Characterisation Studies of Medieval Roof Tile from the A4146 Stoke Hammond and Linslade Western Bypass, Buckinghamshire

Alan Vince

Samples of flat roof tiles from two excavated medieval sites on the line of the A4146 Stoke Hammond and Linslade Western Bypass, Buckinghamshire. The fabric of these tiles was examined at x20 magnification and three thin sections were prepared as a check on the visual identification of inclusion types. In addition, 38 chemical analyses were prepared and used to test internal variation in composition, similarity with fired clay from two sites on the bypass and a range of pottery and tile samples from the A4146 and other sites in the area.

Binocular Microscope Study

The medieval tiles were divided into fabrics on the basis of visual identification of inclusion types and their frequency, size and other visual characteristics ({Vince & Steane 2006 #46763}). A sample of each type is present in the site archive. Sources were suggested on the basis of the visual identification of inclusions. Four fabrics (B, H, S and T) were similar to fired clay from the bypass excavations, which is assumed to be of local origin and probably derived from boulder clay. Two fabrics are similar to calcareous clays of Upper Jurassic origin (Fabrics A and G) and one was similar to the silty micaceous Gault clay, which outcrops locally, with a sand temper which could be derived directly from the Woburn Sands, which also outcrops locally.

Table 1

Fabric	Major Inclusions	Groundmass	Interpretation	Sampled?
FABA	Abundant rounded quartzose sand, mostly red-stained.	Poorly mixed calcareous clays with lenses and streaks of white-firing marl.	Upper Jurassic calcareous clay. Sand rather different from local examples.	1 TS and 5 ICPS
FABB	Sparse rounded fragments of red sandstone < 3.0mm (and one 15mm long). Abundant rounded quartz sand, including polished grains < 1.0mm Abundant rounded white mudstone fragments < 4.0mm.	Lenses and streaks of white-firing inclusionless clay mixed with sandy, inclusionless light red-firing clay.	Local.	4 ICPS
FABC	Abundant rounded quartz sand, including red-stained and polished grains.	Silty, micaceous (muscovite)	Gault clay with Woburn sands temper.	1 ICPS
FABG	Abundant lenticular voids < 0.5mm long. Fine quartz sand <0.2mm used as moulding sand.	Fine-textured clay.	Upper Jurassic clay.	1 ICPS
FABL	Moderate rounded quartzose sand, including red-stained and polished	Poorly mixed, mainly calcareous clay with		1 TS, 3 ICPS

	grains. Finer sand used as moulding sand (< 0.2mm).	lenses of red sandy clay.		
FABQ	Sparse angular white flint fragments <5.0mm. Moderate rounded quartzose sand, including polished grains < 2.0mm. Moderate red fine-grained clay pellets < 1.0mm. Sparse dark red clay/iron pellets < 2.0mm.	Fine-grained with some lenses of lighter and darker red clays, some slightly micaceous.		6 ICPS
FABR	Sparse angular flint fragments < 5.0mm. Sparse rounded red clay/iron pellets < 3.0mm.	Fine-grained with some lenses of lighter and darker red clays, some slightly micaceous.		1 TS, 6 ICPS
FABS	Sparse subangular red sandstone fragments < 2.0mm. Rounded quartzose sand < 0.5mm, abundant in moulding sand, sparse in body. Same as FABE (no medieval examples).	Poorly mixed with lenses of light-coloured inclusionless clay alternating with red-firing clay with sandstone and quartz inclusions. Same as FABE.	Local.	6 ICPS
FABT	Sparse angular white flint fragments <5.0mm. Moderate rounded quartzose sand, including polished grains < 2.0mm. Sparse subangular fine-grained red sandstone <2.0mm. Moderate red fine-grained clay pellets < 1.0mm. Sparse dark red clay/iron pellets < 2.0mm.	Homogenous. Fairly fine textured.	Local.	6 ICPS

Thin Section Analysis

Samples of three fabrics (A, L and R) were thin sectioned by Steve Caldwell, University of Manchester, and stained using Dickson's method ({Dickson 1965 #44803}).

Fabric A (V3634)

Description

The following inclusion types were noted in thin section:

- Subangular quartz. Moderate grains up to 0.3mm across. These occur as strings of inclusions, concentrate in the red-firing clay laminae.
- Angular voids. Sparse voids up to 2.0mm across. The outlines of the voids suggest that they may have been either sparry calcite/dolomite or perhaps selenite.
- Opaques. Sparse fragments, some rounded and others angular (including fragmentary rounded grains), up to 0.4mm across.
- Clay pellets. Sparse clay pellets with opaque staining, up to 1.0mm across.

