Characterisation of Pottery and Ceramic Building Material from Byland Abbey, North Yorkshire

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Archaeological excavations at Byland Abbey undertaken by Field Archaeology Specialists Ltd produced sherds of medieval whiteware which appear to be waste, suggesting that the site might be close to a production site for this ware. Samples of wasters were there sampled for thin section and chemical analysis to establish whether they could have been produced from local resources and to compare them with samples of similar pottery from production sites and consumer sites in the region.

In addition, the ceramic building material from the site was assessed by Cecily Spall and divided by her into five fabrics, Fabrics 1 to 5. An example of each fabric was sampled.

The results of thin section and chemical analysis show that the glazed ware wasters are similar in chemical composition to those produced at the villages of Brandsby and Stearsby, about 10 miles to the southeast of Byland Abbey but located in an area of similar geology. Howevr, unlike the products made at Brandsby and Stearsby, the Byland Abbey wasters have an added quartz sand. This is paralleled at York in York Glazed ware (Jennings 1992) and samples of that ware from York are indistinguishable from the Byland Abbey waste. York Glazed ware was therefore probably made from the same clay outcrops as those used for the later Brandsby-type ware, perhaps including a centre close to Byland Abbey.

The ceramic building material fabrics including one (Fabric 4) with a similar chemical composition to the pottery waste, but made from a red-firing rather than a white-firing clay. The remaining fabrics include three with similar characteristics in thin section and chemical composition which are matched by boulder clay from Easingwold, 7 miles south of Byland Abbey, and one fabric, Fabric 5, which is closer in composition to tiles produced at Wethercote, in Ryedale. However, the clays used at Wethercote also outcrop close to Byland Abbey. It is therefore likely that the ceramic building material used at Byland Abbey was produced in the Vale of York, from boulder clay (Fabrics 1 to 4) or Middle Jurassic clays (Fabrics 4 and 5).

Thin Section Analysis

York Glazed Ware

The six thin sections can be grouped into three fabric groups: a) 3 samples contain quartz sandstone-derived sand and rounded white-firing mudstone fragments in a white-firing groundmass; b) one sample contains a similar quartz sandstone-derived sand, red-firing mudstone fragments in a silty, micaceous red-firing groundmass and c) one sample contains rounded white-firing mudstone fragments in a white-firing groundmass with no quartz sand.

The following inclusion types were noted:

- Quartz. Abundant (fabrics (a) and (b) subangular grains, some coated with dark brown clay/iron, c.0.1mm to 0.3mm across.
- Sandstone. Sparse subangular grains composed of subangular quartz grains c.0.1mm to 0.3mm across, usually with a dark brown clay/iron cement.
- Mudstone. Moderate rounded mudstone fragments of similar colours to the groundmasses but with few inclusions and in the case of fabrics (a) and (c) slightly lighter in colour and more birefringent.

The groundmass of fabrics (a) and (c) consists of reddish yellow (7.5YR 3/6) optically anisotropic baked clay minerals and sparse to moderate angular quartz grains up to 0.1mm across. The groundmass of fabric (b) consists of dark red (2.5YR 3/6) optically anisotropic baked clay minerals and moderate angular quartz and sparse muscovite laths up to 0.1mm long.

The grain size and rounding of the quartz sand indicates that it was formed by the weathering of the sandstone whilst the sandstone is similar to Upper Jurassic sandstones (the calcareous grits) which outcrop extensively on the Yorkshire Moors and form the main element in superficial sands in this part of the Vale of York.

The light-firing mudstones and groundmasses of Fabrics (a) and (c) are paralleled in the Middle Jurassic strata of this area and outcrop along the western edge of the moors, in the upper parts of Ryedale as well as around the north and east sides of the North Yorkshire Moors. The red-firing mudstones and groundmass of Fabric (b) is also paralleled in the Middle Jurassic strata in the same areas.

CBM Fabrics 1 to 3

The samples of fabrics 1, 2 and 3 all have a very similar range of inclusions and similar groundmass characteristics. The following inclusion types were noted:

- Subangular quartz. Abundant ill-sorted grains ranging from less than 0.1mm to 0.5mm across. The larger grains are often coated with a dark brown clay/iron cement. Also, sparse rounded grains up to 0.3mm across.
- Sandstone. Rare fragments of ferruginous sandstone similar to those in the York Glazed ware. Also a single fragment of a finer-textured sandstone (mean grain size c.0.15mm) with a brown matrix and fragments with well-sorted grains c.0.2mm across and a silicious cement, including chalcedonic replacement of some grains.
- Muscovite. Moderate laths up to 0.2mm long, but mainly less than 0.1mm.

