Characterisation Studies of Ceramic Building Material from Wawne, East Yorkshire

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The medieval and post-medieval ceramic building materials from the On-Site Archaeology excavations at Wawne were divided by the author into six fabrics, given the subfabric codes of CBM1 to CBM6 (Table 1). Samples of each fabric were then selected for petrological and chemical analysis. (Table 2). Where sufficient material was available five samples were taken for chemical analysis of each fabric. In addition, three "one-off" fabrics were sampled (CBM1, CBM5 and CBM6).

Table 1

Sub-Fabric	No of samples	Description	Form
CBM1	1	Fired clay	Wattle and daub
CBM2	5	Micaceous untempered clay	Flat roof tiles, brick
CBM3	5	Sand-tempered micaceous clay	Flat roof tiles, hearth tiles, louver
CBM4	5	Untempered Calcareous clay	Flat roof tiles and bricks
CBM5	1	Sand-tempered Calcareous clay	Flat roof tile
CBM6	1	Mixed white- and red-firing clays	Bricks and flat roof tile. Post-medieval?
Grand Total	18		

Table 2

TSNO	Context	cname	Form	Action	Description	subfabric

V21821001	MTIL	BRICK	ICPS		CBM4
V21831001	MTIL	FLAT	ICPS		CBM2
V21841041	MTIL	FLAT	ICPS		CBM3
V21851057	MTIL	BRICK	ICPS		CBM2
V21861019	MTIL	FLAT	ICPS		CBM2
V21871178	MTIL	BRICK	ICPS		CBM4
V21881201	MTIL	FLAT	DR;ICPS	SQUARE PEG HOLE	CBM3
V21891019	MTIL	FLAT	DR;TS;ICPS	ROUND PEGHOLE WITH RAISED RIM AROUND HOLE	CBM2
V21901210	MTIL	FLAT	DR;TS;ICPS	TRIANGULAR NIB	CBM3
V21911001	MTIL	BRICK	ICPS		CBM4
V21921013	MTIL	HEARTH	ICPS	SOOTED UPPER SURFACE	CBM3
V21931176	MTIL	BRICK	TS;ICPS	STRAW IMPRESSIONS	CBM4
V21941156	FCLAY	DAUB	TS;ICPS	BURNT WITH CARBON-RICH CORE AND OXID SURFACE	CBM1
V21951000	MTIL	BRICK	TS;ICPS		CBM6
V2196MACHINING	MTIL	FLAT	TS;ICPS		CBM5

V21971057	MTIL	HIP?	ICPS		CBM2
V21981057	MTIL	FLAT	ICPS		CBM4
V21991057	MTIL	LOUVERDR;ICPS		SOOTED INT;THUMB IMPRESSIONS EXT;COIL BUILT	CBM3

Petrological Analysis

The thin sections were prepared by Steve Caldwell at the Department of Earth Sciences, University of Manchester. They were stained using Dickson's method (Dickson 1965) to help distinguish between ferroan and non-ferroan calcite and dolomite although in the event no calcareous material survived in the samples.

CBM1 (V2194)

The thin section of this sample reveals a light brown clay with a dark grey or black core and one large rounded inclusion (an orthoquartzite with grains c.0.2-3mm across and some opaque grains of similar size with opaque matter marking the original grain boundaries) and one large opaque inclusion, a fragment of tabular ironstone 3.0mm long and 0.5mm wide, a rounded fragment of fine-grained basic igneous rock 1.0mm across, a fragment of a sandstone with rounded grains up to 0.5mm across and an opaque matrix 1.0mm across and a fragment of subangular flint, 1.0mm long. Several irregular voids are present which are either due to poor wedging or the inclusion of organic matter. The groundmass consists of abundant subangular and rounded quartz grains up to 0.5mm across, sparse carbonised roots and sparse muscovite laths up to 0.1mm long.

With the exception of the organic inclusions and voids these features can all be paralleled in samples of boulder clay from sites in East Yorkshire and northeast Lincolnshire and from this we can infer that the daub was made from clay "as dug" and not tempered or cleaned in any way.

CBM2 (V2189)

The thin section reveals that this fabric contains no inclusions larger than 0.2mm except for rare subangular quartz grains up to 0.3mm across and a single possible subangular rhyolite fragment of similar size. The groundmass consists of abundant quartz and moderate muscovite silt up to 0.1mm long in a groundmass of anisotropic baked clay minerals. There are abundant opaque spherical inclusions in the matrix, c.0.05mm across and some of these occur as clumps and lenses. There is also moderate black staining some of which appears to have spread out from the opaque inclusions. The groundmass texture and colour is variable, suggesting that the parent clay included laminations of different colour and texture.

