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Pottery Production and Its Diffusion – Chemical and Petrographical Analyses of Early Medieval Pottery from Develier-Courtételle and their Historical Implications.

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Abstract

Chemical (X-ray Fluorescence, WDS) and petrographical analyses (n=75) of a pottery assemblage found at a merovingian rural settlement situated in the Northern part of the Jura mountain chain suggest import for most of the vessels. Furthermore, the analytical results combined with typological characteristics and macroscopic fabric analyses give indications concerning the organisation of pottery production in the regions of provenance: the hypothesis of a centralised production in Alsace, proposed in a former work, is strengthened, while dispersed production is attested for pottery attributable to Burgundy.

Key-words - Pottery, chemical analyses, petrographical fabric analyses, macroscopic fabric analyses, Early Medieval Period, Alsace, Burgundy, Franks.

1. Introduction

1.1. The site

Extensive excavations preceding the construction of a motorway at Develier-Courtételle in the Northern part of the Jura mountain chain (Fig.1; Federici-Schenardi et al., 2003) brought to light a rural settlement dated between the 6th and 9th century AD. Tons of recovered slag indicate that not only agriculture but also iron working were important activities on this site. The maximum extension of the settlement was reached during the 7th century.

Macroscopic classification of the pottery from this site (Fig.2) reveals a remarkable diversity of fabric types. Some resemble closely those of ceramic productions known from other regions and suggest the presence of imports

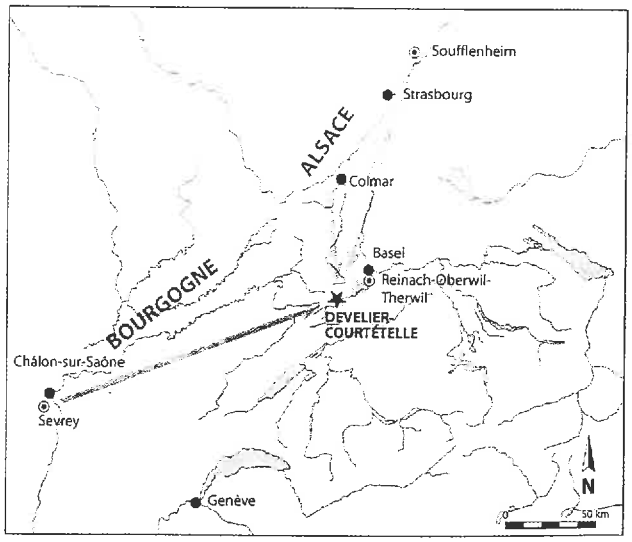

Fig. 1 - Location of Develier-Courtételle and the kiln sites mentioned in the text. Arrows indicate proven origins of pottery found at Develier-Courtételle. *Drawing by T. Yilmaz (OPH-SAR).*

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Macroscopic differentiation				
predominant colours	beige-orange, orange, red	dark beige to reddish brown	very light grey to cream coloured	blue-grey to brownish grey
abundance of temper	varying	very abundant	abundant	very abundant
dimension of inclusions	varying	well sorted around 0.7mm	coarse up to several mm	well sorted fine temper<0.5mm
nature of inclusions	siliceous (various)	siliceous (quartz, feldspars, abundant flecks of mica)	siliceous (quartz, feldspars and few rock fragments)	siliceous (quartz and feldspar)
additional characteristics	many fabric groups (see fig.3)	hand-formed, wheel-thrown finish	hard to extremely hard kaolinitic ware	touch similar to sandpaper
parallels	"orange ware", Burgundy	"micaceous ware", Southern Alsace	"cream coloured ware", Alsace	"sandy ware", Basle area

Fig. 2 - Main fabric characteristics of the differentiated wares.

from Alsace, Burgundy and the Basle area (Paratte Rana et al., 1999). Each of these regions is characterised by the predominance of one typologically defined pottery ware, forming one « pottery province ». Develier-Courtételle is clearly situated at the intersection of these three pottery provinces. The archaeometric study of the pottery not only contributes to the knowledge of the economical and political development of the site itself, considered a consumer site, but also supplies information concerning the production areas – for instance the adjoining regions of Burgundy and Alsace.