- Opaques. Sparse rounded grains up to 0.2mm across.
- Clay/Iron. Sparse rounded pellets up to 0.3mm across.
- Organics. Sparse oval voids up to 0.5mm long surrounded by a darkened halo (roots cut diagonally?)

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

CBM Fabric 4

The following inclusion types were noted:

- Quartz. Abundant subangular grains up to 1.0mm across but mainly up to c.0.5mm. Sparse rounded grains up to 0.3mm across.
- Sandstone. Sparse subangular fragments of ferruginous sandstone containing subangular grains up to 0.3mm across in a dark brown cement.
- Mudstone. Sparse rounded dark brown, laminated pellets up to 0.5mm long.
- Clay pellets. Moderate rounded light coloured pellets containing sparse subangular quartz grains up to 0.2mm across.

The groundmass is variegated and consists of lenses of light brown and darker brown clay ranging in colour from that of York Glazed fabric a to fabric b. The groundmass contains a similar quantity of quartz to York Glazed fabric a, which is less than that found in the light-coloured clay pellets.

CBM Fabric 5

This fabric is similar to Fabric 4 but has less light-coloured lenses in the groundmass and a black core indicative of a high organic content. The following inclusion types were noted:

- Quartz. As Fabric 4 including the sparse rounded grains.
- Sandstone. Sparse fragments with subangular quartz grains up to 0.3mm across in a colourless to light brown amorphous cement.
- Mudstone. As Fabric 4 and some light-firing inclusionless pellets.
- Organics. Sparse voids up to 0.5mm across.
- Opaques. Sparse rounded and subangular grains up to 0.5mm across.
- Biotite. Rare laths up to 0.3mm long.

The groundmass is variegated and consists of sparse lenses of light-coloured inclusionless clay mixed with red-firing lenses with abundant rounded dark brown clay/iron inclusions up to 0.2mm across. the core is black with a sharp core/margin boundary.

Chemical Analysis

Sub-samples of were taken from each sample and the outer surfaces mechanically removed. The remainder was crushed to a fine powder and submitted to Royal Holloway College, London, where it was analysed using Inductively-Coupled Plasma Spectroscopy. A range of major elements were measured and expressed as percent oxides (App 1) and a range of minor and trace elements were measured and expressed as parts per million (App 2). Silica was not measured but was estimated by subtracting the total measured oxides from 100%. The data were normalised to aluminium to take account of variations in silica content.

Lead was measured as a guide to glaze contamination and three of the glazed ware samples have high lead values which are certainly due to glaze. No evidence for associated contamination, e.g. by copper, was noted.

York Glazed Ware

The normalised ICPS data were examined to see if there was any correlation between the petrological groups, a to c, and the chemical composition. Estimated silica content showed no correlation, despite the fact that group c contains no added quartzose sand. The mean silica content for the five samples was 67.95% whilst that for fabrics a, b and c was 67.5%, 69.5% and 67.6%. There are slight differences in composition which are consistent with the petrology: fabric b has the highest potassium content (muscovite in the groundmass?) whilst fabric c has the lowest (feldspars in the added quartzose sand?). Cobalt is highest in fabric b and lowest in fabric c whilst iron is high in fabric b but also in one of the fabric a samples (presumably as a result of finely-divided iron in the groundmass in the first case and iron-rich sandstone fragments in the other). Sodium is lowest in fabric c, also probably due to the absence of feldspar grains in the quartzose sand. Finally, titanium is highest in fabric b. It should be emphasised, however, that these differences are slight and given the low number of samples could be due to chance.

The ICPS data were then compared with samples of glazed medieval whitewares from York (Scarborough ware; York Glazed ware; Brandsby-type ware; Hambleton ware); samples from production sites in the North Yorkshire Moors area (Brandsby; Stearsby; and Ruswarp) and with samples of a coarse quartzose sand gritted whiteware from Easingwold.

Using the least mobile elements (i.e. excluding calcium, phosphorus, strontium and the rare earth elements) and also excluding zirconium, which is incompletely measured using the RHCL procedure, factor analysis was carried out on the normalised data. Three factors were found, explaining in total 62% of the variability in the data.