The characteristics of this sample suggest that it was derived from a silty clay. Locally, the most likely sources for such a clay would be either estuarine clays on either side of the Humber or perhaps lacustrine deposits filling post-glacial lakes and ponds overlying the boulder clay. The texture is certainly less silty than that of objects made from silt at the junction of the Trent and the Humber which would imply a source further downriver. The microscopic opaque spheres are probably of bacterial origin and presumably present in the parent clay whereas the black staining may be secondary.

CBM3 (V2190)

The thin section reveals an oxidized fabric containing abundant rounded sand-grade inclusions. This sand occurs as strings and lenses indicating either that it was added and poorly mixed or that the parent clay has a variable sand content.

The following inclusion types were present in the sand fraction:

- Rounded voids up to 1.5mm
- Angular flint, some with a brown-stained core up to 1.0mm. This includes one fragment with an echinoid shell fossil preserved as a black stain
- Rounded quartz, including grains of lower Cretaceous origin up to 1.0mm
- Rounded inclusionless clay pellets with black staining up to 1.0mm
- Rounded white siltstone up to 1.0mm
- Rounded fine-grained basic igneous rock up to 0.5mm
- Rounded sandstone with grains up to .03mm
- Rounded sandstone with grains including biotite up to 0.3mm and opaque cement up to 1.5mm

The groundmass contains sparse angular quartz silt and muscovite laths up to 0.1mm long in a matrix of isotropic baked clay minerals.

The sand fraction in this fabric is clearly dominated by material of Cretaceous age. The rounded voids, therefore, probably once held chalk. There is a small erratic element present, however, suggesting that the same is actually of fluvioglacial or recent origin.

CBM4 (V2193)

The thin section of this fabric reveals a very poorly mixed clay in which large areas have the silty, black-stained appearance of CBM2 interleaved with lenses containing abundant rounded and subangular quartz sand, up to 0.3mm across. Lenses which once has a high calcareous content are recognisable at x20 magnification with reflected light but no calcareous material remains in the sample.

The once-calcareous lenses have a silt content similar to that of the non-calcareous areas suggesting that the parent clay was a estuarine silt with a variable carbonate content.

CBM5 (V2196)

The thin section of CBM5 reveals a poorly mixed silty clay, similar to that seen in CBM2 and CBM4, with moderate rounded quartz sand inclusions up to 1.0mm and one rounded quartzite pebble 2.0mm across. There are also a few rounded voids up to 4.0mm across. Some of the quartz grains may be of lower Cretaceous origin. As with CBM4, although calcareous clay was identified by eye there is no calcite remaining in the fabric.

CBM6 (V2195)

The thin section reveals that the pellets and lenses of light-firing clay in this fabric are the result of a high calcareous content in the parent clay rather than the presence of kaolinitic clay (the latter would give rise to highly birefringent clays in thin section whereas these are optically isotropic). The only large inclusions present are rounded red clay pellets with black staining and rounded light-coloured marl pellets. The groundmass contains moderate rounded quartz grains up to 0.5mm across and quartz and muscovite silt.

None of the inclusions or features of this fabric can be used to definitely tie this fabric down to East Yorkshire, and in fact the presence of marl pellets might even suggest the use of a Triassic clay, or a boulder clay derived from Triassic clays.

Chemical Analysis

The samples were submitted to Dr J N Walsh, Royal Holloway College, London, for analysis using Inductively Coupled Plasma Spectroscopy (ICP-AES). A range of major, minor and traced elements were measured. The major elements were measured as percent oxides and the remainder as parts per million. The percentage of silica in the samples was not measured directly but was estimated by subtracting all the measured major elements from 100%. This estimate will also include organic matter, such as unburnt carbon, and chemically-combined water. Table 3 shows the number of silica content in 5% bands and indicates that the daub, CBM1 has a higher content that the tiles but that there is only a slight difference in silica content between the other fabrics, even though some are tempered with sand and some are not. This is probably a result of the high silt content of the samples.