1.2. Historical background

During early medieval times, the territory controlled by the Franks was roughly subdivided into four blocs – Aquitania, Burgundy, Neustria and Austrasia. Politically, the settlement of Develier-Courtételle is situated within the territory of Austrasia (attested from the 7th century), close to its border with Burgundy. At the beginning of the 7th century AD, the region passes under the reign of the Duchy of Alsace, newly founded by the Austrasian king (Stekoffer, 1999; Rebetez, 2002). The establishment of a firm Frankish rule in Alsace could have left its mark on the organisation of pottery production and on its diffusion, as has been suggested by Châtelet (1997, 2002): the centralisation of pottery production parallels the establishment of the new reign. A vast archaeometric program concerning pottery from sites situated principally in the Upper Rhine Valley has been put into place to test this hypothesis (Châtelet et al., 1998, 1999, 2000, in preparation), which is supported as well by arguments based on historical sources. Proof of a centralised Alsatian production, however, is not sufficient to deduce the influence of a political process: it might represent a general development taking place at that period independently from the political situation in response to other economical factors. In this context, the pottery assemblage found at Develier-Courtételle contributes to the assessment of the supposed political influence by providing a means to evaluate the organisation of pottery production outside the Alsatian domain, in Burgundy, as about a third of the site's pottery belongs typologically to the Burgundy ware. The present paper shall treat this aspect in particular. Pottery from Burgundy – unlike that from Alsace – has not yet been systematically examined on a large scale. Published studies (e. g. Catteddu 1992, Faure-Boucharlat et al., 2001) do not include fabric analyses.

1.3. Questions

Against the background of these historical interrogations, analyses are carried out in order to address the following questions:

- Is it possible to confirm the provenance attributions based on typological determinations – in particular those to Burgundy?
- Does pottery typologically attributable to Burgundy form one, a few or many compositional groups? Many different groups would indicate a dispersed pottery production in Burgundy. Given a limited number of samples from one single site, the presence of one or of a few groups would, however, not allow a definite answer concerning the general organisation of pottery production.

2. MATERIAL AND METHODS

2.1. The consumer site

About 10'000 sherds have been excavated at Develier-Courtételle. They constitute about 1300 typologically identifiable vessels. These were classified through a three-step procedure into fabric groups defined on the basis of visual characteristics: 1. preliminary definition of fabric groups on the basis of a first macroscopic examination, 2. control of the preliminary classification by chemical and petrographical analyses of a sample, 3. final classification of all vessels.

A total of 75 sherds were chosen for the chemical and petrographical analyses (step 2):
- 15 typologically attributable to Alsace (kaolinitic "cream coloured ware", and hand-formed, wheel-finished "micaceous ware")
- 21 typologically attributable to the Basle area ("sandy ware")
- 40 typologically attributable to Burgundy (fabric groups joined under the term "orange ware", which represents a typologically distinctive, homogeneous assemblage).

Most analysed sherds belong to (cooking) pots, some to bowls, to beakers and one to a pitcher.

2.2. References

The database for the Alsatian cream coloured ware (Châtelet et al., 1998, 1999, 2000) comprises around 200 chemical analyses (sherds and raw materials); 59 samples were examined petrographically. Another 49 sherds constitute the reference group for the Alsatian micaceous ware (14 petrographical analyses). The Alsatian database spans the period from the 6th to the 10th century with a concentration of samples from the 8th century. This covers the entire occupation period of Develier-Courtételle and extends into more recent times.

One reference group (chemical and petrographical analyses) exists for the production from the pottery district Oberwil-Therwil-Reinach in the Basle area (Duruz et al., 2002), having produced the sandy ware. It concerns two kilns from the 8th century, covering therefore only the end of the occupation period of Develier-Courtételle.

Systematic investigations on early medieval kiln sites in Burgundy are still missing. Some analyses (6 chemical and 9 petrographical analyses) are available from Sevrey (fig.1), a production area in Burgundy which was in activity from Roman to late medieval times (Renimel, 1974; Archéologie Médiévale, 1994, 1999). The analysed sherds belong to the period after the 9th century. Unpublished chemical analyses of various other ceramic material from Burgundy have been consulted (database laboratory Lyon).

