Technology neglected?

A painted ceramic fragment from the dated Middle Neolithic site of Vale de Rodrigo 3

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Abstract

Although two decades of intensified research have significantly enhanced our understanding of the Iberian Neolithic a significant number of questions remain unanswered. For instance, especially in Portugal, occasional evidence for painted pottery from contexts of the late Early and early Middle Neolithic has as yet received little in-depth discussion. Consequently, our attention is drawn to certain limitations, and important details remain incomplete in our picture of Neolithic inventions. This paper presents painted ceramics from a dated Middle Neolithic context of the Alentejo, and preliminary results of SEM/ EDX-analysis in assessing the chemical and mineralogical composition.

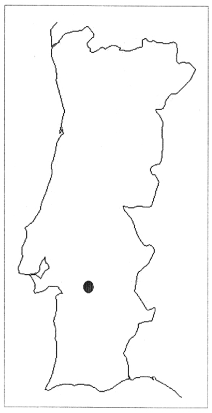
Keywords: Neolithic, southwest Iberia, ceramic painting, absolute data, micro-structure, micro-morphology, elemental composition, SEM, EDX

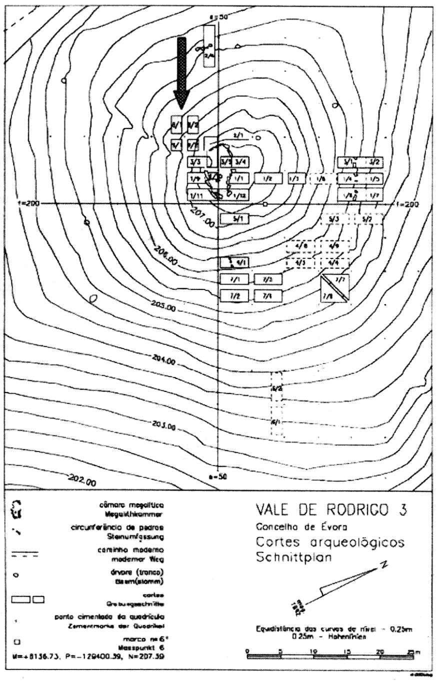
Investigations of the site of Vale de Rodrigo 3 (Évora)

The four megalithic sites of the Herdade de Vale de Rodrigo (Fig. 1) became the subject of archaeological studies as early as 1944. A period of intensified research began in 1987 when the project "Zona megalítica de Vale de Rodrigo" was established by the project directors P. Kalb (Roemisch-Germanische Kommission, Frankfurt/ Germany) and M. Hoeck (Universidade de Beira Interior, Covilhã). The focus of the ongoing activities was targeted upon systematic investigations of Monument 3, where excavations began in 1992 (Hoeck/ Kalb 2000).
While the megalith and mound of Monument 3 may date from a later stage of the Neolithic, the layers related to its erection and occupation are superimposed on remnants of an older settlement. Excavations outside the grave chamber revealed well-preserved remains of a Middle Neolithic occupation, lo-

cated underneath the mound (Armbruester 2006).

Four trenches (8.1, 8.2, 9.1, 9.2) at the south west side of the mound cut into the settlement remains, but trench 9.2 yielded the most detailed insight at about 2,00 x 1,50 m, and a stratigraphy of more than 2 m in depth (Fig. 2). The mound was constructed after the grave chamber had already existed for an unknown period of time (Kalb 2002: 26-28). Other than where the megalithic construction was erected no damage was caused to the older settlement deposits in this particular section of the site. The sediments of the artificial mound and the deeper occupation horizons are divided by a layer of extremely compact black clay of alluvial origin. The black clay was clearly applied at the site in the course of human action, and forms a solid barrier in parts as thick as 20 cm within the stratigraphical sequence. Below this barrier undisturbed archaeological deposits in excess of 1 m in depth have remained well preserved, as is demonstrated by the stratigraphical record of trench 9.2 (Fig. 3).