Table 3

subfabric	60-65%	65-70%	70-75%	75-80%	Grand Total
CBM1				1	1
CBM2	1	3	1		5

CBM3	2		3		5
CBM4	2	2	1		5
CBM5		1			1
CBM6			1		1
Grand Total	5	6	6	1	18

The data were normalised by dividing each set of values by the Al2O3 frequency. This should minimise the dilution effect of the variable silica content. Factor analysis was then carried out on the resulting dataset. Fig 1 shows a scatterplot of the sample scores for the two main factors, F1 and F2. The CBM3 samples plot in the northwest half of the graph, indicating higher F2 and lower F1 scores than the remaining samples. The main elements giving rise to this separation are low values for Cr, Sc and V. Since all three elements are likely to be present in the clay fraction of the sample, this difference is unlikely to be due to the sand inclusions found in CBM3. There is no clear distinction in this graph between the remaining fabrics.

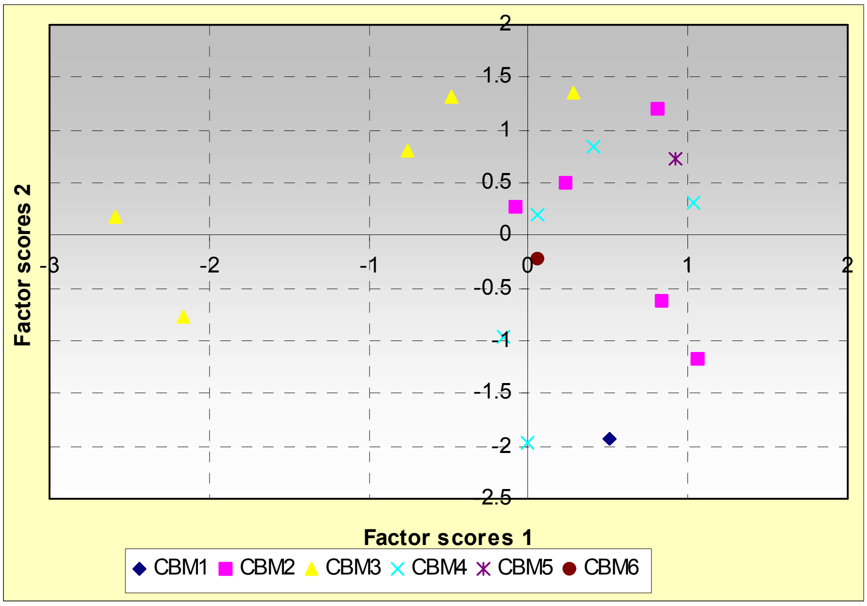

Figure 1

A plot of F3 and F4 (not illustrated) shows no separation of the majority of the subfabrics but does indicate that CBM6 has a strong negative F4 score. This is likely to be due to a lack of K2O and Fe2O3 (consistent with the presence of light-firing clay) and a higher Li content than the other samples.

The data were then reanalysed alongside samples of ceramic building materials from Beverley (*bevo* in Fig 2) and Hull (F1 to F5 in Fig 2).