A supposed production site near Develier-Courtételle at Montsevelier/La Chèvre (10 km distance) is attested by only 20 reconstructable vessels, typologically close to the Burgundy ware (Martin-Kilcher and Quenet, 1987). Six sherds were analysed; they constitute an example of a possible "regional production".

2.3. Analytical methods

Results of two analytical methods are discussed in the present paper:
- Petrographical analyses by polarisation microscopy (characterisation of temper and matrix; semiquantitative estimations after Matthew et al., 1991);
- Quantitative chemical analysis by X-ray fluorescence (WDS) of major and minor elements (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, P) and trace elements (Ba, Cr, Ni, Pb, Rb, Sr, Th, Y, V, Zn, Zr; + Cu, Nb or + Ce, La). Data were treated by uni-, bi- and multivariate statistical methods. Cluster and Principal Component Analyses were executed with the SPSS package on standardised and centered

values of 15 and 14 variables respectively (Si – only cluster analyses -, Ti, Al, Fe, Mn, Mg, Ca, Na, K, Cr, Ni, Rb, Sr, V, Zr).
Sherds from Develier-Courtételle and the Basle references were analysed chemically at the Institute of Mineralogy and Petrography, University of Fribourg on a PHILIPS PW 2400 spectrometer (+ Cu, Nb). Standard sample preparation is described in Zanco (1999) for the recent analyses, in Duruz et al. (2002) for the others.
Sherds concerning the Alsatian project as well as the reference sherds from Sevrey were analysed at the laboratoire de ceramologie, Lyon on a BRUKER SRS 3400 spectrometer (+ Ce, La) with a similar sample preparation.
The compatibility of the analyses from the two laboratories has been regularly controlled (Thierrin-Michael, 1992; Galetti, 1994; Thierrin-Michael and Galetti, 1996) and proved satisfactory under the current data treatments. In some instances, however, the most sensitive multivariate analyses like the calculation of Mahalanobis distances are reported to show a slight displacement between data sets from the two laboratories.

3. Analytical results

The following chapter contains the classification and differentiation of the sherds from Develier-Courtételle and their comparison to the references and the interpretation of these results. The definition and discussion of the reference database itself are published apart (Châtelet et al., in preparation; Duruz et al., 2002; Marti, 2000), including questions directly linked to these pottery productions (precise localisation of production sites and sources of raw materials, homogeneity, representativity…).

3.1. Petrographical differentiation

The matrix and temper of all the analysed sherds are of siliceous nature. Granulometric differences are very marked and constitute the most important classification criteria. Variations in the temper composition allow a further differentiation.
The "sandy ware" is characterised by a very abundant well-sorted temper (around 25-30 vol%) of a grain-size up to and around 0.5mm. Quarz (mono- and polycristalline grains) and feldspar are the principal temper components, rock fragments are rare and predominantly of granitic nature.
The "micaceous ware", equally containing an abundant well-sorted temper (around 25-30 vol%), is distinguished by a slightly bigger grain-size of around 0.7mm and especially by numerous large flecks of mica (mostly around 0.2-0.3mm and up to several mm, biotite as well as muscovite). While feldspars are particularly abundant in this group (the quartz:feldspar ratio is between 3:1 and 2:1), rock fragments, almost exclusively of igneous nature, are few. No obvious metamorphic rocks, like micaschists, were identified.
The "cream-coloured ware" is represented by two groups. Both show quite coarse temper of 1 to 1.5mm; many grains are rounded to subrounded, mostly mono- and polycristalline quartz and alkali feldspar (often with recognisable perthitic texture). Rock fragments, always of plutonic origin, are not frequent. One group contains only the coarse fraction in a matrix free of fine inclusions, while the other displays an almost serial grain-size distribution with a large amount of finer grains.
The "orange ware" is - in contrast to the first three wares – composed of numerous groups. The differentiation of the orange ware as a whole from the three first described wares is nevertheless unproblematic. No sherds attributed visually to the orange ware show grain size distributions similar to the sandy and micaceous wares. The one "orange" group characterised by a grain size distribution very similar to the first described group of "cream coloured ware" is easily distinguished by an exceptional variety and abundance of igneous rock fragments, including volcanic rocks.
The fabrics contained in the orange ware range from very fine-grained sherds (abundant inclusions <0.1mm) with very few coarser grains over medium tempered fabrics to sherds showing a coarse and abundant temper. The different fabric groups are however, with one exception mentioned above, characterised by inclusions of

predominantly quartz and alkali feldspar. The identified temper components are of igneous origin (mostly acid plutonic rocks, rarely volcanic, rhyolitic as well as basic rock fragments). The table in Fig.3 gives an outline of the classification. Eight groups are differentiated, some of which show important variations. The small number of samples, however, rules out a further subdivision.

