Saddler Street and the medieval pottery sequence in the northeast of England

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Chemical analysis

Thirty two samples of pottery of probable north-eastern English origin from Saddler Street were sampled and their chemical composition established using Inductively Coupled Plasma Spectroscopy. These were then compared with data from a further samples collected by the author.

Table 1

Locality	SITECODE	Total	Comments
Newcastle	BG85	1	
Newcastle	bg92	4	
Boulby	boulby	5	East Cleveland Ware
Saddler Street	dc74	32	
Newcastle	hb02	2	
Hartlepool	HCC84A	8	Samples of North Yorkshire Whitewares (TVW A) and redwares (TVW B and C) and Staxton-type ware
Hartlepool	HLS73	5	
Hartlepool	HMG86A	1	
Hartlepool	HPSG81	1	
Jarrow	jarrow	1	
Mirfield	mirfield	4	Samples of Coal Measure clays varying from red to white firing
Monkwearmouth	mk 64	1	
Prudhoe Castle	PRUDHOE CASTLE	24	Samples of various fabrics from the type fabric series
Newcastle	QDB	3	Wasters from the Dogbank kiln
	Grand Total	92	

The data were first examined using a statistical package, Winstat, to identify any outliers, where the measured value for an element was more than 4 standard deviations from the mean value in the dataset. Such values are not uncommon in the chemical analysis of pottery with coarse temper. Although usually composed of silica (and thus not measured in this method) these grains can include material which is measured: calcareous grains, phosphate nodules, iron oxides, manganese nodules and the like. In this instance, 106 samples were included of which fourteen were then excluded from further study.

The data were then studied using Factor Analysis in which a series of factors are calculated which 'explain' the variation in the dataset (Table 2). Factor 1 accounts for the highest percentage of variation, followed by Factor 2 and so on.

Table 2

Element	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
EU	0.927521425	0.02823403	-0.187360092	-0.137105879	-0.063049687	0.918970244
Y	0.911444512	0.085976849	-0.048623611	0.157272222	0.041700694	0.866960873
DY	0.861392755	0.177859148	-0.378860324	-0.037577248	0.08998541	0.926675923
LA	0.842315052	0.270755171	0.052658964	-0.141467187	0.156341658	0.830031656
SM	0.835094307	-0.135922941	0.092284709	0.016119722	-0.275080759	0.800303285
ND	0.74278448	0.271868313	-0.430562615	-0.046326071	-0.007379256	0.813225888
YB	0.729510229	0.294337749	-0.315896536	0.194910032	0.222498677	0.806106088
CE	0.716109776	0.298534932	0.3369795	-0.046955028	0.008937075	0.717776146
AL2O3	0.305283995	0.899652072	-0.095738543	0.081546377	-0.149650926	0.940783248
CR	0.082416583	0.864884432	0.284347211	0.175822455	-0.196305646	0.905120354
SC	0.427234535	0.80157427	-0.147400542	0.018473182	-0.180231272	0.879602148
SIO2	-0.216064144	-0.697066272	0.058371155	-0.596992888	0.038280508	0.8938582
TIO2	-0.024310878	0.650871615	0.498420115	0.038475899	-0.192845456	0.711317255
NA2O	-0.234517302	-0.559355114	-0.088801433	0.073557319	-0.15880617	0.406392282
V	-0.027366562	0.502945561	0.660858993	0.061365386	-0.151724847	0.717223915
BA	0.269458868	-0.211245036	-0.612652593	0.080053398	0.118145595	0.512942675
LI	0.165874648	0.384880078	-0.557441484	0.247452296	-0.33147851	0.657498723
CU	-0.075206267	-0.034019398	0.535582007	-0.040391977	-0.003548712	0.295305494
ZR*	0.149024171	0.358184441	0.521176454	-0.130547961	0.453124301	0.644493596
MNO	0.087949452	-0.034625618	-0.425379661	0.01432233	0.212004111	0.235032768
MGO	-0.011093267	0.089721159	-0.015549078	0.838125388	0.208501812	0.754341893
NI	0.013279878	0.138392105	-0.189841274	0.791355484	-0.031030507	0.682574834
K2O	0.006610925	0.303927889	-0.414310118	0.69851413	-0.049116478	0.754403159
FE2O3	-0.09752855	-0.112437311	0.130724134	0.678991078	-0.087937602	0.508004672
CAO	0.084683431	-0.135170923	-0.01849917	0.020699231	0.844063275	0.738655952
SR	0.008792216	-0.087977775	-0.275278249	0.319259366	0.704643642	0.682044712
P2O5	-0.050453254	-0.207221724	-0.127087582	-0.146177046	0.575369018	0.414054863
Sum of Squares	5.977541901	4.581142697	3.142018628	3.000412001	2.312585607	19.01370083
Percent of Variance	22.13904408	16.96719517	11.63710603	11.11263704	8.565131878	70.4211142

This indicates that the main factor governing variation in the data is the frequency of a group of trace elements: Eu, Y, Dy, La, Sm, Nd, Yb, Ce and Sm. There is a negative correlation with the overall quantity of 'silica' (since this is not directly measured, this is calculated by extracting the sum of all measured elements from 100 percent. For this reason, it also includes chemically-combined water, organic matter as well as silica), and the frequency of Na2O.