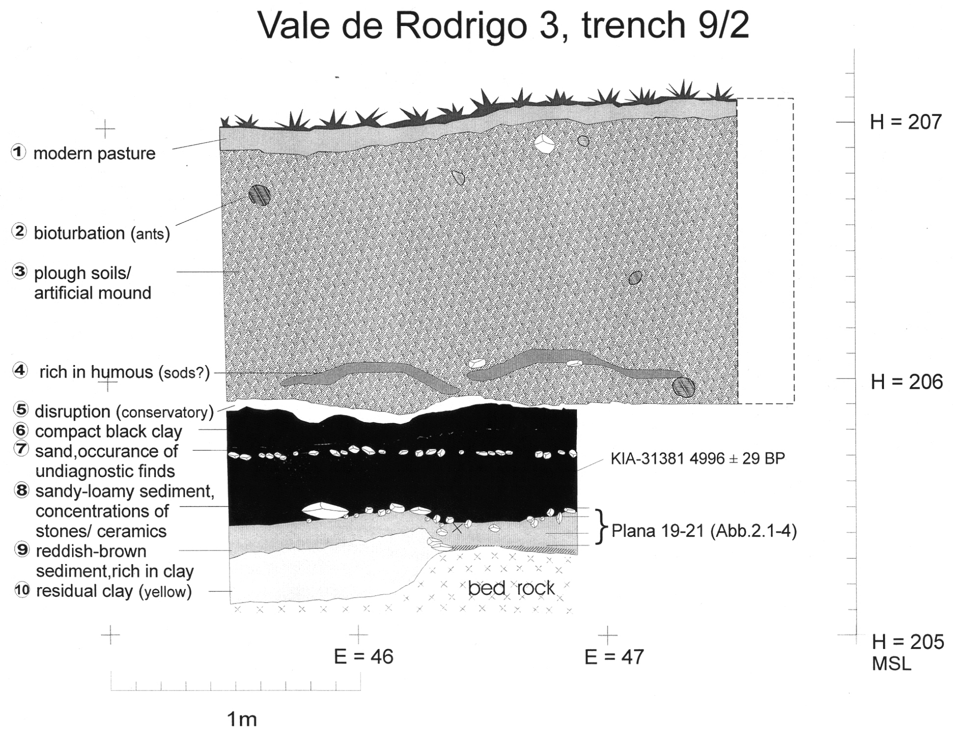


Fig. 1-3 Location of the site, location of trench 9.2 at the site, and the detailed stratigraphy of trench 9.2

The yellow sandy deposit immediately below the black clay (Fig. 3: 7) contained small fragments of undecorated ceramics as well as lithic material, both characterized by a low diagnostic quality. It superimposed on a second sandy deposit that differed in colour and in texture due to the occasional inclusions of reddish brown loam (Fig. 3: 8). On top of this layer, at about 205.70 m MASL, an unusual agglomeration of stones occurred (granite, quartzite) mixed with a considerable number of ceramics and other archaeological finds. Among those ceramics some fragments stand out, showing an incised groove (sulco) below the rim (Fig. 4). The sandy-clayish deposit was as thick as 25 - 30 cm, with archaeological material occurring throughout, although not with constant frequency. At the bottom of the deposit a second agglomeration of stones became visible superimposing on a brown loam deposit (Fig. 3: 9). Some of the larger stones had penetrated into the deeper deposit where its surface lowered towards a shallow depression, indicating that the loam became a soaking swamp during seasons of heavy rainfalls. This assumption is supported by the existence of traces of accumulated organic remains at the bottom of the depression (Fig. 3: 4). The loam yielded more ceramics including some with a groove below the rim, fragments with black engobes on the interior, crescent-shaped microliths, charcoals, wicker negatives, daub fragments, and apatites [1], along with stones which may have served as a fireplace, but the most remarkable object from this context is a small fragment with a black painted zone at the rim.

The underlying brown loam proved sterile, apart from the section where the trench had cut into the shallow depression and its immediate surrounding sediments. The restricted pattern that was marked by the distribution of finds (Fig. 4) appeared to result from physical boundaries, as they generally occur alongside permanent structures (for instance from huts or houses). Although the insight obtained provides only limited information on the formation and taphonomy of the deposits of the prehistoric occupation, it appears very likely that the horizontal agglomerations of stones on top (Fig. 3: NM1) as well as at the bottom of the deposit (Fig. 3: NM2) marked two different horizons of occupation. Within the whole stratigraphy of the deeper deposits of trench 9.2 it is important to notice that the occurrence of ceramic fragments with a groove below the rim is limited to the sediments of and between those two horizons. Pottery with that particular characteristic is commonly attributed to the earlier stage of the Middle Neolithic of the Alentejo and Estremadura.

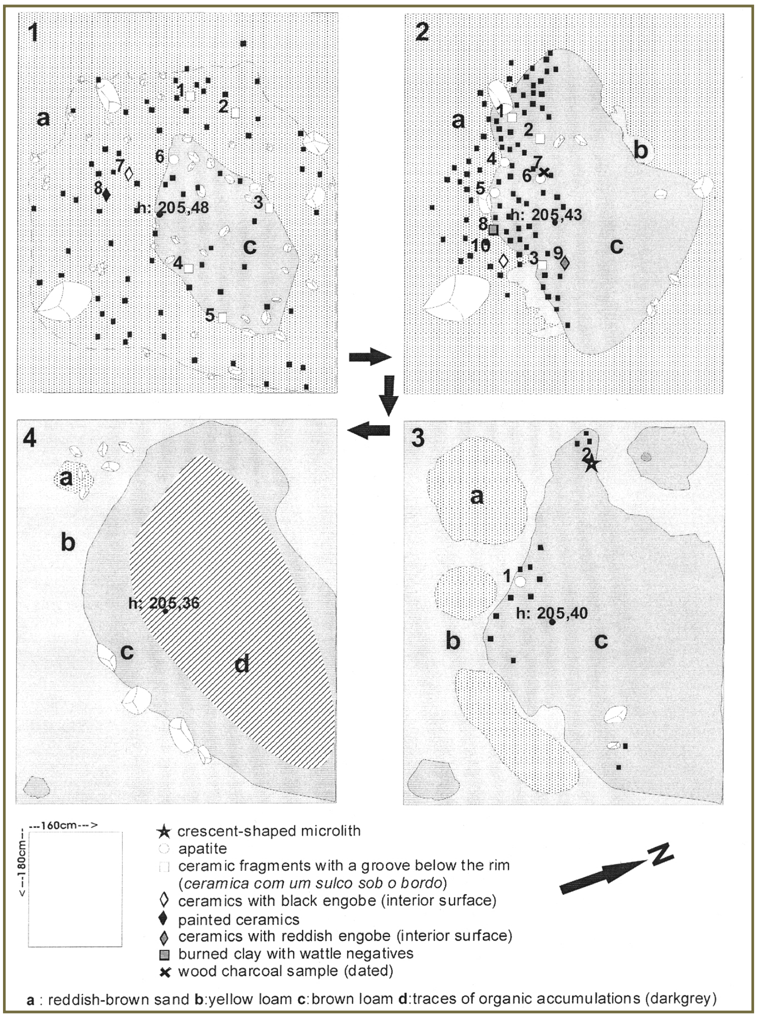


Fig. 4 Plana of trench 9.2: context of the painted fragment and associated findings

Absolute data

One of the charcoals from the bottom of the described reddish-brown deposit yielded a radiocarbon date.
The lab considered the quality of the sample to be high, containing more than the required minimum of 1 mg of carbon [2].