3.2. Chemical differentiation

The four studied wares form four chemically clearly differentiated groups of CaO-poor pottery. Bivariant diagrams allow the differentiation of the sandy ware from the micaceous and cream-coloured wares as well as from the orange ware (Fig.4). The micaceous ware is distinguished from all other samples by particularly high contents in potassium and aluminium. The cream-coloured ware is characterised by low iron and potassium values typical of kaolinitic clays formed under reducing conditions. Samples belonging to the orange ware can be differentiated as a whole from the other three wares, but always show considerable in-group variation. This variation indicates that the orange ware is indubitably composed of several groups, some of which can be clearly individuated and identified with the fabric groups III, V and VI (Fig.5). The same differentiation is obtained by multivariate methods. In view of the small number of samples no chemical classification further than the general indication of the presence of several groups is justified for the rest of the orange ware.

3.3 Provenance attribution

3.3.1 Geological Situation

The compilation of geological maps and treaties (Blanalt et al. 1972, Fournier and Termier 1927, Liniger 1925, Ménillet et al. 1976, 1977, 1978, 1989, Théobald and Schweitzer 1976) allows the inference of the expected characteristics of the silty to sandy fraction in the sediments of the concerned regions, liable to be used in pottery production:

- In the valleys and on the border of the Rhinegraben in Northern Alsace, the sandy fraction is reported to be dominated by components derived from the Buntsandstein (rounded grains of quartz and potassic feldspar between 1 and 2mm). Plioquarternary deposits of kaolinitic clays formed under reducing conditions are noted particularly in the region of the Hagenau Forrest.
- In the valleys and on the border of the Rhinegraben in Southern Alsace, on the southern and western slopes of the Vosges mountain chain, as well as in and near the Morvan hills in Burgundy, components derived from the decomposition of variscan granitic complexes characterise most sediments.
- The Rhine valley itself is mainly covered by Rhine alluvium of alpine origin (characteristic are radiolarites) and Loess sediments.
- The area on jurassic bedrock N-NW of the Jura mountain chain was covered successively by ancient alluvium composed of Vosges' eroded sedimentary cover (originally calcareous, but sometimes decalcified), by ancient Rhine/Aare alluvium composed of alpine elements, and by Loess.
- The area on jurassic bedrock W of the Jura mountain chain belonging also to former Burgundy is rich in decalcified clays derived from the underlying rocks with a monotonous sandy fraction composed of quartz and chert. Further to the west, plioquarternary alluvium is frequent, formed by arrivals from the North with a more varied sandy fraction derived from Vosges material. This is valid for the region north of an imaginary line drawn between Macon and Bourg-en-Bresse. The kaolinitic plioquarternary clays of the plateau are marsh deposits formed under anaerobic conditions like those in the Rhine valley.
- The Delémont basin in the Jurassic mountain chain, where Develier-Courtételle is situated, received ancient alluvium composed of Vosges' eroded sedimentary cover, but most clays are characterised by a sandy fraction of mono-, poly- and microcristalline quartz

