Black-on-red painted pottery production and distribution in Late Neolithic Macedonia
Zoï Tsirtsoni, Vassilis Kilikoglou, Dimitra Malamidou, I Karatasios, L. Lespez

To cite this version:

HAL Id: hal-02870306
https://hal-univ-paris10.archives-ouvertes.fr/hal-02870306
Submitted on 16 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Black-on-red painted pottery is one of the most distinctive ceramic categories of the Neolithic Aegean. Particularly attractive, thanks to its vivid dark-on-light contrast frequently combined with an elaborate motif design (Fig. 1), this pottery is also remarkable for its high technical quality, witnessed by the fineness of the fabric, the uniformity of the surface colours, the regularity of shapes, the density and hardness of the vessels’ walls. Pottery of this kind is found at settlements in Northern Greece (Thessaly, Macedonia and Thrace), dated to an advanced stage of the Late Neolithic period, roughly between 4800/4700-3900/3800 BC. Although it was early recognised as a diagnostic ware for that period in the areas of its occurrence (Welch 1918-19, p. 44-46; Heurtley 1939, p. 74-75; French 1961, p. 114-116; Deshayes and Garašanin 1964), no previous attempt was made to construct a systematic classification or to study its production technology and distribution patterns.

In this paper, we summarise the main results of a series of studies carried out between 2000 and 2004, within the framework of a multidisciplinary research program supported by the French School at Athens (ÉFA) and the French National Centre for Scientific Research (CNRS). The main body of the analytical results, concerning the production areas and distribution of the pottery, has been presented in detail elsewhere (Malamidou et al. 2006; for the NAA analyses, see also Kilikoglou et al. 2007). Here emphasis is given to the scanning electron microscopy examination for the technological characterisation of this pottery class.

ARCHAEOLOGICAL AND CHEMICAL GROUPS: REGIONAL DISTRIBUTION AND POTTERY TRADITIONS

Preliminary macroscopical analysis of archaeological ceramics from more than one hundred Neolithic settlements, according to technological (fabric, surface treatment, paint consistency) and morphological criteria (vessel shapes, decoration), resulted in their classification into four main varieties which also correspond to different

Fig. 1 – Black-on-red painted open vessel from Kryoneri (drawing D. Malamidou).
The overall presence of black-on-red decorated pottery in Late Neolithic Northern Greece reveals the existence of some common technical standards beyond common aesthetic preferences, such as the use of iron-rich clays for the vessels, firing to high temperatures under oxidising conditions, and the use of manganese-based paints. Most of these features have a long history, at least in Eastern Macedonia, where sophisticated dark-on-light painted pottery was produced as early as 5200/5000 BC. (Tsirtsoni 2000, sp. p. 13-18; Yiouni 2000; Yiouni 2001, sp. p. 5-11). On the other hand, the existence of at least four regional varieties suggests an equal number of local pottery traditions, that is, different “recipes” resulting in similar, but not identical, products. These “recipes” differ from one another in several aspects (clay choice and preparation, surface treatments, paints, etc.), reflecting variations in the production processes from one centre to another. Certainly, this variability is related to environmental factors, namely local resources, but the role of tradition should not be underestimated.

Further research focused on the Eastern Macedonian variety 1, which is by far the most abundant and best documented. It is also the most widely distributed, since it is also found (in small quantities) in many other parts of Northern Greece, including Aegean Thrace to the east, the Axios valley to the west and Thessaly to the south, as well as in SW Bulgaria to the north.

Neutron activation analysis (NAA) of some 200 ceramic samples from 14 settlements allowed us to distinguish four main chemical groups (A-D) for the black-on-red ceramics. A fifth group (E) corresponds to samples of the so-called brown-on-cream painted pottery, which is contemporaneous with and technically similar to the black-on-red, but features a light grey-brown decoration on a yellowish background. The distribution pattern of the four black-on-red ceramic groups (Fig. 2) suggests that pottery production took place in at least four separate production centres in Eastern Macedonia. Each production centre could include more than one workshop, exploiting the same, or mineralogically very similar, clay sources.

Extensive geological survey revealed a substantial number (more than 50) possible clay sources, all in strata dated to the Plio-Pleistocene period. However, none of the analysed samples matched the composition of the ceramics found in the same area. Although a straightforward chemical match between clays and ceramics is very rare, the great differences observed lead to the conclusion that the Neolithic clay sources were either exhausted or covered by younger formations. Future survey should take into consideration not only the general geological features, on a regional scale, but the particular characteristics of each valley.