The groundmass consists of poorly-mixed isotropic baked clay minerals. The different lenses of clay vary in their texture, inclusion content and colour. Several lenses are light-firing and probably originally had a high calcareous content. The remaining clay consists of red-firing clay with mottling of light-coloured clay, also probably originally calcareous. The redder clay laminae contain sparse angular quartz up to 0.05mm across.

Interpretation

The groundmass of this fabric is confirmed to be a heat-altered marl. Such marls occur in the Upper Jurassic clays.

Fabric L (V3636)

Description

The following inclusion types were noted in thin section:

- Subangular quartz. Moderate grains up to 0.4mm across, several of which have an opaque coating. Some grains are cemented together.
- Rounded quartz. Sparse well-rounded grains up to 0.3mm across.
- Marl pellets. Moderate rounded fragments up to 1.0mm across. These are often composed of a slightly lighter-coloured clay than the groundmass with abundant ferroan calcite inclusions up to 0.1mm across.
- Dolomite. Sparse sparry grains up to 1.0mm across.

The groundmass consists of optically anisotropic baked clay minerals, sparse ferroan limestone fragments up to 0.2mm across, microfossils with non-ferroan calcite tests and ferroan calcite filling, up to 0.2mm across, and opaque grains, up to 0.05mm across.

Interpretation

The sand inclusions are in the main derived from the Woburn sands but a small quantity of grains of Triassic origin is also present. The groundmass is a Jurassic slightly calcareous clay.

Fabric R (V3646)

Description

The following inclusion types were noted in thin section:

- Subangular quartz. Sparse grains up to 0.3mm across.
- Flint. A single fragment 1.0mm long and 0.4mm wide.
- Opaques. Sparse subangular fragments up to 0.3mm across.

- Clay pellets. Moderate subangular fragments, mostly with few inclusions, up to 2.0mm across. Some of these have black dendritic staining and central cracks.

The groundmass consists of optically anisotropic baked clay minerals and abundant angular quartz silt and clay pellets up to 0.1mm across and sparse muscovite laths up to 0.1mm long. There are some laminae in the groundmass distinguished by colour but all contain the same range of inclusions.

Interpretation

The parent clay was probably the Lower Cretaceous Gault clay whilst the flint inclusions derive from the Upper Cretaceous chalk.

Chemical Analysis

Samples were prepared in Lincoln and submitted to Royal Holloway College, London, where they were analysed using Inductively Coupled Plasma Spectroscopy under the supervision of Dr J N Walsh.

The chemical data consist of the frequencies of major elements, expressed as percent oxides (App 1) and a range of trace elements expressed as parts per million (App 2).

The data were normalised to Aluminium, to take account of variations in silica content, and analysed using the factor analysis module from Winstat for excel (Fitch 2001).

Four factors were found and a plot of F1 against F2 indicated that all formed a single diffuse cluster apart from five of the six Fabric R samples which form a separate cluster distinguished by low F1 and F2 scores (the sixth sample was subsequently re-coded as Fabric Z). The weightings given to the individual elements by the software suggest that this cluster is due to low frequencies of rare earth elements, potassium, magnesium, vanadium and chromium. Examination of the data shows that of these the rare earth elements, vanadium and potassium are the main distinguishing elements.