A plot of the first two factors (Fig 1) shows no clear clustering of any of the samples but a broad spread of scores. The Byland samples have positive F2 scores and neutral to negative

F1 scores placing them with samples from the late 13th century Brandsby kiln and with samples of York Glazed ware and Brandsby-type ware from York. Samples of Scarborough ware, samples from the Ruswarp bank kiln site and of the Easingwold coarse gritted whiteware all have either higher F1 scores or negative F2 scores, or both. The weightings which contribute to the F1 and F2 scores come in this case from a series of elements but nickel and lithium appear to be partly responsible for the high F2 scores of the Byland samples.

The conclusion of this study seems to be that all of the whiteware produced around the North Yorkshire Moors have similar compositions but that there are subtle differences between those produced at sites on the east coast (Ruswarp and Scarborough) and the coarse gritted Easingwold samples and the remainder. There is little to distinguish the York Glazed ware samples from the Brandsby-type ware samples although there is a slight difference in composition between the samples from Brandsby and Byland, on the one hand, and those from consumer sites in York on the other. One explanation for this would be that the samples have been affected by their burial conditions. This is very likely and given that in thin section these vessels are seen to be porous and that the pores often contain phosphates and clays which have clearly been deposited after burial is probably inevitable that there will be some post-burial alteration. The other conclusion is that York Glazed ware and Brandsby-type ware were produced from clays with the same composition.

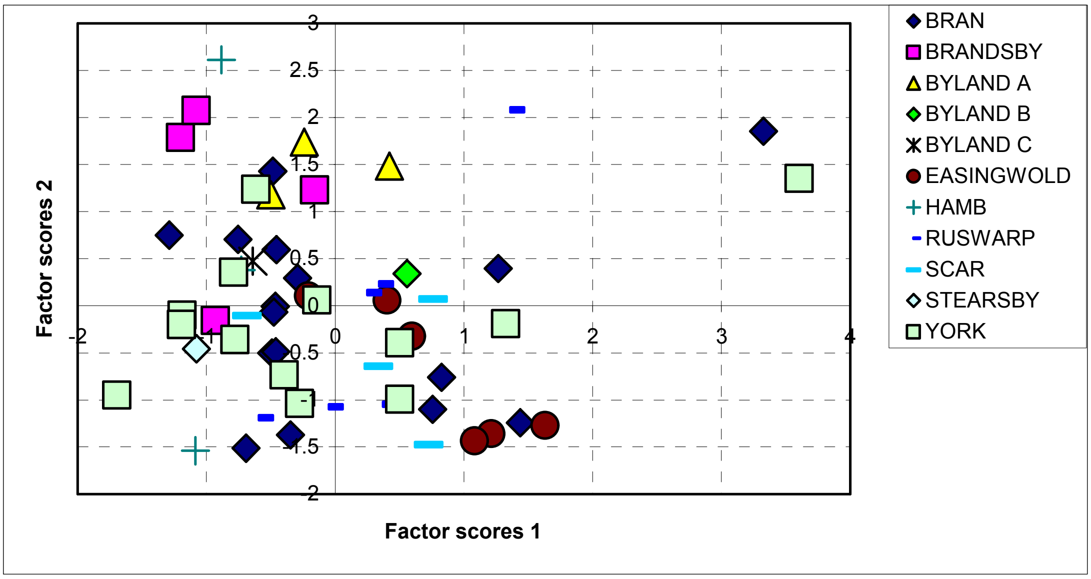

Figure 1

Ceramic Building Material

The normalised ICPS data for the five tile samples (excluding very mobile elements) was examined using factor analysis. Two factors were found, the first of which distinguishes Fabrics 1, 2 and 3 from the remainder and the second of which distinguishes Fabric 4 (high

F2) from Fabric 5 (negative F2). The main elements responsible for the high F1 scores of fabrics 1 to 3 are manganese, sodium, potassium, magnesium and cobalt with iron, scandium, chromium, nickel and zinc having a lesser importance. The high F2 score is due to titanium and the low F2 score is due to high vanadium.

The Byland Abbey data were then compared with analyses of floor tiles from Byland Abbey carried out by Mike Hughes for Jenny Stopford (Hughes 2005; 2005). This analysis was carried out using Neutron Activation Analysis and only a subset of the elements measured were also measured by RHCL. In addition, there are likely to be systematic differences in the measurements between the two techniques. As a check, therefore, analyses of the flat roof tiles from Rievaulx Abbey, and the Hughes/Stopford data for tiles from Rievaulx were also included.

