# Characterisation studies of Anglo-Saxon pottery from Lundenwic: 4) Imported wares

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One of the characteristics of the mid Saxon settlement at *Lundenwic* is the high number of sherds of imported wares. These sherds are from wheelthrown vessels with few inclusions larger than 0.5mm, mostly quartz of fine sand and silt grades.  Some of these vessels are visually identical in fabric, form and decoration to the products of the Vorgebirge region in the middle Rhine valley. These wares are divided into classes, Walbeburg ware and Badorf ware. Both are *types* of pottery, defined by the quantity of tempering material and the range of forms produced and are not the products of specific kilns. Fieldwork in the middle Rhine suggests that even in the 8th/9th centuries this industry was operating on a large scale and exporting pottery over vast distances, not simply to eastern England but also, for example, to Scandinavia and north-western Europe.

By contrast, the sources of the remaining wares found in *Lundenwic* are unknown, but probably lie along the French and Belgian coasts or on navigable rivers.

As a contribution towards the study of these wares a selection was chosen for x20 binocular microscope study and chemical analysis. It was decided that given the limited funding available there would be less value in undertaking thin section analysis than in having a larger body of chemical data.

The samples were chosen by L Blackmore and do not necessarily prove a representative sample of the imports found in Lundenwic but, rather, concentrate on wares whose source is unknown. Nevertheless, they include a number of samples of Badorf ware which are taken here to be securely identified and therefore are used as reference material to compare with other less certainly identified samples.

In addition, reference samples of Rouen area wares, of 10th and later 12th/13th centuries were compared with the *Lundenwic* samples.

## Binocular microscope survey

### Lower Seine Valley whitewares (MSWWA, MSWWB, NFSVB)

Five samples have a white or light brown body and contain abundant quartz of coarse silt to fine sand grade. Three of the samples contain rare larger quartz grains, subangular grains up to 0.5mm in two cases and rounded up to 1.5mm across in the third. Other than those minor differences the samples appear identical at x20 magnification.  Three of these samples were from cooking pots, with sooting on the exterior, one was from a jar and the last from a lamp.

This fabric is visually identical to that of 10th-century Early Rouen Glazed ware, wasters of which have been found in Rouen itself, and to late 12th/early 13th-century Rouen whiteware which although not necessarily made in Rouen is the most common whiteware used in the city and was therefore made in the city's hinterland.

### Walberburg ware (BADOJ, NFSVA)

Two samples of Walberburg ware were examined. They contained abundant, well-sorted subangular quartz sand grains c.0.5mm across in a groundmass of baked clay containing no visible inclusions. The ware also contains moderate rounded pellets of light coloured clay, up to 6.0mm across.

### Badorf wares (BADOB, BADOC, BADOD, BADOE, NFSVB)

Eight samples of Badorf wares were examined. They could be classified into two groups on the basis of the texture and character of the groundmass. The first, BADOB (2 samples), has a groundmass containing abundant quartz silt and moderate ill-sorted subangular quartz grains up to 0.5mm across. The second has a slightly coarser textured groundmass, with grains of fine sand grade, but is usually poorly mixed, with lenses of differing in colour and the amount of inclusions, or their texture. All the samples contain ill-sorted subangular quartz inclusions up to 0.5mm but in some cases larger grains are also present. Mostly these are quartz but in two instances (V1720 and V1729) they are sandstone. These two samples both come from the same site, BRU92, and both have a coarser sand than the remainder. They may therefore be sampled from the same vessel. Two of the other samples in this group, V1746 and V1747, may also be from the same vessel although they differ slightly at x20 magnification. One sample contains rounded light-coloured clay pellets whilst the other contains rare rounded quartz grains up to 4.0mm across.

### Other wares (MSWWB, NFBW, NFBWC, NFGWB, NFSVA)

Thirteen other samples were examined. They range from inclusionless white-bodied wares to sand-tempered red earthenwares and although there are similarities between the samples at x20 magnification there are no clear groups present, nor any examples which are so similar as to demonstrate either that they are from the same vessel or made from the same batch of clay.

The most visible differences in these samples are due to their iron content and firing. Some are clearly made from a white-firing clay but in many cases the deliberate reduction and/or carbon enrichment of the surfaces makes it impossible to determine the iron content of the clay (furthermore, many of the white-firing vessels contain either iron-rich clay pellets or haematite-coated quartz sand temper, thus making impossible to determine the firing colour in oxidized conditions from bulk chemical analysis).

The texture of the groundmass also varies. A group of samples appear to be made from an inclusionless clay, which has a micaceous sheen in favourable conditions (V1757, V1758, V1759, V1760 and V1776). The remaining samples have groundmasses containing quartz of silt to fine sand grade. In two cases, V1730 and V1740, these inclusions appear to include calcareous grains, such as microfossils or finely-divided limestone or shell fragments.

Sparse larger grains, albeit less than 0.3mm across, occur in three samples: V1756 and V1766 contain sparse subangular quartz (and angular brown flint in the latter case) and V1760 contains sparse polished rounded quartz grains up to 1.0mm across.

Deliberate tempering is present in four samples and in each case the grains are haematite-coated. However, in three instances they are a well-sorted sand, in which some grains are polished and rounded (V1755, V1757 and V1759) and in the fourth case the grains are ill-sorted and included some larger, rounded grains, very similar to that seen in the Badorf ware sherds.

On the basis of these observations, together with the firing and treatment of the vessels they have been grouped into seven groups:

### Black and Grey-burnished wares

NFBW, V1730 and V1740. Fine sand/coarse silt in groundmass, probably including calcareous inclusions

NFBW, V1766 and V1775. Fine sand/coarse silt in groundmass.

NFBWC, V1758, V1760 and V1770. Fine-textured groundmass with micaceous sheen. Sparse subangular and rounded quartz inclusions

### Sandy whiteware

NFSVA, Low iron content with a fine-textured groundmass with micaceous sheen. Moderate, well-sorted subangular and rounded haematite-coated quartz sand, including polished rounded grains.

### Early to mid Saxon imports

Evison Group I. V1742.  lowish iron content, fine textured silty groundmass with abundant well-sorted subangular quartz sand up to 0.2mm across.

### Miscellaneous

Possibly BADO? V1746. Silty, micaceous groundmass, including some biotite? Moderate, illsorted quartz grains up to 1.0mm across. The largest grains are rounded and the remainder subangular. Some have haematite coating. Also, rounded iron-rich clay pellets up to 2.0mm.