Principal components analysis was then carried out on the same data. This also calculates factors, or Principal Components, and allows the relationship of one sample to another to be displayed by plotting the positions of the samples in a two-dimensional space whose axes are the principal components.

A plot of PC1 against PC2 shows that the Coal Measure clays from Mirfield can be separated from the rest by their negative PC1 values (ie their 'silica' and Na2O content). The Tees Valley wares and samples of Coal Measures Whiteware and Gravel-tempered red- and white-firing coarsewares from Prudhoe can be separated by their high PC2 values. These are caused mainly by high values for Cr, V and TiO and negative values for Ba.

A plot of PC3 against PC4 separates the Hartlepool Staxton-type ware, Permian Yellow Sand-tempered wares from Prudhoe and the Tees Valley wares from the remainder. In this case, it is a combination of the two components which separate the data, mainly through high Zr values and low Li.

A plot of PC5 against PC6 shows that the Prudhoe Castle Coal Measure Whitewares have higher PC5 values than the remainder whilst the Mirfield clays can be separated by a combination of PC5 and PC6, in this case through their MnO content.

Thus, we can show that the coarsewares found at Durham, Newcastle and Jarrow can be distinguished from various other north-eastern wares:

- East Cleveland ware
- Permian Yellow Sand tempered ware
- Coal Measure whiteware from Prudhoe
- Gravel-tempered coarsewares from Prudhoe
- Coal Measure clays from Mirfield
- Tees Valley white and red-firing wares
- Hartlepool Staxton-type wares

By contrast, this analysis shows no clear separation in chemical composition between red-firing and white-firing wares from Durham, Newcastle and Jarrow, nor between these wares and glazed red earthenwares from Prudhoe Castle.

Since the calculations carried out by PCA are affected by the composition of the dataset, the analysis was then repeated for just those samples which could not be separated in the first study. The three samples from the Dogbank kiln, whose source is known, do not occupy a discrete element of the graph for any of the three plots and this either implies that Newcastle is the source of all these wares or that there is no chemical difference in wares produced in the Tyne valley from Newcastle to Durham. Since these sites are all within 20 miles of Newcastle either explanation is possible.

There is, however, one other possible difference to be accounted for. The Saddler Street site in Durham was anaerobic and preserved leather and wood. Such environments can affect the mobility of trace elements in groundwater and might be responsible for some of the observed variation. To test this, the analysis was repeated omitting 'silica', Fe2O3, MnO, P2O5 and Na2O, all of which might be present in concretions. The result, in fact, was to produce a clearer separation of the remaining data. The Newcastle, Prudhoe, Jarrow and Monkwearmouth samples can be separated from the Durham samples through a combination of PC1 and PC2. Furthermore, rather than being based on one or two elements, this separation is based on two groups of elements (Fig 1).