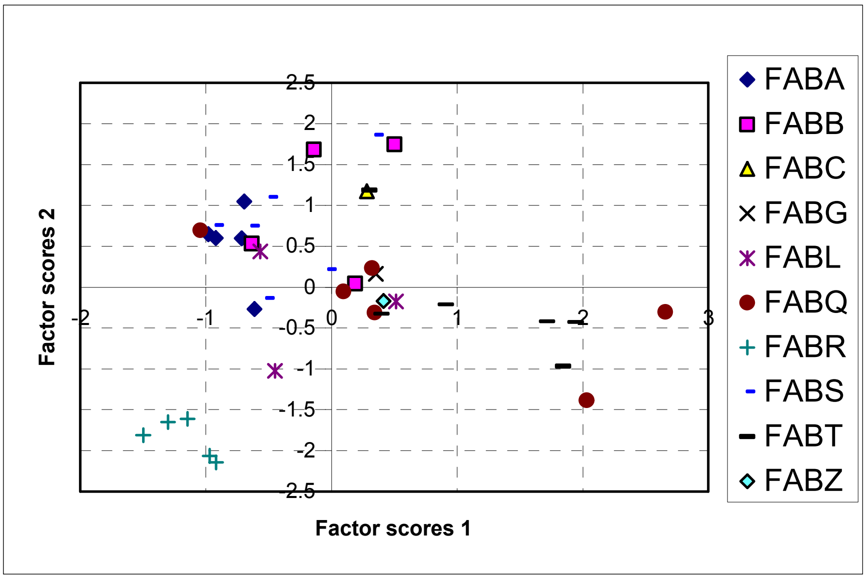
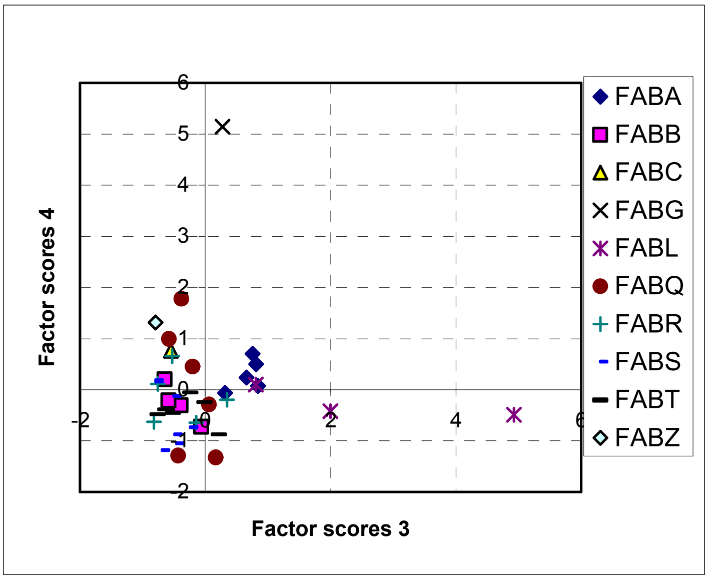


Figure 1

A plot of F3 against F4 (Fig 2) indicates that two anomalous results (the one Fabric G sample and one of the four Fabric L samples) have the effect of compressing all the other variation. However, it is still possible to see that the Fabric A samples form a cluster, distinguished by high F3 scores whilst all four Fabric L samples also have high F3 scores. High Factor 3 scores are due almost entirely to high weightings for calcium and strontium, confirming the visual identification of the groundmass of these two fabrics as being calcareous. The high Factor 4 score which distinguishes the Fabric G sample, is due to high weightings for sodium and lead. Lead is usually a contaminant from glaze but no glaze was noted on any of the tiles and the overall frequency is within naturally-occurring limits. Variations in sodium content are often due to the presence of sodium-rich feldspars (such as plagioclase) but one of the characteristics of this fabric is its fine texture and it is possible that the sodium was present in the clay fraction, perhaps indicating a high level of montmorillonite.



The tile data was then compared with data from the analysis of Iron Age and medieval fired clay. Factor analysis found five factors and a plot of F1 against F2 shows that the fired clay has higher F2 scores than the tiles. This, however, is due mainly to phosphorus, which is extremely mobile and likely to be present filling pores in the samples, which are probably more numerous in the fired clay. Barium, which is also enhanced, is attracted to phosphorus. However, both chromium and iron are also enhanced in the fired clay, as, to a lesser extent, is nickel. Whilst it is possible that these differences are due to post-burial alteration, they do not support a local (i.e. on-site) origin for the tiles.