Lab code	BP	cal. 1 σ	cal. 2 σ	material	δ 13C
KIA-31381 (AMS)	4996±29	3800-3710 BC (68, 2%)	3940-3870 BC (18,6 %) 3810-3700 BC (76,8 %)	wood charcoal	-26,86±0,17

Tab. 1: Trench 9.2: 14C date obtained on charcoal from a brown loam deposit (Fig. 3: 9) at 205.40 MASL (calibrated using OxCal v3.10 [Bronk Ramsey 2005])

Since the sample was solidly attached to the loamy sediment, extraction was not possible without causing serious damage to its physical structure. Consequently it was impossible to accurately verify the plant species. To date, the only information obtained at 100x and 200x zoom under the microscope is that it was an extremely stringy wood displaying the characteristics of shrubs such as *Erica umbellata* or *Calluna vulgaris* [3].
The obtained date for the earliest Middle Neolithic occupation of Vale de Rodrigo 3 fits well within the range of the few absolute data available for the earlier stage of the Middle Neolithic in the region (Silva/ Soares/ Penalva 1986, Carvalho 1998, Diniz 2000, Valera 2005, Armbruester in print). Within an area of less than 600 m exists another megalith, Vale de Rodrigo 2, which was investigated by L. Larsson (University of Lund) and his team during the years 1991 - 2001. Similar evidence of an occupation predating the erection of the megalith chamber and the mound occurred underneath this monument. Although the assemblage from the contexts underneath Monument 2 is lacking in highly diagnostic markers such as ceramics with a groove below the rim, the presence of simply-shaped plain, undecorated pottery with simple rims, round bases and without any kind of handles indicates that the deposits had derived from a Middle Neolithic occupation. This assumption is confirmed by three radiocarbon dates available for the context, ranging around 5175 ±70 - 4905 ± 70 BP. Two of the AMS dates were newly obtained [4]. Viewed from the basis of all absolute and relative data available for Vale de Rodrigo 2 and 3 we can conclude that there existed an extended Middle Neolithic settlement pattern during the first third of the 4th millennium cal. BC.

Fig. 5: Vale Rodrigo 3, trench 9.2 - painted fragment

The painted fragment from Vale de Rodrigo 3

The black banding is restricted to 0, 55 cm in width, showing clearly defined borders to the edge of the rim, and also to the lower parts. This pattern is repeated on the interior side of the fragment. Of particular note is how the two black zones are separated by a small linear space of not more than 1 mm in width where the natural grey-brown colour of the fabric is visible, indicating that no black slip was applied at the ridge of the rim. The painted fragment has a size of only 9, 92 sqm, and the average wall thickness measures about 0, 6 cm. Both the greyish-brown external surface, and the slightly darker coloured internal surface show evidence of a careful smoothing treatment. Due to the homogeneity of the colouration it cannot yet be determined whether the treatment was limited to the use of water and polishing tools (i.e. self-slip) or if an additional layer was actually applied (i.e. engobe) to hide the coarse composition of the fabric (Velde/ Druc 1999: 86).

Fig. 6 Clay matrix and non-plastic inclusions of the painted fragment (F1)

The fabric itself is relatively rich in non-plastic materials (Fig. 1) such as subrounded (Fig. 9) and rounded natural mineral grains. These grains result from sands which are commonly present in primary clay deposits (Velde/ Druc 1999: 78) and arise locally in the course of weathering of the highly siliceous gneiss bed rock. At the same time a considerable amount of quartz as well as a small percentage of feldspar becomes visible in the breakage. Since both quartz and feldspar inclusions show the same angular shapes (Fig. 9), we can conclude that those materials were added to the paste to enhance heat-resistance and thermal reaction (physical/ thermal strength). All non-plastic materials show a very heterogeneous pattern with regard to their distribution and size indicating that the potter exercised little control in the process of preparing the paste (applied mean: hand lens, 6 x/ 8 x/ 12 x zoom).