Possibly Roman whiteware? V1756. Fine-textured, silty white groundmass. Sparse subangular quartz, polished quartz and brown flint inclusions up to 0.3mm

## Chemical analysis

Subsamples of all the sherds were cut off and the outer surfaces removed. The remainder, a lump of c.1-2gm, was then crushed to a fine powder and submitted to Royal Holloway College, London, for analysis using Inductively Coupled Plasma Spectroscopy (ICP-AES) under the supervision of Dr N Walsh.

Next, correlation coefficients were calculated between all of the measured elements and $Al_2O_3$, $Fe_2O_3$, CaO, $P_2O_5$ and 'silica' (that is, the result of subtracting all measured oxides from 100%).

For 'silica', only three positive correlations were noted, TiO, Zr and Pb, and even in these instances the elements had a higher correlation with $Al_2O_3$. This indicates that the main effect of increasing quartz silt or sand in the sample was to reduce the values of the other elements but that some inclusions rich in these three elements were probably present.

For $Al_2O_3$, positive correlations were found with 21 measured elements. However, of these, only two had correlations over 0.5 (Cr and V).

For $Fe_2O_3$, there were 22 positive correlations, but only six greater than 0.5 (MgO, $K_2O$, Li, Ni, V, Zn).

For CaO there were 10 positive correlations, but only one over 0.5 (Sr). CaO has a negative correlation with $Al_2O_3$ and an even lower correlation with 'silica' and is therefore probably present mainly as calcareous contamination.

Finally, for $P_2O_5$ there were 9 positive correlations but only one over 0.5 (Ba). $P_2O_5$ also has a negative correlation with $Al_2O_3$ and a slight positive correlation with 'silica' and therefore probably mainly occurs as phosphatic contamination but perhaps also in phosphate-rich inclusions, such as phosphatic nodules, bone or apatite.

The dataset was then normalised, by dividing each value by that of $Al_2O_3$, and examined to see if any of the measurements were outliers, lying more than 4 standard deviations from the mean for that element in the dataset. Four such values were noted: V1730 has a high $P_2O_5$ value, either due to post-burial contamination or the presence of phosphate nodules or bone in the sample. V1758 has a high MnO value. This may be due to the presence of a Mn-rich grain in the sample or to post-burial contamination (there are green/brown concretions on the sherd). Sample V1759 has high CaO and Sr values. There are sparse rounded calcareous inclusions in the sherd and it is likely that one or more of these were present in the sample. Finally, V1776 has a high $Na_2O$ value.

Fig 1 shows the results of factor analysis for the un-transformed data, including $Al_2O_3$ but excluding CaO, Sr, $P_2O_5$ and Ba. It can be seen that the Lower Seine valley whitewares (here coded 'ROUEN UGW) are separated from the remaining samples.

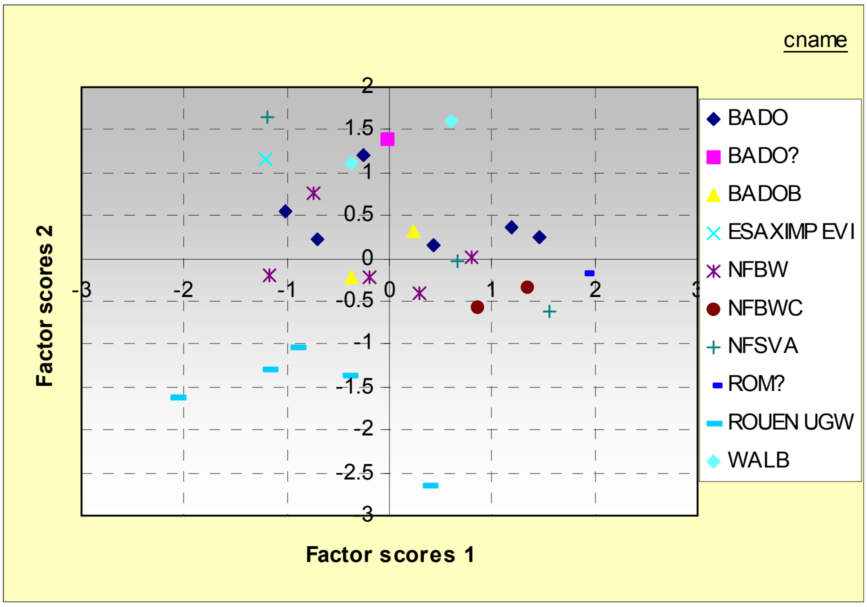


**Figure 1**

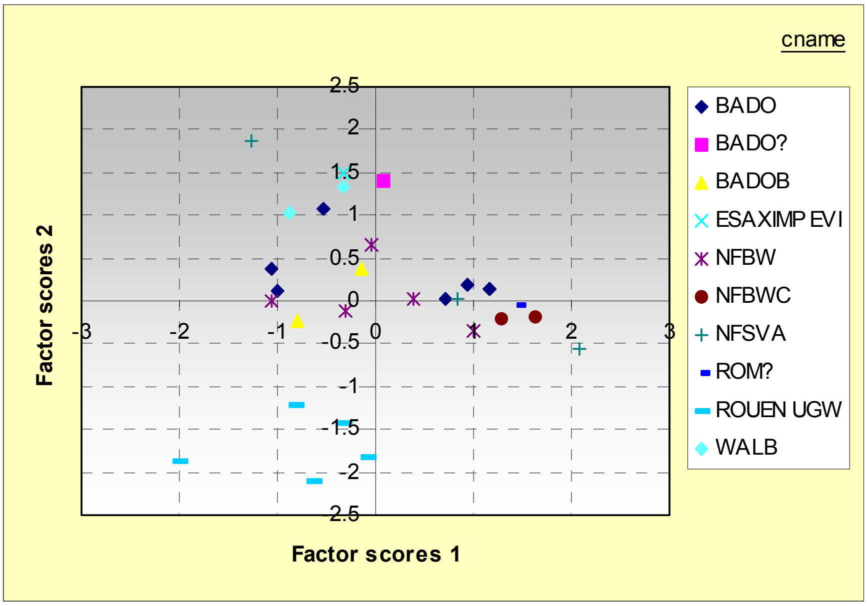


**Figure 2**

Fig 2 shows the same procedure for the normalised dataset. The separation of the Lower Seine valley whiteware is still clear but for the remaining samples there is no separation of Rhenish from other samples.