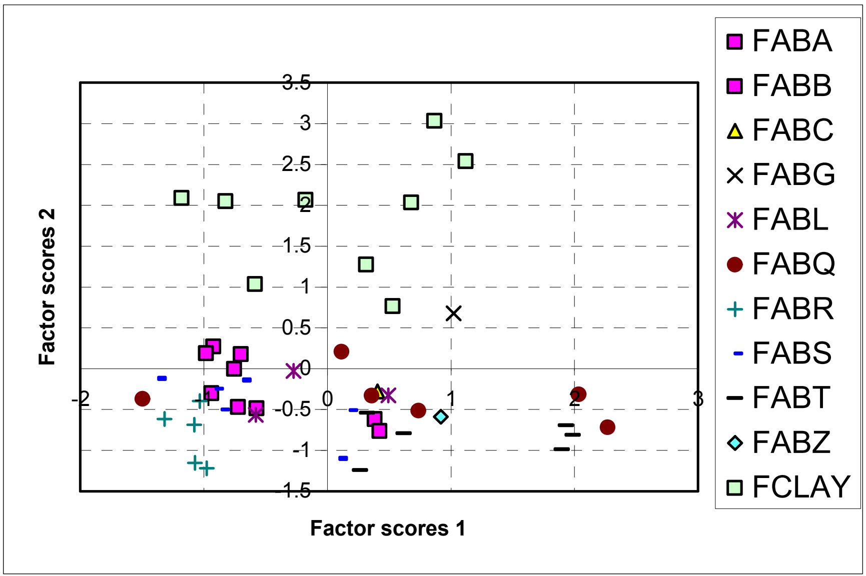


Figure 2

The tile data was next compared with that of the main medieval pottery fabric, MEDLOC, which following thin section analysis can be divided into two groups, MEDLOC (fabrics 1, 2, 5, and 6) and MEDLOC 3/4 (Fabrics 3 and 4). Factor analysis revealed six factors and a plot of F1 against F2 shows that the MEDLOC samples, like the tiles, fall into two groups distinguished mainly by their rare earth element frequencies (Fig 3) with MEDLOC 3/4 forming a separate group. A plot of F3 against F4 showed no further patterning and also failed to distinguish the pottery from the tiles whilst a plot of F5 against F6 found the sample anomalous sodium value of the Fabric G sample and distinguished Fabrics A and L by their higher calcium and strontium values. In that plot too the MEDLOC pottery plotted with the majority of the tiles.

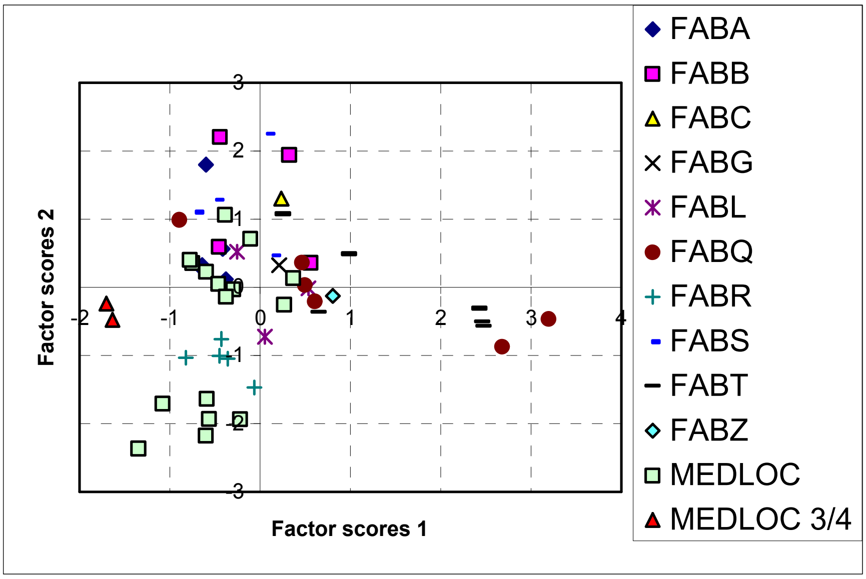


Figure 3

Finally, the tile data were compared with data from the medieval shell-tempered wares from the site (termed "Olney Hyde" here). Five factors were found. A plot of F1 against F2 found that the Olney Hyde ware plotted in the same area as Fabric R. However, the plot of F3 against F4 showed that the F3 scores separated the two groups, and also separated the Olney Hyde ware from all the other tiles. Furthermore, a more detailed examination of the rare earth element values indicates that the shell-tempered ware samples have different ratios of dysprosium to europium, for example. On this evidence, there is little similarity between the shell-tempered wares and the tiles, even with those which are thought to be made using fine-textured, calcareous Jurassic clays, similar to those used at Olney Hyde and Harrold.

Conclusions

There are variations in fabric and chemical composition within the sampled tiles and a fair correlation between visual fabric and chemical composition. The suggested sources of those fabrics, based on visual examination at x20 magnification, is not upheld by the chemical analysis, however.