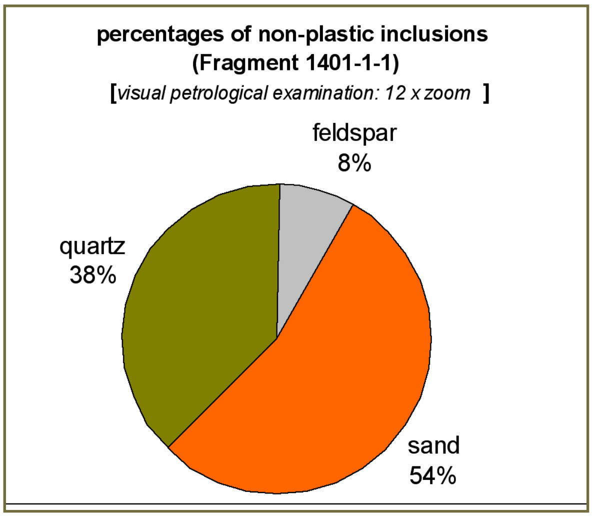


Fig. 7

Morphology, microstructure and elemental composition investigated by SEM and EDX

Studies show that the black colours of pottery can have a variety of origins (Wagner et al. 2007). The earliest technique for producing contrasts in colour on pottery was based on the use of slips (i.e. ceramic painting) rather than on the controlled use of pigments. Early evidence from the Zagros mountain region dates back from the 6th mill. BC (Noll 1991: 124). Such slips consisted of fine clay-rich suspensions in water (Velde/ Druc 1999: 7). Technical similarities between colour slips used with ceramic painting and those which cover the entire surface of pots (e.g. engobes) indicate that their invention was closely linked [6]. Applied to limited zones of the vessels they consisted of a particularly fine paste of selected clays, which possessed chemical properties different from those used for building the body of the vessel. Under certain conditions the intensity in the cleaning and processing of the clay to gain a workable paste may alter its chemical properties significantly so that two pastes made from raw materials of one and the same source would show distinct reactions when being exposed to fire.

A first visual examination of the fragment from Vale de Rodrigo has revealed that a slip as thin as 0, 04 cm was applied to the smoothened surfaces of the rim zone. During firing the slip had sintered into the fabric below so that no physical difference is either traceable or visible apart from the contrast in colour. This may be accounted for by the raw materials for the paste used in both building and smoothing the body of the vessel, and also for the black slip itself having actually been taken from the same clay deposit.

Therefore attention must be focused on the closer characterisation of micro-structural, chemical, and mineralogical composition to obtain further information (Krapukaitytė et al. 2006: 383). Modern techniques for materials characterisation are gaining increasing currency in archaeological materials science. Among them, scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDX) are being successfully applied. The main types of information that can be obtained from SEM and X-ray microprobe analysis are:

1. information on raw materials;
2. information on firing procedures;
3. information on surface decorations (slips, glazes etc.)

Although there may be accompanying disadvantages, SEM does have the specific advantage of a better resolution than optical thin section microscopy. Studies of surfaces are probably the most promising field of the application of SEM/ EDX (Froh 2004: 166-167).

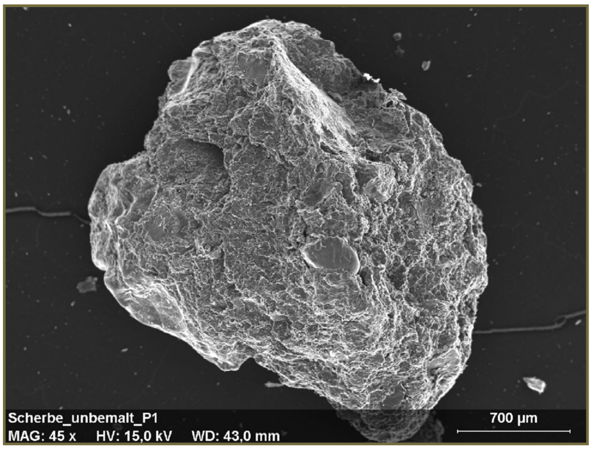


Fig 8: Scanning electron micrograph of sample F1b taken from the uncoloured zone of the painted fragment (no. 1401-1-1).

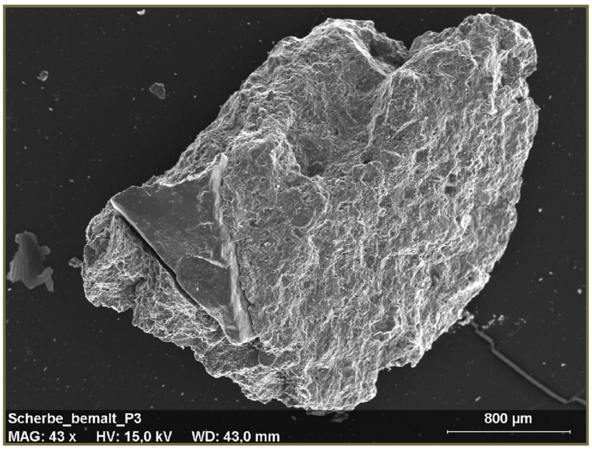


Fig 9: Scanning electron micrograph of sample F1a taken from the coloured zone of the painted fragment (no. 1401-1-1).

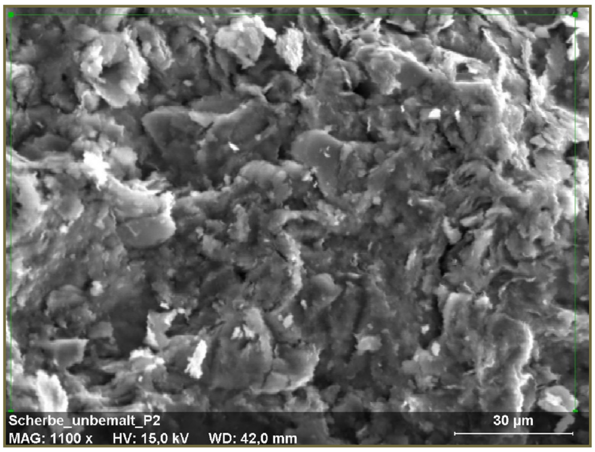


Fig 10: Scanning electron micrograph of sample F1b: micro-morphology of the fabric