Next, the same procedures were carried out for the next two factors, F3 and F4 (Fig 3 – untransformed data and Fig 4 – normalised data). It can be seen that although the separation between the Lower Seine valley whitewares and the rest is lost the normalised data distinguishes between Rhenish and other samples (if we assume that sample V1776 is not indeed a BADO sample or that its atypical Na2O value is responsible for it not being placed in this group.

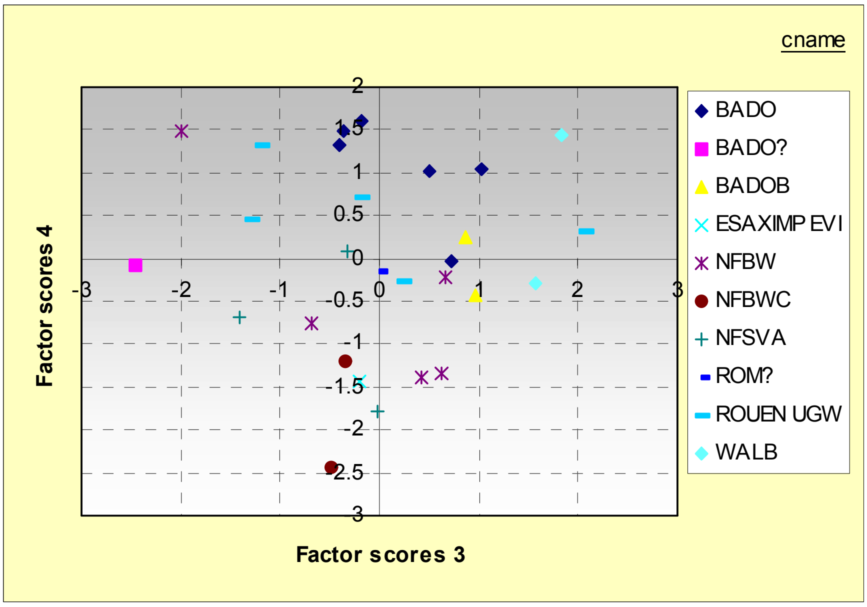


**Figure 3**

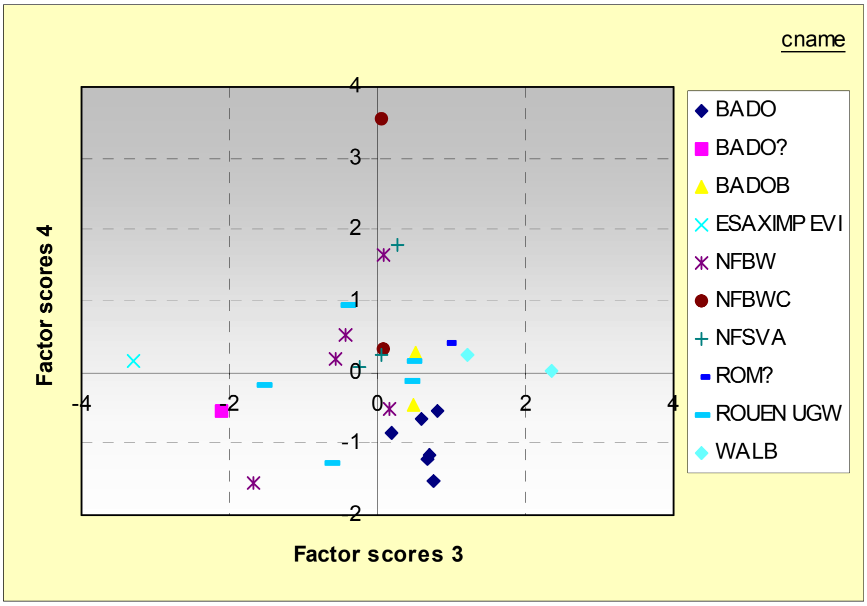


**Figure 4**

This pattern is clearer if we re-plot the Fig 4 data by suggested source (Fig 5).

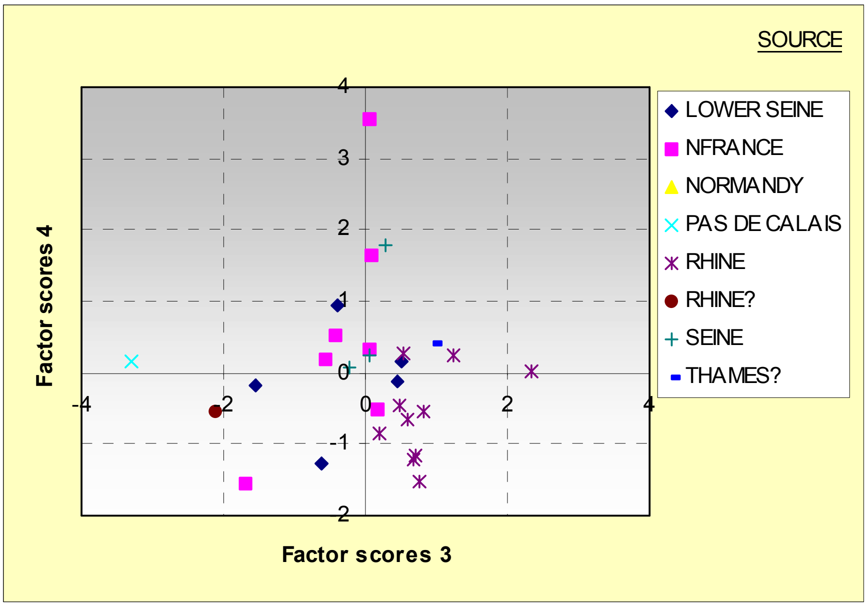


**Figure 5**

To explore further the similarities of the Lower Seine whiteware with the later Rouen wares, data from samples from Rouen and Viborg were compared with them (Fig 6). There is no clear distinction between these Lundenwic finds, 10th-century glazed wares from Rouen and Late 12th/early 13th-century glazed wares from Viborg. Unfortunately, no chemical data is available for the Carolingian pottery production site at La Londe which would be the most likely known source for the Lundenwic finds.