Fig. 2 – Geographical distribution of the chemical groups A-D in Eastern Macedonia, suggesting black-on-red pottery production in at least four separate centres.
MICROMORPHOLOGICAL ANALYSIS AND TECHNOLOGICAL EVALUATION

A representative number of 14 samples was examined under the scanning electron microscope (SEM). The examination of the micromorphology of the ceramic body and surface along with their chemical compositions provided information about the selection and manipulation of the raw materials, as well as the pyrotechnology (Maniatis and Tite 1981). This information provided the necessary evidence to reconstruct the production process of the ceramic ware under study. The main question generated by the results of the previous chemical analysis was whether the selection of raw materials and firing parameters were the same in all the production centres. The answer should provide evidence about the level of standardisation in black-on-red pottery production during the Late Neolithic period in Eastern Macedonia.

As far as the clay is concerned, analysis shows a definite preference for non-calcareous clays of a fine nature containing moderate amounts of quartz. Twelve of the fourteen samples studied were found to have been manufactured with clays containing low amounts of CaO (2-6%) (Table 1). Actually, the two samples which are clearly calcareous (CaO up to 12%) do not belong to black-on-red, but to brown-on-cream ceramics (supra). The low calcareous (that is, the true black-on-red) group can be further subdivided into two: a virtually non-calcareous sub-group (CaO around 2%), fitting almost perfectly with the chemical group A, which is mainly found in settlements along the Angitis and in the lower part of the Strymon valley, and a second group with CaO between 5-6%, which agrees quite well with the group B, typical of coastal sites.

The majority of the samples examined showed vitrification of the clay minerals in their microstructure, in most cases well developed, as evidenced by the extensive networks of glass filaments present. This applies to ceramics coming from both A and B chemical groups, in other words, to samples produced in different production areas. In most cases the glass network is composed of fine filaments (Fig. 3), as a result of the small grain size of the original clay particles, while the firing temperature suggested, for this type of microstructure, is between 900 and 1000 °C. Extensively vitrified microstructure was also developed in the ceramic bodies of the calcareous group E, but the microstructure here is cellular due to the decomposition of calcium carbonate during firing (Fig. 4).

As far as the clay is concerned, analysis shows a definite preference for non-calcareous clays of a fine nature containing moderate amounts of quartz. Twelve of the fourteen samples studied were found to have been manufactured with clays containing low amounts of CaO (2-6%) (Table 1). Actually, the two samples which are clearly calcareous (CaO up to 12%) do not belong to black-on-red, but to brown-on-cream ceramics (supra). The low calcareous (that is, the true black-on-red) group can be further subdivided into two: a virtually non-calcareous sub-group (CaO around 2%), fitting almost perfectly with the chemical group A, which is mainly found in settlements along the Angitis and in the lower part of the Strymon valley, and a second group with CaO between 5-6%, which agrees quite well with the group B, typical of coastal sites.

Table 1 – Main results of the SEM examination of black-on-red and brown-on-cream ceramic samples; the second column shows correspondence with the chemical groups identified by NAA analysis.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Chemical group</th>
<th>CaO content (%)</th>
<th>Vitrification stage</th>
<th>Paint</th>
</tr>
</thead>
<tbody>
<tr>
<td>KRY 01/06 A</td>
<td>1.6</td>
<td>V</td>
<td>med+Mn</td>
<td></td>
</tr>
<tr>
<td>KRY 01/16 A</td>
<td>2.6</td>
<td>V</td>
<td>med+Mn</td>
<td></td>
</tr>
<tr>
<td>DIM 01/142 A</td>
<td>1.9</td>
<td>V</td>
<td>med+Mn</td>
<td></td>
</tr>
<tr>
<td>LUE 01/91 B</td>
<td>5.4</td>
<td>V</td>
<td>fine+Mn</td>
<td></td>
</tr>
<tr>
<td>GAL 01/80 B</td>
<td>5.6</td>
<td>V</td>
<td>fine+Mn</td>
<td></td>
</tr>
<tr>
<td>AKR 01/72 B</td>
<td>5.6</td>
<td>V</td>
<td>fine+Mn</td>
<td></td>
</tr>
<tr>
<td>DT 01/160 D</td>
<td>3.6</td>
<td>V</td>
<td>fine+Mn</td>
<td></td>
</tr>
<tr>
<td>KRY 01/64 E</td>
<td>11.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KRY 01/63 E</td>
<td>11.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FID 01/101 C</td>
<td>2.0</td>
<td>IV</td>
<td>med+Mn</td>
<td></td>
</tr>
<tr>
<td>KRY 01/08 A</td>
<td>2.0</td>
<td>IV</td>
<td>med+Mn</td>
<td></td>
</tr>
<tr>
<td>DT 01/161 D</td>
<td>5.9</td>
<td>V+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KRY 01/09 A</td>
<td>2.7</td>
<td>TV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KRY 01/02 A</td>
<td>3.9</td>
<td>V+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3 – SEM microphotograph of a black-on-red pottery sample (DIM 01/142) with a well-developed microstructure, containing an extensive network of fine glass filaments; the estimated firing temperature lies between 900 and 1000 °C. Photo width = 60 μm.