Without further data, it is not possible to tell whether these fabrics come from the same tilery or represent different sources of tile. However, it is clear that there is a difference in composition between the tiles and samples of local fired clay, suggesting that the tiles were not made on site, whilst there is also a difference between the shell-tempered pottery from the site and the tiles, despite both groups being made from calcareous clays which ultimately are of Jurassic origin.

The main group of pottery found on the two sites (D and E) is very similar in chemical composition to the tiles. Unfortunately, the characterisation studies of the pottery failed to pinpoint its source, although they did show that there was a difference in composition between the products of the Bedfordshire and Buckinghamshire Late Medieval Reduced Ware production sites (such as Flitwick) and MEDLOC.

The range of inclusion types present are identical to those found in the local fired clay and it is likely that most of the tiles were also made from local exposures of fired clay, but not, probably, those found on site.

Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V3624	15.77	7.52	1.33	5.66	0.23	2.61	0.71	0.3	0.037
V3625	15.85	7.72	0.94	0.91	0.25	2.12	0.68	0.15	0.059
V3626	16.15	7.98	0.99	0.77	0.25	2.37	0.69	0.18	0.089
V3627	9.73	5.4	0.79	0.7	0.49	1.68	0.46	0.17	0.064
V3628	17.43	9.22	1.25	3.58	0.19	2.67	0.77	1.15	0.043
V3629	16.28	7.28	1.65	0.59	0.25	2.92	0.74	0.17	0.047
V3630	15.46	7.71	0.95	1.21	0.28	2.5	0.69	0.4	0.102
V3631	19.46	6.24	1.69	5.14	0.27	3.55	0.84	0.2	0.028
V3632	17.76	7.03	2.01	0.74	0.3	3.28	0.88	0.17	0.041
V3633	18.28	9.76	1.26	0.74	0.22	2.82	0.78	0.16	0.045
V3634	17.06	7.45	1.46	6.96	0.3	2.71	0.83	0.15	0.04
V3635	17.57	6.76	1.44	0.63	0.24	2.74	0.91	0.14	0.021
V3636	11.35	4.7	0.9	13.23	0.2	1.49	0.46	0.61	0.116
V3637	17.75	8.93	0.64	0.78	0.26	1.82	0.82	0.43	0.024
V3638	14.47	8.89	0.81	0.87	0.26	2.17	0.68	0.3	0.088
V3639	20.71	9.42	1.51	0.7	0.21	3.71	0.84	0.13	0.023
V3640	15.72	7.74	0.89	0.94	0.12	1.84	0.73	0.1	0.04
V3641	20.4	7.92	1.36	0.88	0.2	3.52	0.91	0.15	0.02
V3642	15.66	8.14	0.82	0.66	0.23	2.28	0.72	0.38	0.077
V3643	20.31	8.86	1.45	0.63	0.22	3.72	0.83	0.14	0.041
V3644	15.13	6.58	1.51	8.53	0.19	2.41	0.7	0.21	0.056
V3645	14.4	9.22	0.54	1.08	0.17	1.74	0.6	0.52	0.186

V3646	17.9	8.98	0.76	1.14	0.19	1.32	0.76	0.17	0.034
V3647	13.17	13.28	0.49	0.93	0.15	1.52	0.54	0.55	0.149
V3648	17.17	8.48	0.28	1.04	0.11	1.03	0.77	0.23	0.141
V3649	18.49	8.5	0.76	0.85	0.18	1.39	0.81	0.39	0.025
V3650	15.12	7.78	0.74	0.76	0.21	1.97	0.7	0.58	0.095
V3651	13.49	9.93	0.64	1.05	0.15	1.58	0.58	0.45	0.317
V3652	14.35	9.23	0.68	0.84	0.18	1.84	0.62	0.29	0.171
V3653	13.68	10.02	0.47	0.72	0.15	1.66	0.62	0.25	0.154
V3654	17.41	9.05	0.49	1.3	0.24	1.31	0.71	0.64	0.048
V3655	14.52	8.22	0.65	5.16	0.16	1.49	0.55	0.29	0.07
V3656	17.08	8.27	1.06	0.92	0.25	2.26	0.73	0.12	0.055
V3657	17.66	8.5	1.39	0.49	0.17	2.66	0.72	0.1	0.025
V3658	16.7	7.48	1.8	0.55	0.27	3.02	0.79	0.13	0.048
V3659	19.52	7.92	1.39	0.87	0.21	3.4	0.88	0.11	0.05
V3660	16.69	6.49	1.84	1.15	0.31	2.94	0.86	0.17	0.033
V3661	18.6	8	1.43	5.28	0.23	2.94	0.86	0.14	0.042