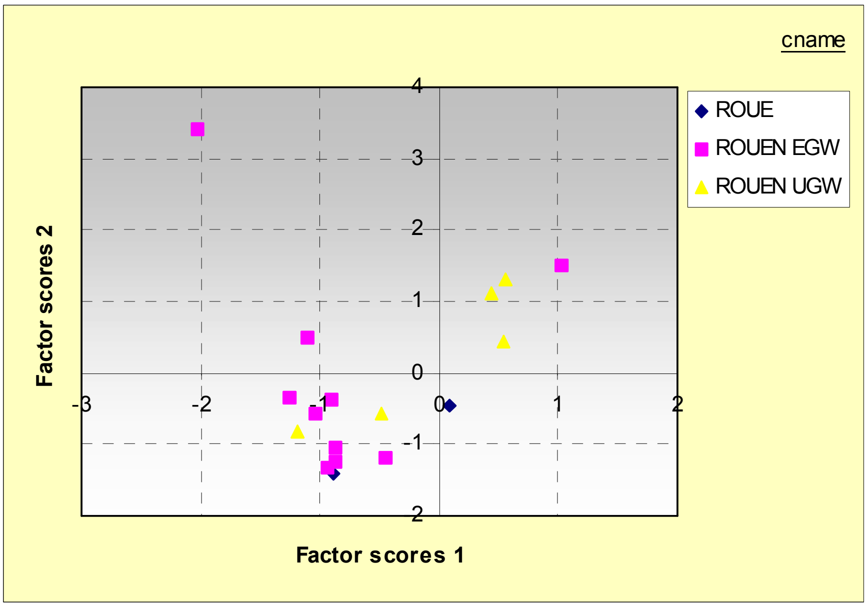


**Figure 6**

Next, those Lundenwic samples for which a Rhenish source is suggested were compared with samples of Badorf ware from Flixborough (Fig 7). Of the two putative BADO samples in this analysis one is indistinguishable from the BADO samples and the other (V1776 from Lundenwic) is not. This analysis not only confirms the attribution of the Lundenwic samples (or, at least indicates that both Lundenwic and Flixborough were receiving Badorf-type wares which are chemically indistinguishable) but also shows that the Walbeburg wares for a distinct sub-group within the Badorf cluster. This separation is shown more clearly in a plot of F3 against F4 (Fig 8). However, that plot places the two putative Badorf ware samples in the Badorf cluster.

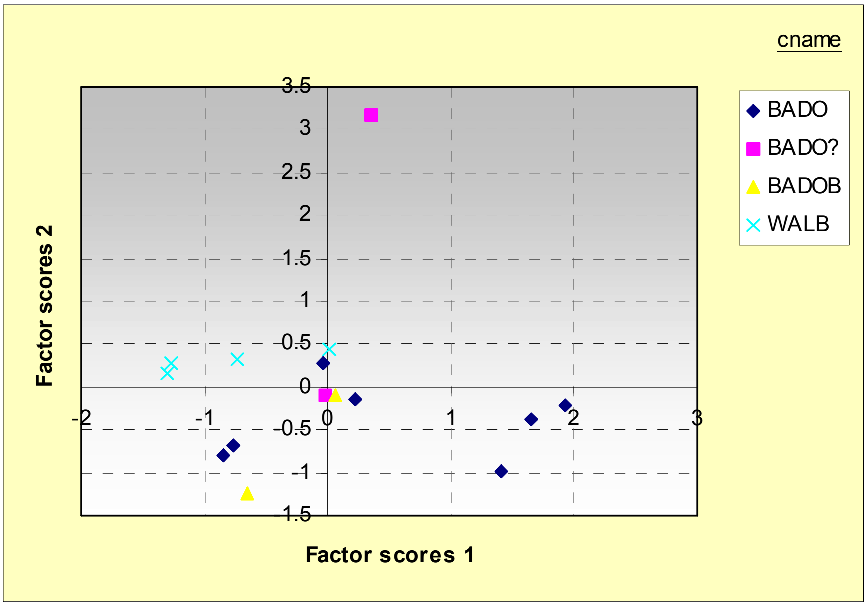


**Figure 7**

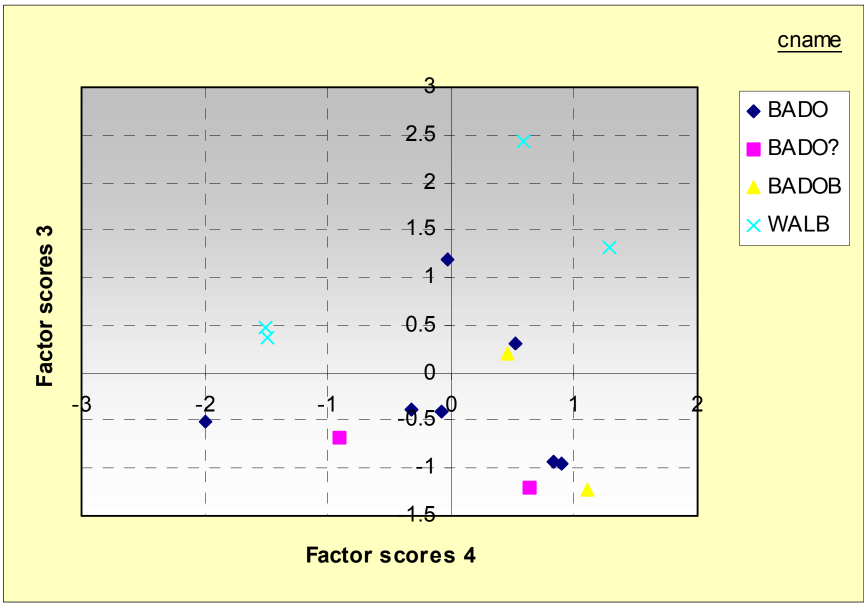


**Figure 8**

Finally, the remaining Lundenwic samples were analysed alongside samples of Evison Group I imports from two sites in Suffolk and from Castledyke South, Barton-upon-Humber and samples of Black and grey burnished wares from Flixborough. The black burnished ware samples from Flixborough are not matched by any from Lundenwic (although none of the typical examples of this ware were included in the sample selection). Three examples of sandy greyware imports from Lundenwic have a similar composition to these burnished wares, although the tempering and surface treatment of these types show them to be quite different in the hand. The four samples of Evison Group I imports plot close together, alongside one of the Lundenwic black burnished wares, V1730, which could indeed be from the neck of one of these bottles. The remaining Lundenwic black burnished wares and a sample of a black-surfaced whiteware from Flixborough plot in a line governed by their low F2 and high F1 scores apart from one NFSVA sample (V1759) which plots with the Evison Group I and the Flixborough black burnished wares samples. This sample, however, is that for which anomalous values for CaO and Sr were obtained, which may have affected the other measurements.