Petrographical classification of "orange ware" from Develier-Courtételle (consumer site)					
	group	granulometric characteristics	principal temper components	secondary temper components	particularities
fine grained	I, n=12	abundant inclusions <0.2mm; rare grains up to 1mm	quartz mono-, poly-, microcristalline	feldspars, small flecks of mica	**heterogeneous group**
	II, n=2	abundant inclusions <0.1mm; rare quartz grains up to 2mm, ferrugineous grains around 0.2 and up to 5mm	quartz mono-, poly-, microcristalline	feldspars, small flecks of mica, composite ferrugineous grains	distinctive feature composite ferrugineous grains
medium grained	III, n=7	poorly sorted, grain-size up to 2mm (few large grains), abundant inclusions	quartz, alkali feldspar	granitic rock fragments, chert, small flecks of mica	rock fragments with micrographic texture, many large grains of alkali feldspar with perthitic texture; **homogeneous group**
	IV, n=5	close to hiatal grain-size distribution, variable grain frequence, coarse grains up to 1.5mm	quartz, various (none or alkali feldspar)	plagioclas.undet. rock fragments	**heterogeneous group**
	V, n=5	very abundant well sorted temper up to 1.5mm, most grains around 1mm in inclusion-free matrix	fragments of various igneous rocks, quartz, feldspars		distinctive feature abundant plutonic and volcanic rock fragments; **homogeneous group**
coarse grained	VI, n=3	bimodal grain-size distribution, coarse fraction up to 3mm, fibrous matrix and abundant small flecks of mica	quartz, feldspars, granitic rock fragments, mica		distinctive feature abundant flecks of mica, **homogeneous group**
	VII, n=2	poorly sorted temper up to 3mm	monocristalline quartz and feldspar	various	
	VIII, n=4	abundant well sorted temper around 1.5 to 2.5mm	quartz, various	various	**heterogeneous group**

Fig. 3 - Description of fabrics represented among the orange ware.