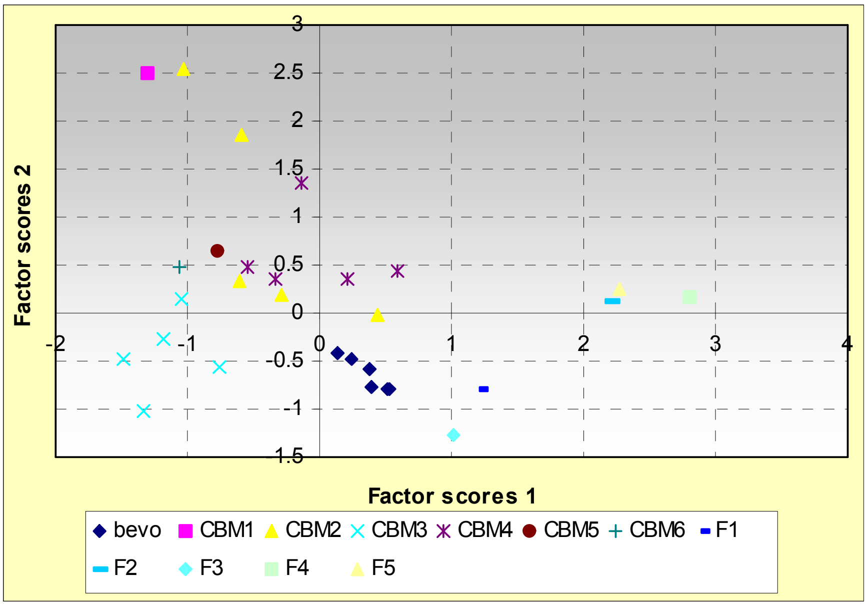

Figure 2

The plot of F1 against F2 for this dataset showed that the samples from Wawne, Beverley and Hull were chemically distinct and that the separation of CBM3 from the remainder was still visible. However, it also suggests that there may be two composition groups within the CBM2 samples, one midway between CBM4 and the Beverley samples and the other closer to the daub, CBM1. A plot of F3 against F4 for this dataset (Fig 3) shows that CBM3 can also be separated from the remaining Wawne samples by its strong negative F4 score, again due to a combination of low Cr, V and Sc values. Here too the Beverley and Hull samples can be separated from the Wawne ones, although in this case the two factors separate the Hull samples, Fabrics 1 and 3 having high F4 scores and Fabrics 4 and 5 having high F3 scores and F2 plotting in the centre of the graph, alongside Wawne samples.

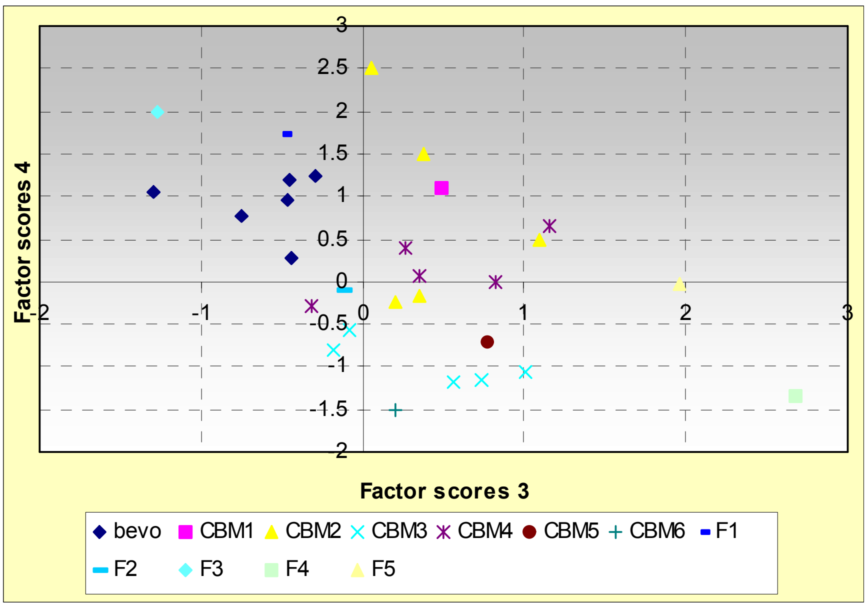

Figure 3

Finally, the data for the Wawne CBM samples was analysed alongside data for Beverley pottery and tile. Fig 4 shows a plot of F1 against F2 for this dataset. Wawne CBM1, CBM2 and CBM4 have high F1 scores whilst the Beverley tile samples also have a high F1 score, but lower F2 scores. CBM3, however, has a similar composition to the Beverley pottery samples, as do the CBM5 and CBM6 samples. High F1 scores are due to Na2O, CaO, Sr and MgO values, indicating firstly that it is the calcareous groundmass which separates these fabrics, secondly that the Na2O in this case is likely to come from the formation of a sodium-calcium-aluminium silicate through the presence of brine and calcareous clay during firing and thirdly, that the groundmass may have contained dolomite as well as calcite.

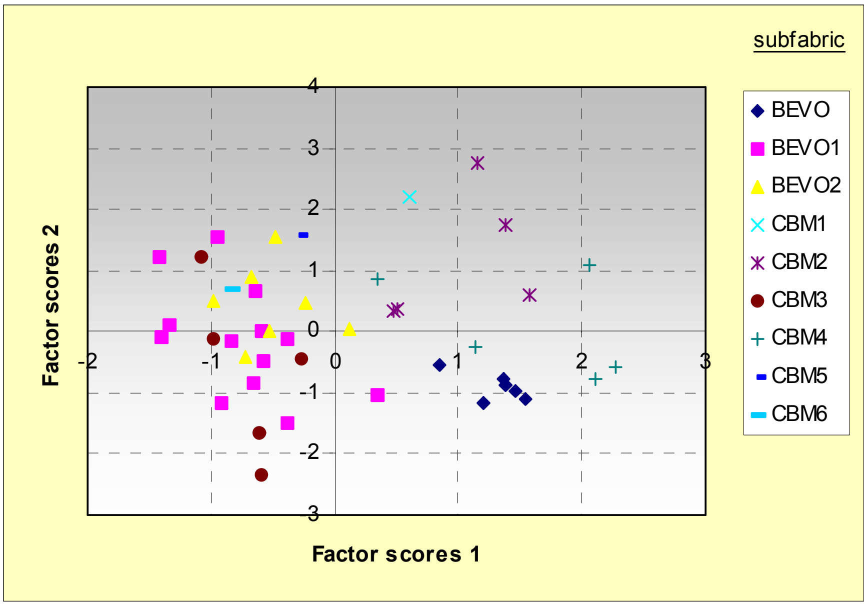

Figure 4

A plot of F3 against F4 (not illustrated) shows all the samples forming one large cluster, with two outlying Beverley 1 glazed ware samples forming outliers.

