.4 | 1.02 | 0.1 | 0.82 | 0.58 | 0.47 | 0.033 |

*Appendix 2*

| TSNO | Ba | Cr | Cu | Li | Ni | Sc | Sr | V | Y | Zr* | La | Ce | Nd | Sm | Eu | Dy | Yb | Pb | Zn | Co |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V3547 | 462 | 446 | 38 | 59 | 214 | 18 | 119 | 398 | 31 | 182 | 129 | 459 | 165 | 26 | 3 | 9 | 4 | 58 | 315 | 44 |
| V3548 | 359 | 382 | 29 | 38 | 145 | 17 | 64 | 332 | 26 | 169 | 89 | 317 | 118 | 19 | 2 | 7 | 4 | 52 | 206 | 35 |
| V3549 | 563 | 142 | 34 | 61 | 111 | 14 | 102 | 177 | 38 | 98 | 59 | 121 | 67 | 11 | 2 | 7 | 4 | 40 | 294 | 26 |
| V3550 | 373 | 116 | 25 | 35 | 64 | 14 | 46 | 154 | 28 | 91 | 39 | 79 | 50 | 10 | 1 | 5 | 3 | 39 | 119 | 17 |
| V3551 | 373 | 359 | 42 | 39 | 118 | 15 | 71 | 372 | 20 | 149 | 58 | 195 | 77 | 14 | 2 | 5 | 3 | 52 | 208 | 28 |
| V3552 | 267 | 243 | 24 | 28 | 87 | 15 | 42 | 319 | 27 | 107 | 59 | 171 | 78 | 13 | 2 | 6 | 3 | 44 | 120 | 20 |
| V3553 | 380 | 109 | 30 | 37 | 67 | 13 | 47 | 138 | 26 | 92 | 30 | 56 | 34 | 5 | 1 | 4 | 2 | 50 | 119 | 16 |
| V3554 | 420 | 114 | 46 | 70 | 121 | 24 | 65 | 163 | 121 | 138 | 107 | 136 | 139 | 24 | 4 | 17 | 9 | 32 | 185 | 27 |
| V3555 | 443 | 379 | 22 | 48 | 139 | 17 | 51 | 408 | 25 | 168 | 72 | 261 | 102 | 18 | 2 | 7 | 4 | 44 | 164 | 30 |
| V3556 | 420 | 392 | 22 | 57 | 111 | 17 | 94 | 395 | 25 | 171 | 78 | 264 | 104 | 18 | 2 | 6 | 4 | 38 | 152 | 26 |
| V3557 | 414 | 118 | 31 | 51 | 88 | 14 | 56 | 148 | 22 | 97 | 35 | 86 | 44 | 8 | 1 | 4 | 3 | 48 | 132 | 23 |
| V3558 | 346 | 117 | 53 | 57 | 160 | 18 | 52 | 160 | 36 | 93 | 32 | 58 | 48 | 9 | 1 | 6 | 4 | 36 | 166 | 22 |