Factor analysis of this dataset, for the elements shared by the two methods, revealed two factors. The first separates the Byland Fabric 1 to 3 samples from the others and the second separates the NAA data from the ICPS data.

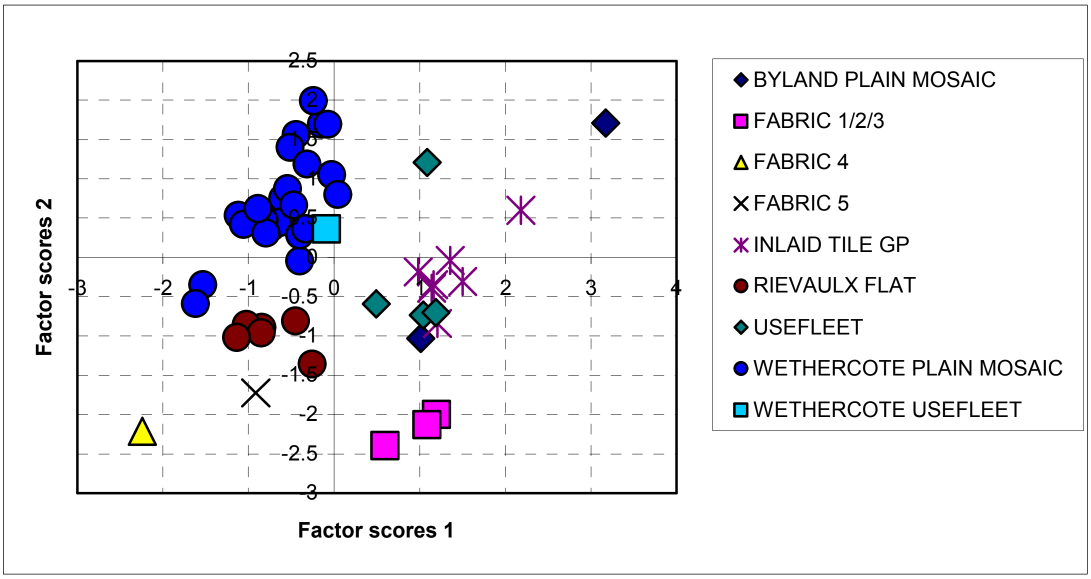

Figure 2

This analysis indicates that the floor tiles from Rievaulx and Byland can be divided into two groups. The group characterised by negative F1 scores includes plain mosaic which matches that found at the production site of Wethercotes, a grange of Rievaulx located in the upper Rye valley. This group also includes one slip-decorated square tile whose design places it in the Usefleet group, indicating a re-use of the Wethercotes site c.1300. The Rievaulx flat roof tiles, analysed using ICPS, also have negative F1 scores as do the Fabric 4 and 5 Byland fabrics.

The high F1 group includes a plain mosaic tile from Byland Abbey, inlaid tiles from Rievaulx and Byland and Usefleet group tiles from both abbeys.

The two groups therefore seem to correspond to mixed white/red-firing clays quarried from the Middle Jurassic outcrops (Wethercotes, and Fabrics 4 and 5) and those produced from red-firing boulder clays, which contain Middle Jurassic material, but with a wider range of sources. To test this further, the Byland tile data was examined alongside the whiteware pottery and Rievaulx flat tiles, all analysed using ICPS.