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3624	264	124	23	55	49	14	187	148	19	96	38	82	51	7	1	4	2	46	88	19
V3625	337	109	27	54	62	16	76	115	41	84	56	107	62	11	2	6	3	65	106	23
V3626	357	112	28	54	64	16	78	133	31	72	51	98	58	11	2	6	3	43	119	28
V3627	302	71	19	43	42	9	65	64	20	50	34	72	42	7	1	3	2	57	70	19
V3628	394	132	24	59	61	17	164	139	24	94	46	88	56	9	1	4	3	42	125	19
V3629	368	120	30	41	71	17	79	137	37	88	48	95	58	10	2	6	3	56	95	28
V3630	394	103	21	57	64	15	85	108	36	77	52	105	61	11	1	6	3	51	121	40
V3631	351	155	46	113	73	19	183	162	25	100	42	85	56	8	1	4	3	49	111	21
V3632	449	134	34	82	65	20	107	156	31	119	47	84	49	8	1	5	3	44	107	22
V3633	328	144	25	72	59	18	124	172	23	118	45	103	47	9	1	4	3	38	92	27
V3634	292	131	24	62	52	15	231	155	22	103	42	88	57	7	1	4	3	34	94	19
V3635	373	122	31	59	52	19	91	153	38	122	51	105	64	12	2	7	4	45	85	27
V3636	476	76	25	70	78	12	311	88	20	80	30	70	60	6	1	4	2	33	70	22
V3637	393	118	22	63	53	16	73	77	23	103	42	70	37	6	1	4	2	31	82	13
V3638	382	112	24	60	77	14	78	127	32	92	47	88	48	9	1	5	3	45	115	22
V3639	340	159	28	81	40	22	120	192	37	137	42	81	40	7	1	4	4	49	105	19
V3640	418	109	23	49	66	17	91	116	30	110	41	67	36	5	1	4	3	36	77	25
V3641	397	155	28	75	42	21	131	182	23	146	45	87	48	8	1	4	3	34	84	15
V3642	430	108	28	57	68	15	74	101	41	127	51	100	58	9	1	6	3	47	118	24
V3643	358	149	32	78	47	21	99	189	25	137	48	92	61	10	2	5	3	42	111	22
V3644	421	105	27	47	55	14	302	124	21	101	38	78	60	6	1	4	3	28	104	16
V3645	473	94	30	72	84	15	85	97	47	84	62	114	72	13	2	8	4	42	204	22
V3646	301	122	27	53	46	17	77	78	27	107	45	75	41	7	1	4	3	30	74	14
V3647	487	83	25	78	84	13	66	106	44	81	54	95	69	11	2	7	4	45	197	24

V3648	441	109	24	114	48	15	95	103	27	103	35	91	46	7	1	5	3	22	67	19
V3649	326	117	23	65	40	17	79	120	33	113	43	77	42	7	1	4	5	29	74	14
V3650	581	107	30	95	84	16	68	121	42	90	45	90	56	10	2	7	4	35	112	20
V3651	564	92	27	73	76	15	91	124	49	85	60	105	72	13	2	8	4	40	203	29
V3652	382	98	27	64	73	15	65	103	48	86	62	101	71	13	2	7	4	40	209	22
V3653	431	92	26	69	78	15	57	102	42	91	55	102	68	12	2	7	4	51	210	26
V3654	623	115	29	85	49	17	120	94	26	102	46	77	44	7	1	4	2	28	88	13
V3655	341	93	24	26	73	15	189	111	23	82	36	76	51	7	1	4	3	40	64	17
V3656	339	118	29	73	66	17	77	148	41	94	54	98	66	10	2	6	3	45	111	25
V3657	328	119	24	46	90	18	84	144	38	103	59	93	58	10	1	6	3	45	96	39
V3658	371	124	31	54	73	19	79	158	40	93	48	90	61	11	2	7	3	43	98	32
V3659	370	154	26	86	64	20	111	203	28	107	52	105	61	10	1	5	3	49	102	28
V3660	384	121	32	83	61	19	100	163	37	104	48	90	58	10	2	6	3	36	95	24
V3661	325	138	25	83	65	17	191	188	27	104	47	96	61	8	1	5	3	36	107	22