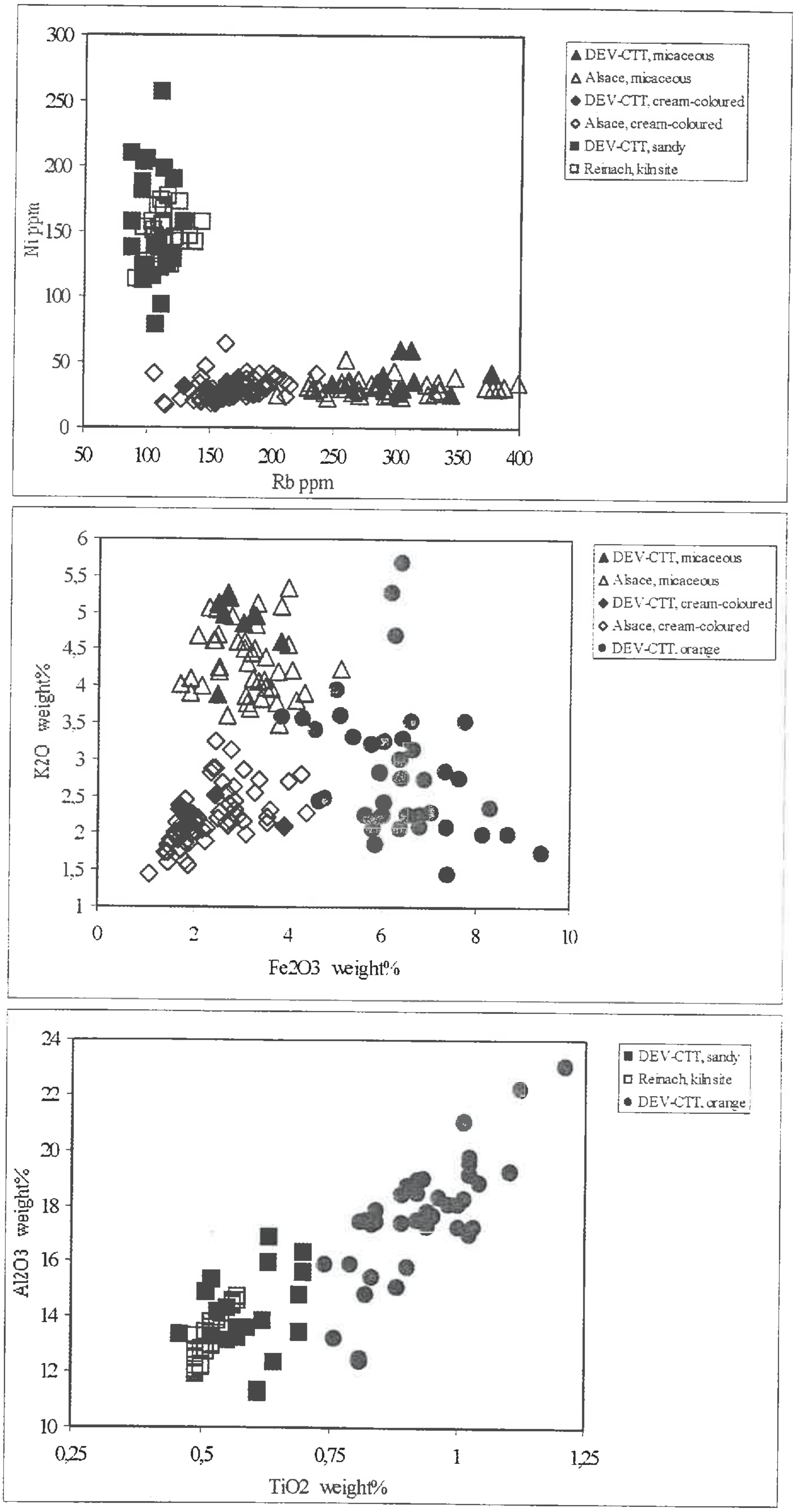

Fig. 4 - Different wares from Develier-Courtételle (DEV-CTT) plotted with available references in selected bivariant graphs

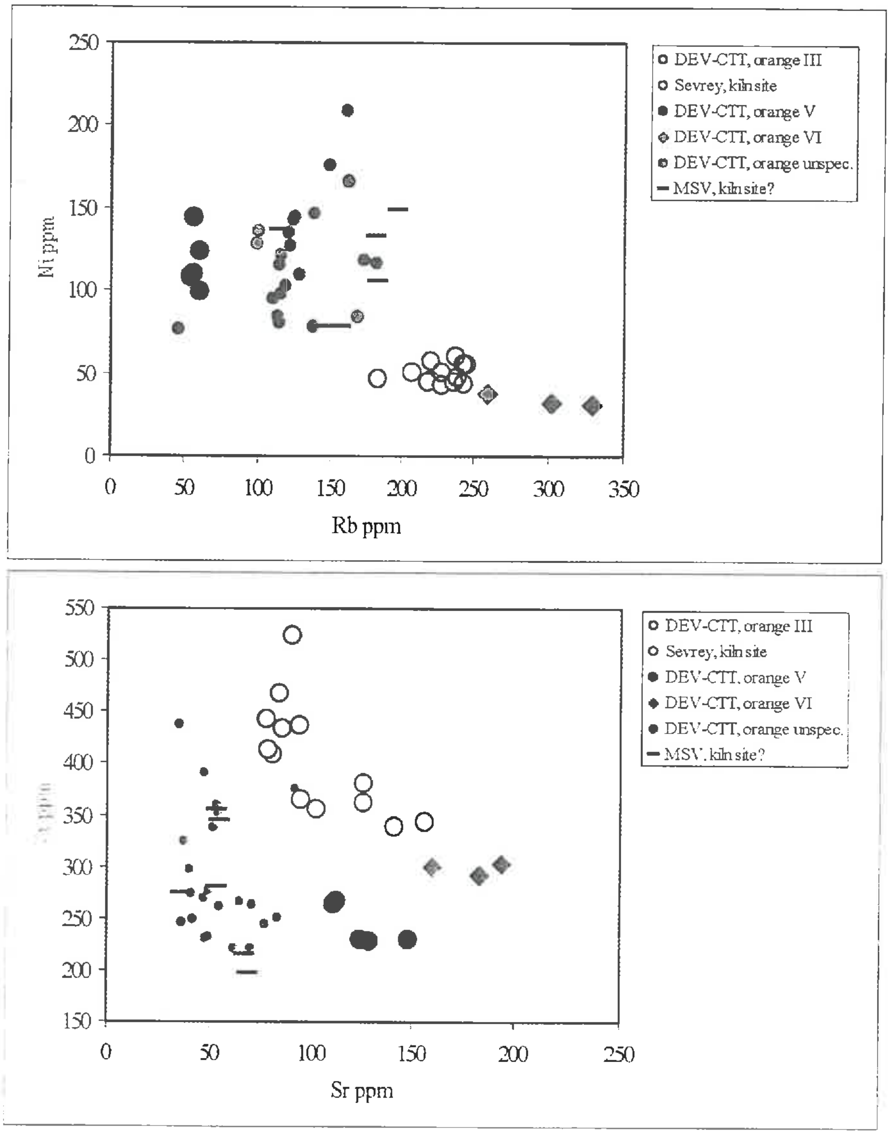

Fig. 5 - Groups of orange ware (Roman numbers refer to the petrographic subdivision in fig.3, orange unspec. assembles groups I, II, IV, VII, VIII) and references from Sevrey, Burgundy, France and Monsevelier, Jura, Switzerland (MSV) plotted in selected bivariant graphs.