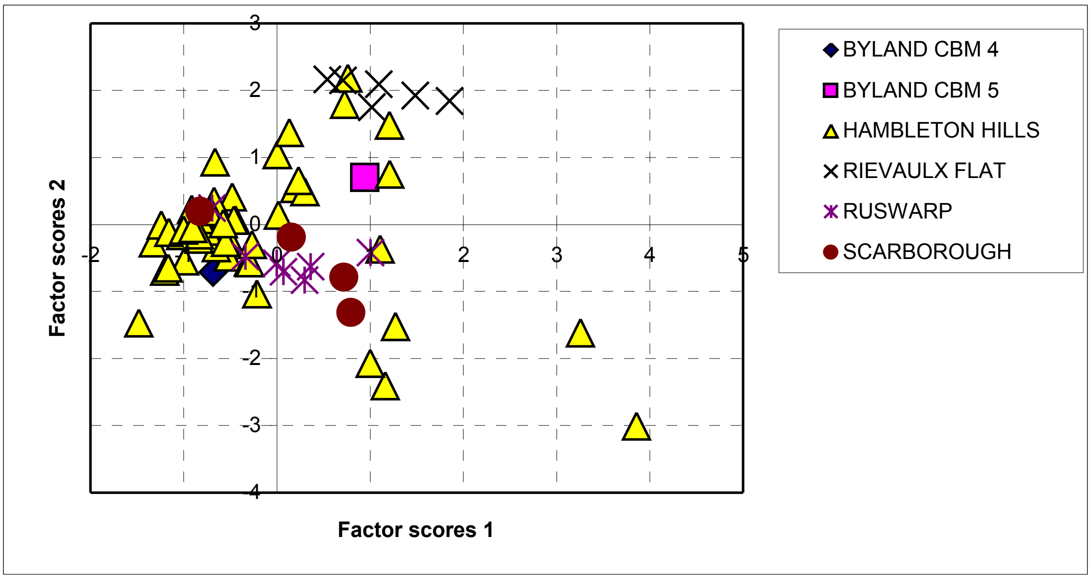

Figure 3

Factor analysis of this dataset indicates that both Byland Fabrics 4 and 5 have similar compositions to Hambleton Hills samples rather than with the Rievaulx tiles.

The fabric 1 to 3 samples were then compared with samples produced from boulder clays in the Vale of York: clays from a kiln of unknown function at Easingwold; pottery of late medieval date from Holme-upon-Spalding Moor and York. Factor analysis shows that there is a major difference in the composition of the Easingwold clays and the remaining samples and so the analysis was repeated excluding those samples. This second analysis indicates that the Humberware samples have a similar composition, distinguishable from that of the Byland Abbey and Rievaulx flat tile samples. This analysis therefore does not support the idea of a Vale of York (i.e. potentially local) origin for fabrics 1 to 3 and confirms that they are unlikely to be Wethercotes products.