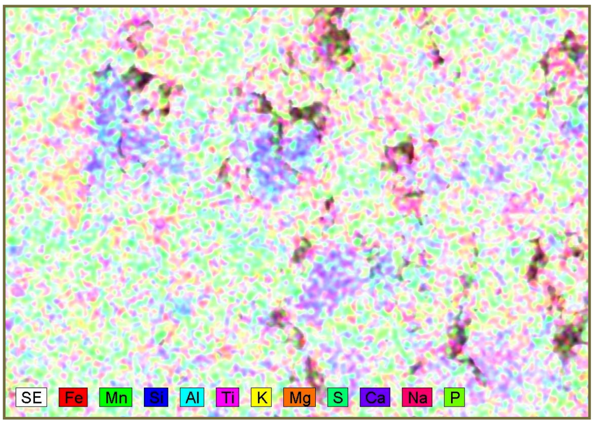


Fig 11: Energy dispersive X-ray of sample F1a.

SEM and EDX were used with the objective of identifying compositional and structural differences between the painted (F1a) and the unpainted zones (F1b) [5].

Measurements were recorded under vacuum conditions in the specimen chamber of the scanning electron microscope JEOL JSM 6300 equipped with energy dispersive X-ray RÖNTEC QUANTAX operating in secondary electron mode. The applied accelerating voltage was 15 keV, and the working distance was 8 mm. The characteristic X-rays emitted when electrons with several kilovolts strike a solid specimen were measured providing a signal of quantitative reference for the presence of the main elements of its composition.

Scanning electron microscopy operating in secondary electron mode was utilized to investigate the micro-morphological structure of the fabrics. The micrographs pictured in fig. 8 and 9 show the morphology of the fine grained clay matrix and some rather large inclusions. While the inclusions visible in fig. 8 can be identified as quartz and feldspar grains the size of sand (0,063 – 2 mm), the large angular shaped object shown in the micrograph of fig 9 clearly represents quartz temper. No significant morphological difference becomes visible between the painted and unpainted samples F1a und F1b.

At higher magnification (x1100) specimen F1b exhibits agglomerates of fine particles broadly distributed through the loose porous texture, voids and particles displaying arbitrary shapes. The comparatively low degree of densification and sintering indicates that the vessel was fired at lower to medium temperatures (Krapukaitytė et al. 2006: 386-387).

Although the energy dispersive X-ray spectrum show that the elements Fe, Al, Mn, Si, Ti, K, Mg, S, Ca, Na and P are all present in both samples of specimen F1, the content of calcium, phosphorus, sulphur, and manganese remained below detection.

Vale de Rodrigo 3 is located within an area of residual soils, which in terms of geomorphology are composed of Hercynian granites and Palaeozoic metamorphics. As is characteristic of many metamorphics the bedrock is highly siliceous but comparatively poor in calcium (Scheffer/ Schachtschnabel 2002). Residual clay deposits of such parent material can generally be expected to possess chemical properties similar to the composition of the investigated samples of F1, except for their content of sulphur and phosphorus. The sulphur content of a rock is normally within the range of minor elements (< 1%), and sulphur occasionally occurs along with iron in low quantities, which may explain the pattern displayed by the spectra. Higher ratios of phosphates are occasionally reported as a compound of prehistoric ceramics. Their presence is explained by either the use of the vessel with certain organic substances (e.g. milk) or as a result of post-depositional processes (Klein et al. 2004: 339) [7]. Phosphates accumulate at sites of human occupation and penetrate into the soil, particularly when excrements, compost or even synthetic fertilizers are used to ensure high and stable crop yield. While microbial mineral dissolution appears to be an important source of phosphorus in the soil, labile phospho-

specimen	measurement	SiO_2	Al_2O_3	Fe_2O_3	K_2O	MgO	Na_2O	TiO_2
F1a (painted)	1	57,4	26,5	10,4	3,5	1,24	0,56	0,37
	2	56,3	25,8	10,7	4,0	1,73	0,75	0,73
	3	60,7	23,1	9,7	3,6	1,49	0,43	0,98
	4	59,1	24,9	9,7	3,7	1,58	0,39	0,76
	5	55,8	26,2	10,4	4,1	1,96	0,76	0,76
	6	59,1	25,2	7,3	5,1	1,46	1,28	0,63
specimen	**measurement**	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**K_2O**	**MgO**	**Na_2O**	**TiO_2**
F1b (no paint)	1	58,3	25,5	9,0	4,1	1,56	0,38	1,12
	2	57,2	24,3	11,7	4,0	1,54	0,32	1,01
	3	62,9	21,8	8,9	3,4	1,55	0,61	0,83
	4	59,3	23,4	10,1	4,4	1,53	0,45	0,82
	5	60,6	22,8	7,9	4,0	1,48	2,16	1,14
	6	55,0	26,1	10,5	4,8	1,85	0,57	1,20

Tab. 2 Relative quantities of chemical elements in specimens F1a and F1b.

rus is best preserved by clay, iron, and aluminium minerals and thus can occur as a component (≤ 0.12%) of raw clays (Chacón et al. 2005: 555).

A quantitative analysis of EDX spectra provides further information on the composition of the fabrics, firing conditions and techniques applied to obtain the black slip.