The same dataset was re-analysed omitting the suite of elements which are likely to be present in the calcareous groundmass (Na2O, CaO, Sr and MgO). Fig 5 shows the F1/F2 plot for this analysis and indicates that the separation into two groups is still visible, mainly as a result of high La and Ce values in the non-calcareous fabrics. In this analysis the Beverley tiles still form a coherent group whilst CBM2 and CBM4 , CBM5 and CBM1 form a loose cluster, within which the CBM4 samples occupy a small area, indicating that it is mainly variations in the carbonate content which distinguish the samples.

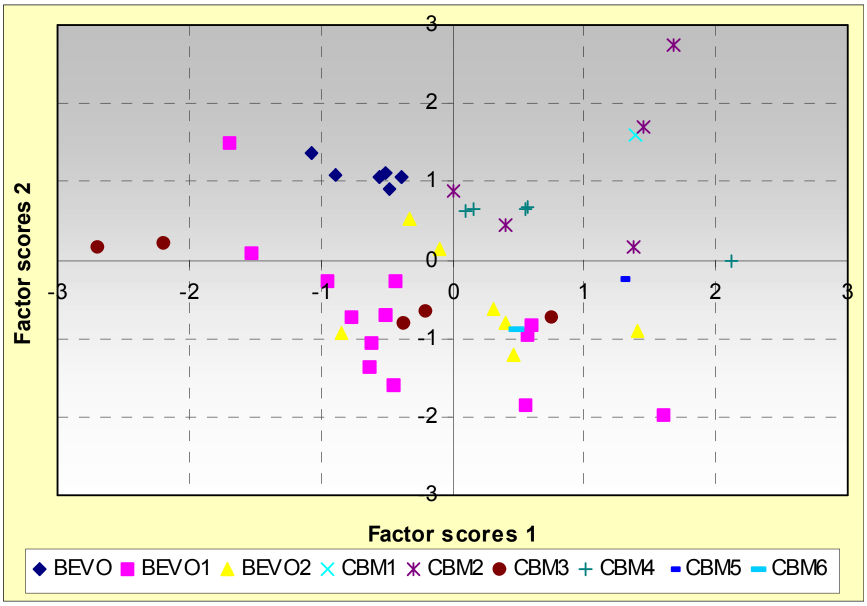

Figure 5

Conclusion

The petrological and chemical analysis confirm that the six fabrics identified visually in the Wawne CBM collection can be differentiated, either petrologically or chemically or both. The analyses also show that none of the Wawne samples have chemical composition identical to that of ceramic building materials from Beverley or Hull but that CBM3 has a composition indistinguishable from that of Beverley pottery. Despite this, it is quite possible that all the fabrics (except for CBM1) were produced at Beverley but from batches of clay which have yet to be analysed.

The daub, which must have been prepared on site and probably dug locally, has a similar chemical composition to that of CBM2 and CBM4 although these two fabrics are clearly distinguished from CBM1 by their petrological characteristics and these differences probably outweigh the chemical similarity.

The thin sections of fabrics CBM2 and CBM4 clearly suggest that these two fabrics are calcareous and non-calcareous clays from the same tilery and that the two clays were being exploited contemporaneously. It is quite possible that the difference in composition was accidental and that both fabrics occurred in the same batch of tiles.

Only one of the fabrics, CBM6, could not be shown by thin section analysis to have a local origin although it too contained no rock or mineral types which could not occur locally. It was not separated from the remainder by chemical analysis except in one analysis. Nevertheless, should samples of bricks made from marly Mercian Mudstone become available it might be worth re-running the analysis to include those samples.