grains and a little feldspar. The Vosges alluvium contains a considerable variety of rocks and minerals though is characterised by a substantial amount of carbonate grains. The original sediment may be sometimes redeposited and decalcified.

This overview shows, that the same characteristic bedrocks are at the origin of argillaceous to sandy sediments usable as potters' clays in several regions (for instance the Jurassic sediments or the variscan granitic complexes and triassic sedimentary cover of the Vosges and the Morvan). Therefore no regional differentiation of the Burgundy area is possible on the basis of geological arguments alone. The accordance of the fabric to the geological environment of the assumed production area may nevertheless strengthen the provenance hypotheses.

3.3.2 Comparison

The fabrics of the *cream coloured*, *micaceous* and *sandy* sherds from Develier-Courtételle are petrographically identical to the fabrics of the respective reference groups (fig.2). The two cream-coloured groups present at that site cover the variety of this ware as defined by

Châtelet (1997) macroscopically and by Châtelet et al. (1999, 2000) analytically. Concerning the *sandy ware* it has to be noted that the reference group from Reinach contains a majority of relatively coarse-grained sherds (around 0.5mm), while the Develier-Courtételle group includes as well many slightly finer-grained sherds (up to 0.5mm).

The petrographical resemblance is confirmed by the chemical results, as shown in the bivariate plots (fig.4). Chemically, however, the *cream-coloured* and the *micaceous* sherds are somewhat marginal to the reference groups defined (Châtelet et al., 2000), especially under multivariate analysis (Mahalanobis distances). The group of *sandy ware* from Develier-Courtételle shows a chemical variation larger than that observed in the reference group, which is consistent with the petrographical evidence.

Among the *orange ware*, group III and the references from Sevrey are very close petrographically – both showing a similar grain size distribution and among others inclusions of granitic rock fragments with micrographic texture - though with a tendency to coarser temper in the references. Most bivariant plots and the cluster analyses of the chemical data for the orange ware join the sherds from group III and those from Sevrey, although one of the bivariant plots (fig. 5) demonstrates, that not all of the constituents show overlapping ranges.

The six reference sherds for a possible regional production show a very abundant, fine temper identical to groups I and II. Like group I, however, they are of heterogeneous chemical composition. While the temper composition is compatible with an origin around Develier-Courtételle, it is too unspecific to exclude another provenance for the sherds.

Concerning the other groups of orange ware, we have to rely on the comparison of temper composition to geological environment alone (see 3.3.1.). The exclusively siliceous temper of predominantly granitic origin identified in these groups is not distinctive enough in itself: while consistent with a provenance from Burgundy, the temper association cannot exclude other origins like the southern Vosges for example. Their production in the region of Develier-Courtételle is highly unlikely, however, because the coarser sediments there generally contain a considerable amount of carbonate grains (Liniger, 1925). Raw materials compatible with these fabrics can be found among the plioquarternary alluvial sediments in the Saône – Doubs region, as well as among colluvial sediments near the Vosges or Morvan mountain chains.

3.3.3. Discussion

In order to check the provenance hypotheses for the pottery from Develier-Courtételle, we deal with databases of very different qualities for the regions concerned:

- an archaeologically well-studied substantial database for the Alsace, of a time-frame similar to the settlement
- an archaeologically well situated, numerically reasonable one for the Basle region, however of kilns operating at a late period in respect to the studied consumer site,
- scant analytical data for the Burgundy ware, which – in addition – stem from more recent sherds than the ones under study.

The provenance attributions to the Alsace are accordingly considered well founded. The slightly marginal character of the chemical composition is of little concern, as it is most probably due to the mixing of data from two laboratories and counterbalanced by the good petrographical match.