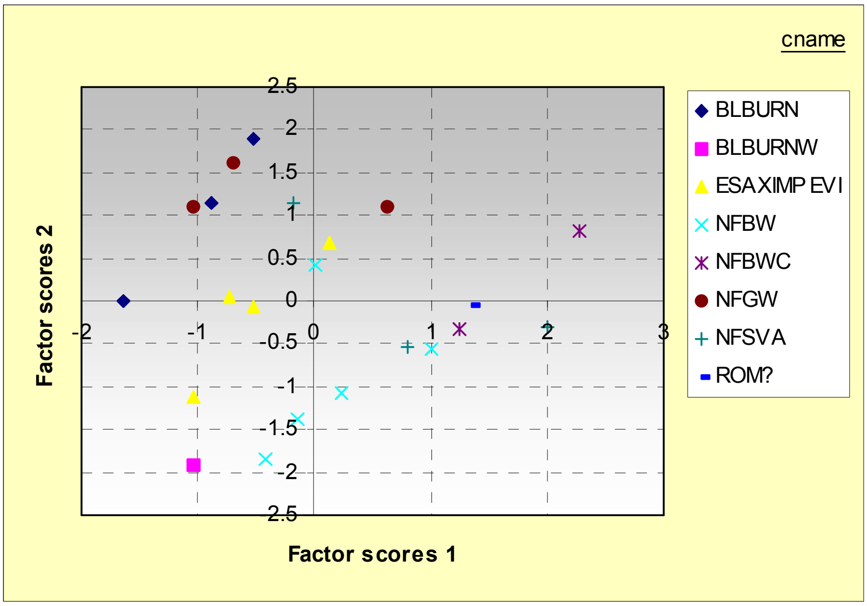


**Figure 9**

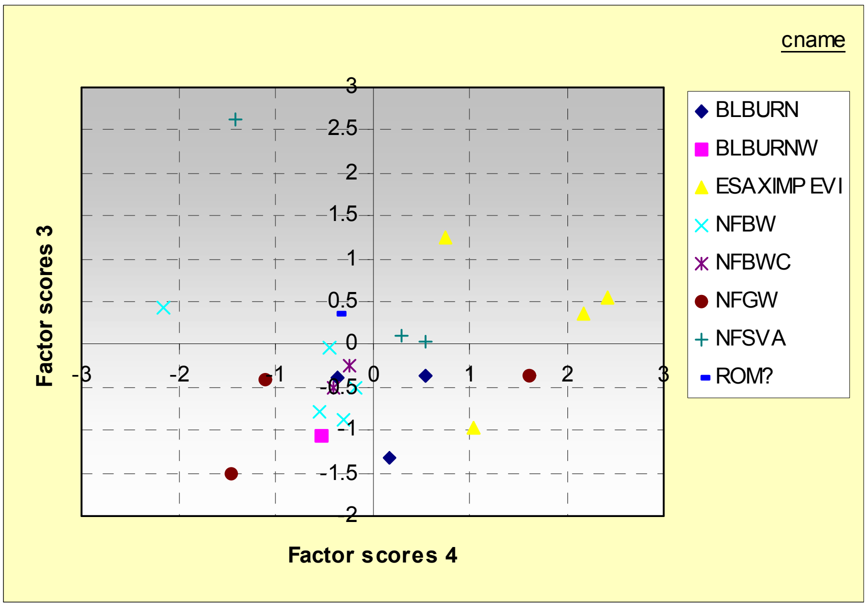

**Figure 10**

The plot of F3 against F4 scores (Fig 10) shows the same structure to the data except that the Flixborough and Lundenwic black burnished wares plot closer together. Finally, a plot of F5 against F1 separates samples from north Lincolnshire from the remainder (Fig 11). Factor 5 scores are mainly influenced by high loadings for Ce and La and by strong negative scores for Zr. In this case, a plot of Ce against La shows that the Lincolnshire samples have similar values to those from London and Suffolk but a plot of Ce against Zr reveals abnormally low values for the Lincolnshire samples. Clearly, further samples are required before one can actually say that the French/Belgian imports from north Lincolnshire are from a difference source from those in the south, especially since the result affects several distinct ware groups.

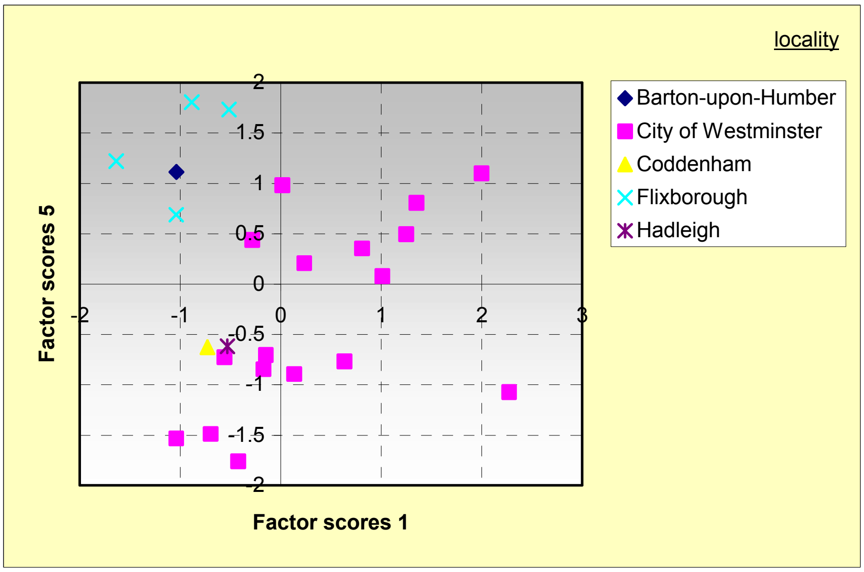


**Figure 11**

## Conclusions

Despite the fact that the imported wares from Lundenwic are very fine-textured it is clear that the decision not to undertake thin section analysis alongside chemical analysis has made the interpretation of the results more difficult.

Nevertheless, the chemical analysis clearly shows that the imports divide clearly into two groups, one of which is from the Lower Seine valley and the other is not. These Lower Seine valley wares compare well with later samples from Rouen, but whether this should be taken to mean that they are indeed Rouen products or whether similar clays outcrop elsewhere in the valley, for example at La Londe, where a Carolingian pottery production site is known, is difficult to say without further comparative data.