Six spectra were obtained per specimen. While little difference becomes visible in terms of morphology and microstructure of the two differently coloured samples F1a and F1b, individual aspects of their chemical composition reveal some distinct patterns (Tab. 1). The well-evolved line oxygen in each of the obtained spectra (Fig. 12, 13) points towards a major impact of metal oxides (Velde/ Druc 1998: 127). In this context it is noteworthy that no carbon residues could be detected.

In direct comparison, the composition of the samples of the painted and the unpainted zones of specimen F1 exhibited the following distinctions: Silicon oxide (SiO_2) is the most abundant component in all spectra [8], although the ratio of SiO_2 is found diminished from the substrate to the black slip. Conversely, the detected content in aluminium oxide is clearly higher in the slip. Total ratios of iron oxide (Fe_2O_3) and potassium oxide (K_2O) are almost identical, but a slight diminution becomes apparent for magnesium oxide (MgO). Finally, the sample of the black zone displays a further and clearly more relevant diminution of sodium oxide (Na_2O) and, more dramatically, of titanium oxide (TiO_2). The occurring distinctions are, viewed collectively, of minor significance. Such alterations can be accomplished by processing the paste, e.g. levigating, washing, and the addition of water, or by mixing different clays (Orton et al. 1993: 146). The fusing agent CaO, which would have helped hastening the fusing process, is absent or remained at least below detection (Velde/ Druc 1998: 132).

The most detectable distinctions in chemical compositions are, among others, reduced quantities of MgO, Na_2O, and TiO_2, which account for the deep black colour of ancient Greek fine pottery (Mirti et al. 1996: 107). Although the evidence from Neolithic Alentejo is clearly less elaborate, and it is most likely that the clay used for producing the black slip was acquired from the same local source as the material for building the vessel, this provides an important insight into technical inventions of the period [9].

Neolithic pottery was commonly fired in pit or open kilns. The most frequent technique applied by the potters was mono-step single-stage short firing with temperatures ranging at around 600 – 700°C. As a consequence of such simple techniques of firing, minimal control was possible, and conditions as well as temperatures often underwent rapid unpredictable changes. When submitted to higher temperatures commencing at 573°C, Quartz undergoes minor structural changes (quartz inversions). Changes at the first inversion step of quartz are difficult to identify, and although the quartz inclusions in specimen F1 show no visible traces of alterations, we cannot conclude that the firing temperature remained below 573°C. Fe_2+ (iron) in a clay matrix can be observed to be oxidized when heated in air at 400°C and be completely oxidized at 600°C, with the formation of haematite (Fe_2O_3), which under oxidizing conditions gives a red colour to the paste (Velde/ Druc 1998: 127). Judging from the EDX spectra obtained for specimen F1 the step of oxidizing was completed during firing, but the grey colour of the paste indicates that the final oxidation step might have been deliberately or incidentally incomplete (Mirti et al. 1996: 105). In a reducing atmosphere iron-silicates are formed earlier, starting at around 500°C, and iron oxides are transformed into FeO (wustite) or Fe_3O_4 (magnetite), which are opaque black minerals and thus give a grey colour in ceramics. These indicators suggest that the painted vessel from Vale de Rodrigo 3 was fired at a temperature of between 500 – 700°C but either the oxidizing process of iron oxides remained incomplete or a reducing atmosphere led to grey (substrate) and black ("painted") colouration. Under oxidizing conditions the process may also have led to a change into brown and reddish colours.

Evidence for early painted ceramics from the Iberian Peninsula

The occasional evidence for painted pottery from contexts of the late Early and early Middle Neolithic has as yet received little in-depth discussion.

The painted fragment from Vale de Rodrigo 3 and the remains from various vessels with their entire surfaces coated with black engobe demonstrate that elaborate capability for obtaining contrasts in colour by the application of special slips to pottery existed among Middle Neolithic populations of the Alentejo at the time of the early 4th mill. cal. BC. Although the site of Vale de Rodrigo 3 has yielded more than 5000 ceramic items in total, no further evidence for the presence of painted ceramics has been recovered. When the perspective is extended to the entire central Alentejo the pattern is very much the same. While the presence of pottery with engobe is sporadically reported from Neolithic sites, especially from concelho de Reguengos de Monsaraz (Gonçalves 2001: 59, 62) [10], no such evidence can be reported for ceramic painting on pottery. G. Leisner and V. Leisner mentioned the occasional occurrence of painted ceramics within megalithic contexts from the Alentejo as well as from Beira Alta (1943, 1959, 1998), but investigations on ceramics stored at the Museo Nacional de Arqueologia (Lisbon) led to the unexpected result that, apart from red and black engobe, no ceramic painting occurred on vessel fragments characteristic of types of Neolithic pottery [11]. Hence the rim fragment with the black banding from Vale de Rodrigo 3 may be indicative of a foreign origin, e.g. evidence of a vessel used as a container for the importation of goods. On the basis of information obtained by SEM/ EDX analysis however, all data indicate that in terms of tempering, chemical composition, and micro-morphology nothing points towards an extra-regional origin. Regional potters apparently possessed the elaborate skill required for applying ceramic painting on pottery, but the skill went neglected. This poses the question of what the factors were that led to the neglect of such elaborate skills at a time when the technique of ceramic painting flourished and spread throughout the Eastern Mediterranean (Noll 1991: 140).