The larger variation of the sandy ware from Develier-Courtételle in respect to the reference group is justifiable by its larger chronological span and is not contradictory to an origin of all these samples from the pottery district Oberwil-Therwil-Reinach near Basle. The variation is moreover quite in accordance with the results of macroscopic fabric analyses of an important corpus from that pottery district, where Marti (2000) notes the same variations. On the basis of his observations, the slight granulometric variations do not seem indicative of different production sites. In view of these considerations, there remains no doubt concerning the attribution of the sandy ware.

As to the orange ware, the small reference base in addition to the small number of samples composing the identified groups does not allow a clear attribution. In view of the repetitive geological situation, the attribution of group III to Sevrey is to be considered a plausible working hypothesis, as long as no other reference groups from Burgundy are available to prove the differenciability of the reference group.

Group I is petrographically the least distinctive group. Raw materials for this kind of fabric can be found almost anywhere. For geological reasons mentioned above, groups I and II are however the *only* pottery present in the sample, which *could* have been produced around Develier-Courtételle.

As references are missing, the other groups of orange ware cannot be linked directly to Burgundy by the results of the analyses. The temper composition is quite consistent with an origin in Burgundy. But as pointed out above, no general regional differentiation is possible: even for the very distinctive temper composition of group V, several origins in Burgundy or another region close to a variscan granite complex could be suggested. There is, however, no doubt, that the different fabric groups of orange ware (groups I – VIII) represent at least as many different productions. The number of production sites may be higher still, as the groups showing considerable variations in some parameters are probably composed of representatives of several productions. In view of the small sample number no specific production can be isolated.

3.4. Extrapolation of analytical results to macroscopic fabric analyses

The analyses clearly confirm the typological subdivision into four wares (fig.2). On the basis of the analyses, a finer classification into fabric groups identifiable by macroscopic examination can be suggested for the orange ware. This means that the classification as presented for the sample of 75 cases can be applied to the whole corpus with few restrictions. The main classification criteria for the orange ware are the granulometric differences used in the petrographical classification, combined with some particularities (fig.3), which are discernible visually, resulting in 7 differentiated fabric groups (classes) as follows: Groups I, II, VI and VII are readily distinguished visually. Macroscopic differentiation of groups V and VIII is more difficult and the attribution uncertain in some cases, while groups III and IV cannot be separated macroscopically with any degree of certainty and have to be treated as one class. This constitutes the most severe restriction in extrapolating the analytical results to macroscopically discernible characteristics and means that the production from the kiln site of Sevrey is not sufficiently definable macroscopically at the present time (sample too small). The part of the orange ware belonging to the only group attributable to a specific kiln site is therefore not yet accurately quantifiable.

Different persons applied this classification independently to the whole corpus and obtained coinciding groups (including one group of non-classified specimen, different from the defined groups), thus proving the effectiveness of the differentiation criteria. This extrapolation allows a quantification of the whole corpus and shows the relevance of the identified groups. The variety of groups composing the orange ware signalled by the analyses is confirmed.

4. Conclusions

In summary, the study permits the following conclusions:

- The provenance attributions based mainly on typology and macroscopic fabric characteristics are confirmed by the analyses for the cream-coloured (Alsace), micaceous (Alsace) and sandy (Basle area) wares; the analytical results are compatible with the orange ware's origin from Burgundy, but, with one exception, do not permit any positive confirmation.
- The cream-coloured, micaceous and sandy wares can be assigned to only a few homogenous groups, thus confirming the

archaeological hypothesis of centralised production. As far as the orange ware is concerned, the analyses prove a heterogeneous composition with several definable groups, indicating a dispersed pottery production. If the assumed contemporaneity of the different pottery wares from Develier-Courtételle holds true, this result constitutes an additional argument in favour of political influences in the organisation of pottery production in Alsace…

- One of the groups composing the orange ware can be attributed to the production site at Sevrey (Saône et Loire, Burgundy).
- Analytical results can be extrapolated successfully through macroscopic examination to the entire ceramic material of Develier-Courtételle, allowing an assessment of the analysed groups' significance. Results of the macroscopic classification strengthen the assumption of heterogeneity among the orange ware.

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