The attribution of several samples to the Rhineland appears to be confirmed by a comparison of the Lundenwic samples with those from Flixborough. This analysis also distinguishes Walbeburg ware from Badorf ware. This indicates that the distinction between these two groups is not simply due to the more abundant temper found in the former fabric but is also reflected in the composition of the clay itself. However, it still remains necessary to compare these samples directly with reference material from the middle Rhine production sites.

Finally, the lack of clear patterning within the residue of samples, which do not match the lower Seine groups but which overlap with the Rhenish groups (until the Lower Seine samples are removed from the analysis), can be interpreted in several ways. Visually, the material can be divided into at least seven groups but in most cases the group is represented by a single sample. In such circumstances it is impossible to use chemical analysis since there is no way of determining the variance in measured values. The data might therefore come from samples which were made at seven or more separate sources or the samples might all come from a single centre producing whitewares, black burnished wares greywares and oxidised red earthenwares, with or without added sand. Comparison of these samples with those from early Anglo-Saxon imports from Suffolk and Lincolnshire and from mid Saxon imports in Lincolnshire is again equivocal since it seems to show that there are three main chemical groups within the sampled data: (i) untempered black burnished wares from Flixborough and sandy greywares from Lundenwic, (ii) Evison Group I imports and some black burnished wares from Lundenwic and (iii) a range of black burnished wares and white-bodied wares from Lundenwic. However, this result is cast into doubt by the realisation that it is based, in part, on an element which appears to have been abnormally low in its occurrence in samples from sites in north Lincolnshire. Further samples of this group of wares would undoubtedly provide more clarity.

## Acknowledgements

Samples were selected by L Blackmore, MoLSS. Sample preparation was carried out by Peter Hill and the chemical analysis was carried out by Dr N Walsh, Department of Geology, Royal Holloway College, London. I am grateful to Dr D Dufournier, Laboratoire de Ceramologie, Centre de Researches Archaeologiques Medievales at the University of Caen for supplying samples of the Rouen early glazed wares and J Hjermind of Viborg Museum, Denmark, for supplying samples of the medieval Rouen glazed ware. The Flixborough samples were analysed for Humber Archaeology Partnership.

# Appendices

## Appendix One

| TSNO | Sitecode | outlier | Context | cname | SOURCE | Form | Action |
|---|---|---|---|---|---|---|---|
| V1716 | BOB91 | | 327 | ROUEN UGW | LOWER SEINE | CP | ICPS |
| V1720 | BRU92 | | 317 | BADO | RHINE | JAR | ICPS |
| V1722 | BRU92 | | 407 | BADOB | RHINE | JAR | ICPS |
| V1725 | BRU92 | | 497 | WALB | RHINE | AMPH | ICPS |
| V1726 | BRU92 | | 511 | BADOB | RHINE | AMPH | ICPS |
| V1729 | BRU92 | | 604 | BADO | RHINE | JAR | ICPS |
| V1730 | BRU92 | yes | 655 | NFBW | NFRANCE | SPP | ICPS |
| V1732 | BRU92 | | 725 | BADO | RHINE | SPP | ICPS |
| V1739 | DRY90 | | 171 | WALB | RHINE | JAR | ICPS |
| V1740 | DRY90 | | 171 | NFBW | NFRANCE | JAR | ICPS |
| V1742 | DRY90 | | 198 | ESAXIMP EVI | PAS DE CALAIS | JAR | ICPS |
| V1746 | DRY90 | | 271 | BADO | RHINE | JAR | ICPS |
| V1747 | DRY90 | | 276 | BADO | RHINE | JAR | ICPS |
| V1748 | DRY90 | | 3 | ROUEN UGW | LOWER SEINE | LAMP | ICPS |
| V1751 | JUB85 | | 29 | BADO | RHINE | JAR | ICPS |
| V1754 | ROP95 | | 4389 | ROUEN UGW | LOWER SEINE | JAR | ICPS |
| V1755 | SGA89 | | 1102 | NFSVA | SEINE | JAR | ICPS |
| V1756 | SGA89 | | 1164 | ROM? | THAMES? | JAR | ICPS |
| V1757 | SGA89 | | 274 | NFSVA | SEINE | SPP | ICPS |
| V1758 | SGA89 | yes | 465 | NFBWC | NFRANCE | SPP | ICPS |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| V1759 | SGA89 | yes | 599 | NFSVA | SEINE | SPP | ICPS |
| V1760 | SGA89 | | 773 | NFBWC | NFRANCE | - | ICPS |
| V1763 | SOT89 | | 14 | ROUEN UGW | LOWER SEINE | CP | ICPS |
| V1765 | SOT89 | | 15 | ROUEN UGW | LOWER SEINE | CP | ICPS |
| V1766 | SOT89 | | 172 | NFBW | NFRANCE | SPP | ICPS |
| V1770 | SOT89 | | 23 | NFBW | NFRANCE | JAR | ICPS |
| V1775 | BOB91 | | 153 | NFBW | NFRANCE | SPP | ICPS |
| V1776 | Rop95 | yes | 455 | BADO? | RHINE? | JAR? | ICPS |