When the Iberian Peninsula is considered at a broader scale the picture remains unchanged. Two further datings from Portugal (see Tab. 3: 1, 2) indicate that ceramic painting occurred even as early as the first half of the 5th mill. cal. BC in Central and South Portugal (Valera 2002/ 2003: 15). The remains of pottery from the site of Castelo Belinho in Algarve yielded examples of red paints (Gomes 2006: 259). Red painted pottery is also reported from La Vaquera (Segovia) located in the northern Meseta of Central Spain, and dated to a period of around 3600 cal. BC (Estremera 2003: 103, 128, 188). Earlier evidence is reported from Cova Fosca in Northeast Spain (Castellón), where one isolated black painted fragment out of a total of more than 5000 was recovered from an Early Neolithic context, dated to the last quarter of the 6th mill. cal. BC (Olària 1988: 247). Neolithic burials from Cueva de los Murciélagos de Zuheros in South Spain (Albuñol, Granada), which were found to contain fragments of red (and probably black) painted baskets yielded further evidence for painted decorations on containers dated to 5100 - 4900 cal. BC (Díaz-Guardamino 1997). Finds of elaborate black decorated ceramic vessels from the megalithic site of Las Vegas de Aranjuez (Aranjuez) are purported to date from a pre-megalithic stage, although no absolute date was obtained (Asquerino 1985: 186). The dearth of evidence of painted pottery from dated contexts renders it almost impossible to arrive at definitive conclusions. The pattern in other parts of Spain and Portugal is, however, similar to the one observed in central Alentejo: although occasional evidence for the presence of ceramic painting techniques exists as early as the Early Neolithic, this did not apparently lead to a wider spread of painted pottery through the south and central Peninsula before the end of the Neolithic. The reasons underlying the pattern remain broadly beyond current understanding.

lab. code	location	BP	1 sigma	2 sigma	sample	method
GrN-23558 (1)	La Vaquera 9	4870±50	68.2% probability 3710BC (2.4%) 3630BC	95.4% probability 3780BC (80.6%) 3620BC 3590BC (14.8%) 3520BC	charcoal	conventional
Sac-1774 (2)	Quinta da Assentada (UE 850)	5870±110	68.2% probability 4900BC (2.4%) 4860BC 4850BC (65.8%) 4590BC	95.4% probability 5000BC (95.4%) 4450BC	charcoal?	AMS?
CSIC-356 (3)	Cova Fosca (C-II, nivel IA)	7100±70	68.2% probability 6050BC (68.2%) 5900BC	95.4% probability 6100BC (95.4%) 5790BC	charcoal	conventional

Tab. 3 14C data of contexts, which yielded evidence of painted ceramics (calibrated using OxCal v3.10 [Bronk Ramsey 2005]): (1) Estremera 2003, (2) Valera 2002/2003, (3) (Olària 1988)

Conclusions

The painted fragment from Vale de Rodrigo 3 is dated to the Middle Neolithic period of about 3800/3700 cal. BC [12]. At the current stage of investigations no further evidence for the use of ceramic painting as a mean of decoration on pottery of this period is available from the south of Portugal. Similarly isolated finds are reported from other parts of the Iberian Peninsula, dating from the Early Neolithic, and to the late Middle or early Late Neolithic. The pattern indicates that the technical skill required for obtaining contrasts in colour by the application of clay slips existed throughout this period but for the most part went neglected. This does not necessarily imply that the technological know-how had evolved from local traditions, but extra-local or even extra-regional contacts are likely to have triggered the adaptation of such skills, since the scarcity of Iberian evidence appears to indicate that no tradition of ceramic painting existed in Early and Middle Neolithic Southwest Iberia, while painted pottery was very common in other parts of the Mediterranean.

Therefore, this study is aimed at characterizing the micro-morphology and chemical composition of the paste, which formed the vessel body, and its distinctions in comparison to the black coloured rim with the objective of determining the possible origin of the vessel as well as obtaining information on the applied technology. The non-destructive method of SEM/ EDX was successfully used on the painted fragment, and the recorded data indicate that it was built from regional but not necessarily local clays, since its highly siliceous paste exhibits characteristics typical of the metamorphic substrates which form the bedrock of both Alto and Baixo Alentejo, which are divided only by the sediments of the Sado valley and a ridge of Hercynian volcanics. Nothing points, so far, towards an extra-regional origin.

Hence we must ask what had prevented the application of this technological know-how to the broader skill of pottery production within the Alentejo and other parts of the Peninsula. Hansen has for instance claimed that the occurrence of (ceramic) painting in the Balkans during the Neolithic was closely linked to the development of religious ideas, patterns of worship, and increasing complexity in social structures (Hansen 2005). On the other hand, history demonstrates that while some religious ideas along with social conventions had the effect of serving as a trigger for the evolvement of arts, crafts, and skills, others had the effect of suppressing them. Following this pattern, the broad absence of ceramic painting within the southwest of the Mediterranean during a period of time when it commonly existed in the Balkans as well as in the Eastern and Central Mediterranean, may indicate that social or religious conventions were the cause for an elaborate technical skill falling into disuse over a significant period of time. [13].

Evidently, the earliest decorative usage of painting techniques which included the application of slip-like pastes, can be observed directly on megaliths in the far north of Portugal beginning at around 3900 cal. BC if not earlier (Steelman et al. 2005: 384-387). The relation between spiritual if not specifically religious expression, symbolism and painting is demonstrated by those megaliths painted with symbols of unclear meaning in red, black, and white (Bueno/ Balbín in print: 727). But once again no evidence exists from the earliest dated contexts for paintings applied on ceramic objects. This hints of an exclusivity which made paintings a factor of megalithism rather than of pot-making.