Fig. 4 – SEM microphotograph of a brown-on-cream pottery sample (KRY 01/63): the extensively vitrified cellular microstructure is due to the decomposition of calcium carbonate during firing at high temperatures (900-1000 °C). Photo width = 60 μm.
This microstructure is consistent with firing temperatures of more-or-less the same range (900-1000 °C). Slightly lower firing temperatures are assumed for two samples whose microstructures did not exhibit such an extensive state of vitrification as the others.

In all cases the black decoration was obtained by the addition of manganese oxide to a clay suspension and its application prior to firing. This resulted in a paint layer less than 10 µm thick, which does not appear vitrified in the SEM examination, although, as mentioned above, the firing temperatures were relatively high (Fig. 5a, b). A closer look at the semi-quantitative analytical data obtained by SEM (especially the Al to Si ratio) reveals two patterns: one with the clay suspension of the paint layer (Fig. 5c) being very fine compared to the clay of the body (Fig. 5e), and one with the clay chemistry being the same in both the paint layer (Fig. 5d) and the body (Fig. 5f). In the first case, a fine suspension of the clay used for the body was obviously prepared, then mixed with Mn-oxide.

Fig. 5 – SEM microphotographs and comparative spectra of two black-on-red pottery samples (LUE 01/91, KRY 01/16). a-b: paint layers on top of the vitrified body. Photo width = 60 μm; c-f: comparison of the chemical compositions of the paint and body (especially the Al/Si ratio) suggests differences in the preparation of the paint mixtures for the two samples.
to produce the paint, whereas in the second, clay was
mixed with water and Mn-oxide, then applied to the
body, without prior refinement. It is important to note
that the fine suspension pattern is only found in samples
coming from the coastal group B, while the untreated one
is typical for group A. These differences also had a visual
effect, with the black decoration of the “fine” paints being
brighter and more durable than the others.

One of the questions that SEM analysis tried to
resolve was that of “black” paints that appear grey or white,
a feature observed in many specimens of the variety 1
(Fig. 6). Actually, in these cases, the paint does not appear
white everywhere, but only in patches—most commonly
on the outer surface of the vessel. White motifs are usually
surrounded by a black outline, forming a sort of contour. Close
examination of samples with such decoration revealed that
they had been originally exposed to very high temperatures,
well over 1000 °C, as attested by their microstructures
(Fig. 7). Another characteristic of these paint layers is that
they are low in alkalies and Mg, but rich in Ca, although
in the surrounding black lines the situation is exactly the
opposite. One possible explanation is that the whitish colour
is a result of the effect of the burial environment on the high
temperature phases developed in the paint layers: the latter
being unstable, they could undergo leaching of K, Na and
enrichment of Ca. This is very similar to what happens in
glass where a whitish corrosion layer is also formed during

Whether these high temperatures were reached during the
original firing or during the destruction of the settlement, is
not known for certain. It seems however more probable that
it happened during the original firing, as suggested by the
extent of the white zones on whole vessels.

To summarise, it is obvious that there is essentially
one technological tradition all over Eastern Macedonia.
However, two variations exist in paint preparation: the
first, observed mainly in settlements close to the coast,
uses a very fine suspension taken from the same clay as
the body, whereas the second one uses this same clay, but
without prior refinement. Everywhere there is very good
control of firing conditions and high temperatures are
applied (usually between 900-1000 °C), in order to obtain
hard-fired fabrics with bright, uniform colours. Accidents
do happen, however, since we find vessels that have been
exposed locally to temperatures above 1000 °C. This
should certainly not lead to a depreciation of the Neolithic
potters’ skill, but rather to a re-evaluation of the constraints
with which they had to deal, and to extra appreciation of
the overall quality of their products.

Black-on-red vases feature, indeed, a remarkably
standardised quality in all stages of the chaîne opératoire.
Cases like this invite us to reconsider our way of thinking
about Neolithic pottery production and Neolithic society
in general, which may have been less “unspecialised” and
less “self-sufficient” than usually thought.

Fig. 6 – Black-on-red vessel from Dikili Tash (h. ca 11 cm): the black paint appears white in some parts of the vessel’s exterior (photo: Ph. Collet/EFA).

Fig. 7 – SEM microphotograph of a pottery sample with “white-painted” decoration (KRY 01/09): its microstructure suggests firing well above 1000 °C. Photo width = 60 μm.
REFERENCES


Heurtley W.A. 1939, Prehistoric Macedonia, Cambridge.


Maniatis Y., Tite M.S. 1981, “Technological examination of Neolithic-Bronze Age pottery from central and southeast Europe and from the Near East”, Journal of archaeological science 8, p. 59-76.