Bibliography

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

Appendix. ICPS Data

Major elements measured as percent oxides

cname	TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
MTIL	V2182	13.17	5.24	2.26	5.69	0.8455	2.52	0.58	0.15	0.082
MTIL	V2183	16.62	6.97	2.12	1.52	0.7695	2.93	0.8	0.16	0.098
MTIL	V2184	17.48	6.15	1.32	1.08	0.437	2.37	0.77	0.12	0.062
MTIL	V2185	14.18	6.68	1.73	2.43	0.779	2.57	0.68	0.51	0.239
MTIL	V2186	16.5	6.64	2.87	6.17	0.9785	2.85	0.89	0.18	0.117
MTIL	V2187	12.97	5.18	1.8	3.96	0.8835	2.54	0.61	0.69	0.092
MTIL	V2188	19.82	6.98	1.85	5.3	0.456	2.8	0.91	0.16	0.071
MTIL	V2189	16.17	7.86	1.87	2.28	0.7505	2.72	0.78	0.54	0.472
MTIL	V2190	20.43	7.64	1.67	1.28	0.475	2.75	0.9	0.11	0.108
MTIL	V2191	13.82	5.74	2.36	6.32	0.8835	2.54	0.77	0.18	0.101
MTIL	V2192	16.83	6.48	1.38	0.38	0.551	3.3	0.76	0.13	0.04
MTIL	V2193	18.44	7.43	2.42	1.46	0.874	3.31	0.84	0.28	0.185
FCLAY	V2194	11.98	4.88	0.78	0.91	0.6175	2.13	0.56	0.46	0.226
MTIL	V2195	17.99	5.27	1.13	1.5	0.5225	1.96	0.79	0.27	0.087
MTIL	V2196	16.41	6.44	1.66	3.13	0.57	2.3	0.74	0.19	0.064
MTIL	V2197	17.23	7.37	2.1	1.02	1.026	3.34	0.77	0.2	0.094
MTIL	V2198	17.31	7.48	2.26	4.84	0.7695	2.96	0.83	0.31	0.132
MTIL	V2199	16.52	6.44	1.29	0.89	0.494	2.59	0.71	0.14	0.053

Minor and trace elements measured as parts per million

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V2182	456	81	20	73	38	11	176	73	21	53	34	50	35.72	6.9	1.076	4	1.9	52.196	89	12
V2183	479	109	26	91	51	15	131	106	25	78	45	71	46.812	8.8	1.403	4.8	2.4	78.256	115	16
V2184	472	109	19	106	49	15	114	125	25	75	45	66	46.154	8.1	1.185	4.1	2.3	78.024	83	18
V2185	540	87	24	79	46	12	157	96	21	66	40	61	42.394	7.9	1.132	5.1	2.1	41.184	119	18
V2186	458	107	25	97	50	15	190	117	28	79	45	70	47.47	8.7	1.336	5.5	2.8	29.8	106	18
V2187	549	89	19	64	38	11	204	73	20	60	35	53	36.848	7	1.082	4.2	1.9	54.136	84	11
V2188	430	125	24	122	59	18	196	145	27	94	51	78	52.922	9	1.402	5.3	2.8	38.716	89	20
V2189	724	90	28	76	62	14	143	96	24	75	45	69	48.034	8.8	1.314	6.1	2.4	42.596	127	24
V2190	551	127	27	126	62	18	128	149	28	91	57	85	58.938	10.6	1.636	5.7	2.9	52.684	95	24
V2191	470	86	23	77	40	12	191	91	25	69	39	59	41.172	7.6	1.126	4.8	2.4	15.116	81	16
V2192	365	107	18	99	46	15	90	108	15	78	40	60	40.42	5.6	0.752	3	1.8	38.004	86	12

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V2193	517	113	25	101	59	17	144	126	27	83	51	76	53.204	9.8	1.557	5.6	2.6	47.872	127	20
V2194	589	72	19	57	41	10	107	69	17	58	34	51	35.72	6.3	0.912	4	1.7	52.424	94	17
V2195	574	110	29	104	48	16	126	111	26	75	49	76	50.76	8.8	1.373	5	2.4	59.412	121	19
V2196	632	101	24	90	55	15	140	110	28	70	46	71	47.752	8.8	1.356	4.8	2.4	52.508	83	23
V2197	459	109	23	87	55	15	131	115	24	70	46	67	47.846	9.4	1.363	4.9	2.4	48.524	115	19
V2198	580	110	26	97	51	16	187	111	26	77	46	68	48.128	8.7	1.452	5.2	2.4	38.328	124	16
V2199	423	101	27	86	46	14	116	106	16	73	39	57	39.668	6.4	0.856	3.2	1.8	48.676	83	15