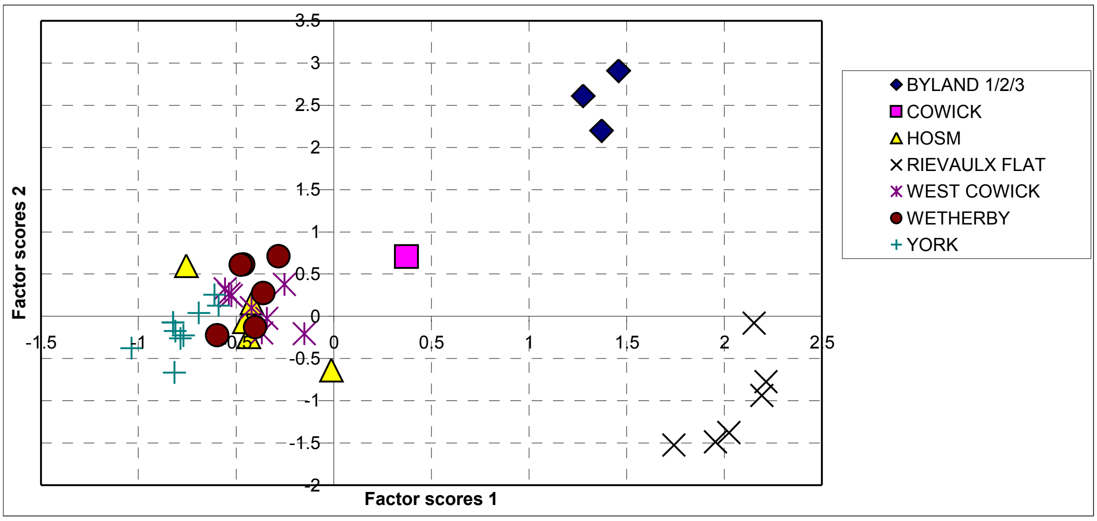

Figure 4

Discussion and conclusions

Byland Abbey lies on boulder clay at the foot of the North Yorkshire Moors. No samples of the local boulder clay have been analysed but it can be assumed that it contains predominantly fragments derived from the rocks over which the ice passed (mainly lower Jurassic mudstones at Byland) together with material from western edge of the North Yorkshire moors and, perhaps, with erratics derived from strata to the northwest. This description is compatible with the range of inclusions found in the thin sections of ceramic building material fabrics 1 to 3. However, the lack of chemical similarity between these three samples and samples of boulder clay from Easingwold means that the identification of these three fabrics as the products of a local industry unproven and whilst there is more similarity between these samples and fabrics produced from quaternary deposits (probably lacustrine clays and estuarine silts) from further south in the Vale of York these too can easily be distinguished from Fabrics 1 to 3 by examining their chemical composition. A source further north-east, in the Ryedale, is possible and would be consistent with the fact that a boulder clay with similar chemical characteristics was used to make some of the inlaid tiles used at Byland. However, the source of these tiles is unknown although their Neutron Activation Analysis suggests that both Byland and Rievaulx were supplied from the same source. In order to test this further, samples of the inlaid tiles would need to be examined using the same methods as we used on the Byland ceramic building material fabrics.

The remaining two ceramic building material fabrics and the five samples of possible waste glazed whitewares may have been produced in the same centre. All appear to have been made from Middle Jurassic clays. The lightest-firing examples were probably produced from clays associated with the thin coal deposits at the base of the Long Nab member of the Scalby Formation. Outcrops of this clay are mapped by the British Geological Survey about a mile to the northwest of Byland Abbey, and the hillside immediately north of the abbey is mapped as slumped deposits including the same clay. Alternative sources consist of the villages of Brandsby and Stearsby, where later medieval pottery was produced, and the grange at Wethercotes, where floor tiles and roof tiles were made for Rievaulx abbey and traded to other sites, including Byland Abbey. A Wethercotes source can probably be discounted because of the difference in composition between the Byland samples and the flat roof tiles from Rievaulx which were analysed at RHCL using the same procedure as that used for the current Byland Abbey samples. A source in the Brandsby area cannot be discounted since there is no apparent petrological or chemical difference between the five glazed ware samples from Byland Abbey and samples from the Brandsby kiln. A possible explanation for why there should be a difference in chemical composition between ceramics produced in the Brandsby area and Wethercotes but not between Brandsby and Byland Abbey is that the Rye river does not cut so deeply into the Jurassic strata as does the Vale of York whilst there is no great difference in the geological situation of Byland Abbey and Brandsby.

However, whether the sherds are indeed waste from local production or were traded to the site from the Brandsby area the importance of the results is that they make it clear that York Glazed ware is a product of the same region as Brandsby-type ware but is slightly earlier in date.

Bibliography

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Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V4499	24.19	5.4	1.19	0.57	0.19	2.88	1.22	0.13	0.024
V4500	23.47	2.77	0.96	0.55	0.33	2.81	1.28	0.52	0.013
V4501	20.38	4.58	0.99	0.27	0.21	2.6	1.32	0.14	0.013
V4502	22.63	3.26	0.77	1.22	0.16	1.83	1.32	1.19	0.016
V4503	20.96	2.97	0.79	0.6	0.23	1.94	1.25	0.08	0.014
V4504	13.39	5.78	1.61	0.76	0.57	2.85	0.67	0.24	0.059
V4505	14.57	5.77	1.82	0.6	0.63	3.12	0.72	0.1	0.061
V4506	15.53	5.94	1.47	1.14	0.54	3.21	0.76	1.14	0.052
V4507	19.83	4.31	0.6	0.43	0.17	1.24	1.09	0.28	0.006
V4508	17.81	6.2	0.73	1.02	0.25	2.14	0.75	0.97	0.013

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V4499	348	187	28	175	63	23	94	193	33	120	55	97	57	7	2	6	3	1,485	95	24
V4500	325	173	38	217	63	26	86	226	38	134	67	132	70	14	3	8	4	1,792	103	21
V4501	430	134	27	91	45	21	88	157	30	99	60	109	61	9	2	5	3	382	75	21
V4502	489	130	61	123	50	21	106	194	36	130	53	113	56	11	3	7	4	1,420	71	18
V4503	338	129	33	158	55	20	84	187	31	165	53	95	55	9	2	5	3	195	69	21
V4504	365	111	20	40	49	13	81	96	22	70	41	66	42	5	1	4	2	39	87	14
V4505	381	117	19	44	52	14	79	107	22	73	42	66	43	6	1	4	2	20	85	15

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TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V4506	465	129	21	38	56	14	167	116	22	118	47	77	47	6	1	4	2	38	108	16
V4507	310	127	34	65	41	16	88	124	21	101	43	76	44	6	1	3	2	49	73	14
V4508	481	143	44	57	69	16	144	193	19	82	43	76	44	6	1	3	2	29	122	16

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