## Appendix 2a ICPS Data for major elements (percent oxides)

| TSNO | Al2O3 | Fe2O3 | MgO | CaO | Na2O | K2O | TiO2 | P2O5 | MnO |
|---|---|---|---|---|---|---|---|---|---|
| V1716 | 19.21 | 2.38 | 0.23 | 0.96 | 0.152 | 0.93 | 1.05 | 0.55 | 0.01 |
| V1720 | 16.88 | 2.82 | 0.85 | 0.55 | 0.133 | 1.93 | 0.85 | 0.18 | 0.02 |
| V1722 | 18.76 | 3.76 | 0.93 | 0.86 | 0.143 | 2.31 | 1.02 | 0.4 | 0.04 |
| V1725 | 20.93 | 4.43 | 1.39 | 0.82 | 0.143 | 2.87 | 0.88 | 0.12 | 0.02 |
| V1726 | 19.2 | 2.46 | 0.74 | 0.89 | 0.171 | 1.97 | 1.12 | 0.67 | 0.02 |
| V1729 | 18.87 | 3.31 | 0.94 | 0.52 | 0.133 | 2.12 | 1.01 | 0.13 | 0.02 |
| V1730 | 14.25 | 3.12 | 1.1 | 1.72 | 0.314 | 2.65 | 0.74 | 1.73 | 0.04 |
| V1732 | 17.5 | 3.49 | 0.97 | 0.59 | 0.143 | 1.94 | 1.03 | 0.25 | 0.02 |
| V1739 | 19.53 | 3.54 | 1.22 | 0.8 | 0.143 | 2.61 | 0.87 | 0.31 | 0.02 |
| V1740 | 16.26 | 2.65 | 0.54 | 1.6 | 0.133 | 1.66 | 0.92 | 1.65 | 0.06 |
| V1742 | 13.47 | 5.42 | 1.29 | 0.9 | 0.285 | 2.61 | 0.72 | 0.67 | 0.03 |
| V1746 | 18.36 | 4.9 | 1.11 | 0.61 | 0.162 | 2.34 | 0.96 | 0.18 | 0.03 |
| V1747 | 18.37 | 4.33 | 1.09 | 0.58 | 0.171 | 2.35 | 0.98 | 0.15 | 0.03 |
| V1748 | 15.78 | 1.23 | 0.19 | 0.51 | 0.067 | 0.38 | 1.34 | 0.1 | 0.01 |
| V1751 | 18.36 | 5.27 | 1.18 | 0.88 | 0.143 | 2.31 | 0.91 | 0.42 | 0.03 |
| V1754 | 15.31 | 2.43 | 0.37 | 0.44 | 0.105 | 0.92 | 1.01 | 0.11 | 0.01 |
| V1755 | 16.78 | 2.89 | 0.79 | 0.67 | 0.238 | 2.2 | 0.92 | 0.54 | 0.04 |
| V1756 | 18.79 | 3.12 | 0.92 | 0.7 | 0.219 | 2.64 | 1.11 | 0.4 | 0.14 |
| V1757 | 16.15 | 3 | 0.78 | 0.85 | 0.219 | 2.46 | 1.01 | 0.59 | 0.03 |
| V1758 | 15.02 | 2.59 | 0.71 | 1.17 | 0.171 | 2.29 | 0.99 | 0.79 | 0.16 |
| V1759 | 16.64 | 5.39 | 1.26 | 11.4 | 0.2 | 2.98 | 0.67 | 0.51 | 0.12 |
| V1760 | 17.67 | 3.22 | 0.87 | 1.12 | 0.228 | 2.64 | 1.06 | 0.64 | 0.11 |
| V1763 | 13.32 | 1.92 | 0.21 | 0.93 | 0.133 | 0.79 | 1.16 | 0.56 | 0.04 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| V1765 | 21.72 | 1.9 | 0.2 | 0.92 | 0.124 | 0.43 | 1.8 | 0.6 | 0.02 |
| V1766 | 17.78 | 2.95 | 0.75 | 1.1 | 0.238 | 2.49 | 0.95 | 0.5 | 0.04 |
| V1770 | 18.95 | 3.94 | 0.94 | 0.57 | 0.219 | 2.53 | 1.04 | 0.22 | 0.03 |
| V1775 | 15.31 | 2.59 | 0.65 | 1.04 | 0.19 | 2.36 | 0.95 | 0.75 | 0.05 |
| V1776 | 15.81 | 5.09 | 1.51 | 1.05 | 0.58 | 2.61 | 0.69 | 0.36 | 0.06 |