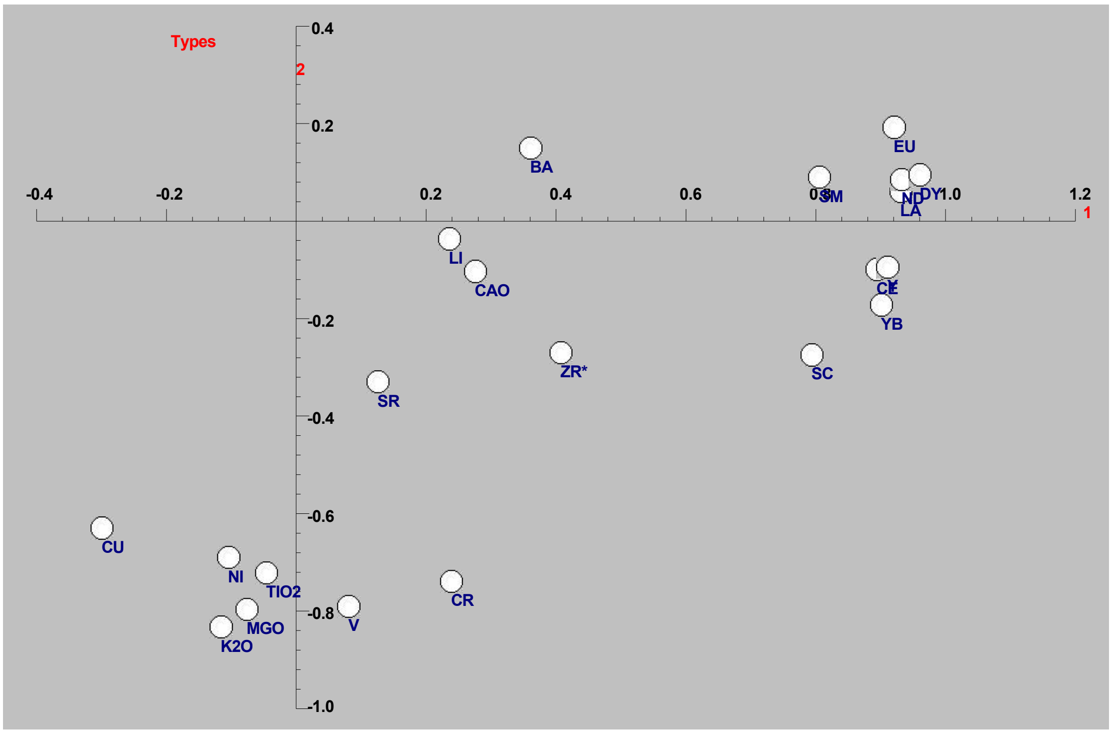

Figure 1

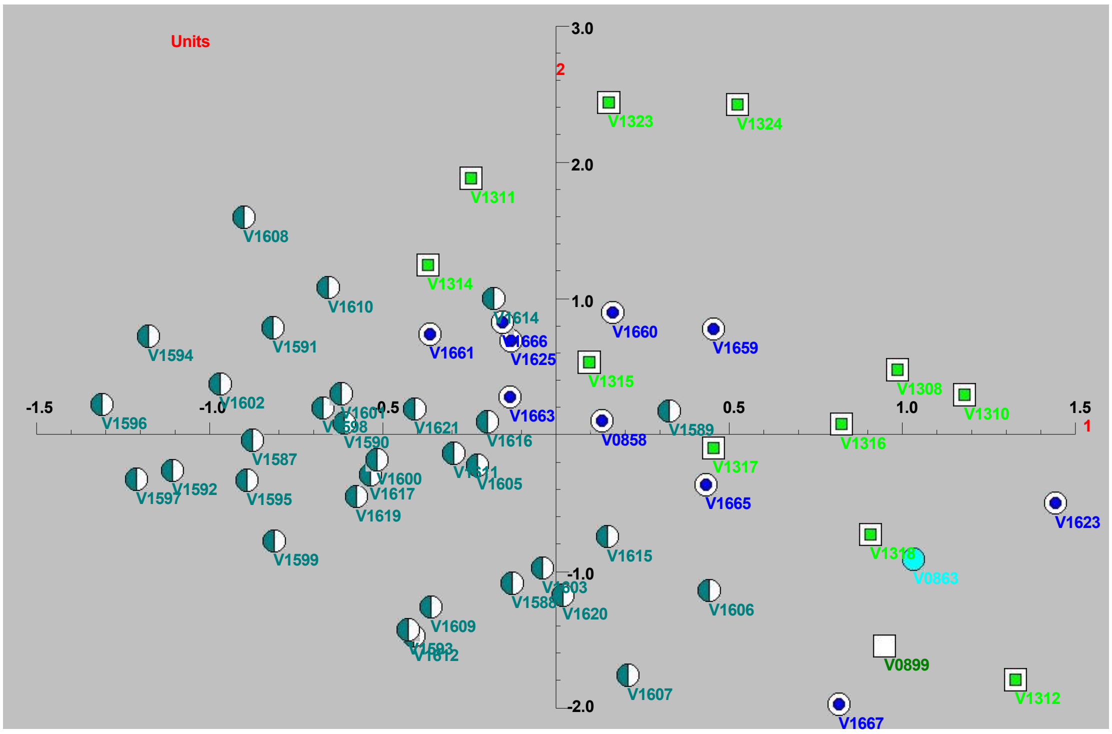

Figure 2 Key: Durham – half-filled circles, Newcastle – dotted circles, Prudhoe – squares in squares, Monkwearmouth – open square and Jarrow – filled circle.

The implications of this analysis would be that the Durham samples come from a different source from the remainder and that whereas the Jarrow, Monkwearmouth and Prudhoe pieces may be Newcastle products those from Durham are probably not.