**Appendix 2b. ICPS data for minor and trace elements (PPM)**

| TSNO | Ba | Cr | Cu | Li | Ni | Sc | Sr | V | Y | Zr* | La | Ce | Nd | Sm | Eu | Dy | Yb | Pb | Ag | Zn | Co |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V1716 | 210 | 95 | 36 | 19 | 37 | 10 | 78 | 82 | 22 | 121 | 48 | 95 | 49.16 | 7.286 | 1.033 | 4 | 2.1 | 41.98 | 0 | 50 | 5 |
| V1720 | 268 | 123 | 22 | 78 | 35 | 16 | 104 | 130 | 21 | 95 | 57 | 113 | 58.37 | 10.55 | 1.903 | 5 | 1.9 | 54.64 | 0 | 95 | 20 |
| V1722 | 344 | 109 | 51 | 77 | 44 | 17 | 138 | 138 | 22 | 98 | 53 | 100 | 54.52 | 8.872 | 1.637 | 5 | 2.5 | 52.78 | 0 | 116 | 14 |
| V1725 | 379 | 136 | 32 | 137 | 73 | 18 | 133 | 171 | 29 | 94 | 53 | 126 | 54.99 | 8.871 | 1.69 | 6 | 2.8 | 65.14 | 0 | 105 | 29 |
| V1726 | 394 | 102 | 28 | 71 | 36 | 16 | 150 | 129 | 19 | 99 | 50 | 92 | 50.67 | 7.462 | 1.228 | 4 | 2.3 | 51.7 | 0 | 82 | 8 |
| V1729 | 340 | 83 | 21 | 83 | 39 | 17 | 120 | 137 | 18 | 95 | 49 | 83 | 49.54 | 6.907 | 1.168 | 4 | 2.1 | 35.86 | 0 | 57 | 12 |
| V1730 | 647 | 93 | 17 | 67 | 38 | 12 | 248 | 77 | 18 | 69 | 47 | 83 | 47.85 | 7.264 | 1.182 | 4 | 1.9 | 61.5 | 0 | 91 | 11 |
| V1732 | 360 | 91 | 17 | 104 | 37 | 15 | 138 | 114 | 18 | 89 | 47 | 84 | 46.91 | 5.553 | 0.956 | 3 | 1.9 | 51.7 | 0 | 84 | 13 |
| V1739 | 377 | 115 | 26 | 116 | 53 | 17 | 121 | 152 | 27 | 102 | 47 | 87 | 48.32 | 6.938 | 1.352 | 4 | 2.5 | 41.84 | 0 | 124 | 17 |
| V1740 | 525 | 98 | 26 | 65 | 30 | 14 | 217 | 110 | 26 | 106 | 33 | 55 | 34.69 | 5.005 | 1.015 | 4 | 2.3 | 38.98 | 0 | 73 | 9 |
| V1742 | 506 | 106 | 32 | 40 | 29 | 15 | 142 | 147 | 19 | 96 | 41 | 64 | 41.64 | 4.674 | 1.021 | 3 | 2.3 | 34.76 | 0 | 104 | 13 |
| V1746 | 389 | 134 | 26 | 89 | 44 | 17 | 131 | 120 | 35 | 88 | 64 | 121 | 66.83 | 11.73 | 2.257 | 7 | 3.2 | 49.58 | 0 | 84 | 17 |
| V1747 | 402 | 131 | 26 | 95 | 43 | 17 | 135 | 123 | 32 | 77 | 64 | 120 | 66.08 | 11.3 | 2.097 | 6 | 2.9 | 46.66 | 0 | 82 | 17 |
| V1748 | 171 | 76 | 14 | 20 | 12 | 6 | 44 | 47 | 14 | 114 | 25 | 39 | 25.85 | 3.831 | 0.614 | 3 | 1.5 | 61.54 | 0 | 27 | 8 |
| V1751 | 477 | 130 | 24 | 143 | 46 | 16 | 158 | 134 | 29 | 89 | 51 | 88 | 51.98 | 7.019 | 1.431 | 4 | 2.4 | 52.88 | 0 | 94 | 16 |
| V1754 | 190 | 73 | 15 | 27 | 20 | 12 | 44 | 63 | 15 | 100 | 46 | 84 | 46.34 | 7.371 | 1.13 | 3 | 1.5 | 51.58 | 0 | 39 | 10 |
| V1755 | 543 | 105 | 34 | 71 | 41 | 17 | 150 | 117 | 30 | 111 | 56 | 99 | 57.53 | 10.33 | 1.798 | 5 | 2.7 | 53.44 | 0 | 97 | 20 |
| V1756 | 524 | 115 | 33 | 95 | 51 | 19 | 149 | 146 | 30 | 115 | 70 | 131 | 72.19 | 13.36 | 2.382 | 7 | 3.2 | 54.12 | 0 | 106 | 20 |
| V1757 | 651 | 70 | 36 | 64 | 41 | 17 | 135 | 111 | 33 | 115 | 62 | 124 | 64.58 | 13.8 | 2.39 | 7 | 3.4 | 39 | 0 | 101 | 14 |
| V1758 | 569 | 100 | 32 | 56 | 42 | 16 | 135 | 119 | 29 | 137 | 47 | 98 | 50.2 | 11.32 | 2.019 | 6 | 3.4 | 40.56 | 0 | 108 | 20 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V1759 | 474 | 72 | 23 | 116 | 71 | 15 | 391 | 110 | 19 | 103 | 36 | 75 | 37.69 | 5.783 | 1.223 | 4 | 2.2 | 32.62 | 0 | 111 | 15 |
| V1760 | 699 | 105 | 31 | 62 | 44 | 19 | 165 | 134 | 31 | 113 | 64 | 115 | 65.89 | 11.93 | 2.175 | 6 | 3.1 | 33.46 | 0 | 93 | 15 |
| V1763 | 274 | 69 | 14 | 26 | 16 | 9 | 92 | 69 | 15 | 104 | 42 | 72 | 42.58 | 6.224 | 0.766 | 3 | 1.7 | 46.66 | 0 | 45 | 10 |
| V1765 | 313 | 120 | 18 | 19 | 18 | 12 | 99 | 105 | 25 | 174 | 58 | 88 | 59.13 | 7.73 | 1.267 | 5 | 2.5 | 61.16 | 0 | 54 | 8 |
| V1766 | 515 | 107 | 30 | 51 | 34 | 18 | 145 | 132 | 21 | 125 | 51 | 86 | 51.89 | 7.415 | 1.394 | 4 | 2.6 | 36.94 | 0 | 83 | 9 |
| V1770 | 463 | 119 | 30 | 69 | 40 | 20 | 130 | 147 | 27 | 116 | 61 | 105 | 62.32 | 10.42 | 1.924 | 5 | 2.8 | 42.2 | 0 | 86 | 16 |
| V1775 | 535 | 102 | 28 | 43 | 36 | 16 | 146 | 116 | 26 | 105 | 49 | 96 | 50.85 | 9.623 | 1.819 | 5 | 2.9 | 38.38 | 0 | 73 | 14 |
| V1776 | 642 | 74 | 27 | 79 | 50 | 15 | 125 | 101 | 29 | 75 | 47 | 80 | 49.54 | 8.473 | 1.644 | 6 | 2.8 | 50.38 | 0 | 102 | 15 |

## Appendix 3. List of comparative samples consulted

| TSNO | Locality | Sitecode | Context | REFNO | cname |
|---|---|---|---|---|---|
| AG086 | Barton-upon-Humber | CS89 | | | ESAXIMP EVI |
| AG189 | Flixborough | flx89 | 207 | 55 | BADO |
| AG190 | Flixborough | flx89 | 1833 | 42 | BLBURNW |
| AG191 | Flixborough | flx89 | 3915 | | BADO? |
| AG192 | Flixborough | flx89 | 10772 | | BLBURN |
| AG195 | Flixborough | flx89 | 5553 | | BLBURN |
| AG198 | Flixborough | flx89 | u/s | 44 | BLBURN |
| AG199 | Flixborough | flx89 | 10337 | 13 | WALB |
| AG200 | Flixborough | flx89 | u/s | | WALB |
| V0698 | Viborg | viborg | | 51 E1892/GB | ROUE |
| V0701 | Viborg | viborg | | 51 E1881/E1 | ROUE |
| V0702 | Viborg | viborg | | 51 E2658/VD | ROUEN EGW |

| | | | | | |
|---|---|---|---|---|---|
| V1289 | Rouen | rouen pp | | 1123-2 | ROUEN EGW |
| V1290 | Rouen | rouen pp | | 3067-3 | ROUEN EGW |
| V1291 | Rouen | rouen pp | | 1125-3 | ROUEN EGW |
| V1292 | Rouen | rouen pp | | 1125-21 | ROUEN EGW |
| V1293 | Rouen | rouen pp | | 1125-23 | ROUEN EGW |
| V1294 | Rouen | rouen cm | | 5138 | ROUEN EGW |
| V1295 | Rouen | rouen cm | | 5145 | ROUEN EGW |
| V1296 | Rouen | rouen pf | | 3575-a | ROUEN EGW |
| V1297 | Rouen | rouen pf | | 13113-4 | ROUEN EGW |
| V1626 | Rouen | had 059 | 0410 | | ESAXIMP EVI |
| V1627 | Rouen | cdd 050 | 0168 | | ESAXIMP EVI |