However, it is clearly too early to arrive at final conclusions, and approaches towards an explanation must consequently be constrained to hypotheses. To date only one ceramic specimen has been investigated, and such an assemblage hardly constitutes a representative sample. Further investigations are required aiming at to shed more light on a very intriguing aspect of the Iberian Early and Middle Neolithic.

Acknowledgements

I would like to thank Philine Kalb for inviting me to study the Vale de Rodrigo 3 assemblage, as well as for her patient dedicated help and support. L. Larsson provided information on new absolute data from Vale de Rodrigo 2. This article was greatly improved by helpful comments and suggestions from G. Salisbury (Preston/ UK). The Römisch-Germanische Kommission, Frankfurt/Main, W. Armbrüster, H. Gomolka, G. Dorau, and J. Endemann provided funds for this study. L. Raposo gave his kind permission for visual examinations to be conducted on archaeological ceramics of supposedly megalithic origin (mentioned by Leisner&Leisner 1943, 1959, Leisner 1998 and stored at the MNA Lisbon); C. Martinho (MNA) also provided helpful assistance and support to my research. Thanks are also due to H. Hecht, and R.-T. Schmitt (Museum für Naturkunde, Berlin) for their cooperation, namely for conducting SEM/ EDX analysis and Raman spectroscopy.

Notes

[1] The collagen in bone contains poorly crystallised inorganic material, primarily calcium phosphate ('bio-apatite'). Bio-apatite contains carbonate (0.5-1.0%), substituting phosphate in the crystal lattice. This structural carbonate originates in blood bicarbonate, and therefore is directly related to the food the person or animal has eaten. The fragments of apatite from Vale de Rodrigo 3, trench 9.2 may be remains of sheep or goat according to their size, currently being investigated by Dr. M. Hüls, Leibniz-Laboratory for Radiometric Dating and Stable Isotope Research, Christian-Albrechts-Universität, Kiel.

[2] Data provided by Prof. Dr. P. M. Grootes, Leibniz-Laboratory for Radiometric Dating and Stable Isotope Research, Christian-Albrechts-Universität Kiel.

[3] The vegetation at the time before the megalith of Vale de Rodrigo 2 was built, consisted mainly of oak and shrub according to pollen samples taken from archaeological deposits underneath the monument (Larsson 2000: 447). It would fit such a type of palaeo-vegation if the charcoals from the settlement at the site, where the megalith of Vale de Rodrigo 3 was most likely erected around the same time, resulted from burning shrub (Armbruester in print).

[4] Larsson 2000: 450 and personal communication Prof. Dr. L. Larsson, Dec. 2006.

[5] Scanning electron microscopy and energy dispersive X-ray were conducted by Dr. L. Hecht and his team (Museum für Naturkunde, Humboldt University of Berlin).

[6] In archaeological publications the terms "slip" and "engobe" are often used interchangeably. Technically, the precise term is engobe, a coating that masks the colour and texture of the clay body. Such coatings are applied onto the leather-dry ceramic body. However, the term "slip" is used here to describe a particularly fine coating (e.g. fine clay-rich suspension) applied to a limited zone of the vessel and producing a difference/ contrast in colour, while "engobe" is used to describe a coating, which covers the entire surface in order to hide the native texture of the clay body. Other than (colour) slips engobes may or may not cause alterations in colouration compared to the clay body after firing.

[7] In other cases the presence of phosphorus in ceramics is accounted for evidence of the use of bone material as temper, since phosphorus occurs most abundant in bio-apatite (Gerke et al. 2006: 6). Since there is hitherto no evidence for the use of bones as tempering material in ceramics from Neolithic Alentejo, this possibility remains, so far, neglected in the course of the current interpretation. Alternatively it appears possible that the porous fabric of the vessel might have absorbed some chemical compounds from organic phosphates buried in the soil along with the vessel remains (since trench 9.2 had yielded fragments of bio-apatite along with the painted fragment).

[8] The content of silicon oxide was relatively constant, consequently it was chosen as a constant value (= y) in the plots (Fig. 13, 14).

[9] Clay acquisition during the Neolithic focused on the closer vicinity of settlements within an estimated radius of about 7 – 10 km (Martineau et al. 2007: 24).

[10] Such engobe-coatings can be either of a black or reddish colour, which is mainly depending on whether the pot was fired under oxidizing or reducing atmosphere (see SEM/ EDX analysis). Along with engobes of a strongly contrasting colouration was the use of non-contrasting (e.g. brownish to

greyish) coatings/ engobes extremely common.

[11] According to G. Leisner and V. Leisner (1943, 1959) and V. Leisner (1998) the assemblages from the megaliths of 1) Herdade de Farisoa 1, 2) Herdade de Farisoa 7, 3) Herdade do Monte Novo 1, 4) Herdade do Passo 1, 5) Herdade das Vidigueiras 1, 6) Anta Grande da Comenda da Igeja (Anta 1), 7) Tholos da Comenda (Anta 2), 8) Anta Grande do Olival da Pega (Anta 1), 9) Herdade de Vale de Rodrigo 1, and 10) Anta Grande do Olival da Pega (Anta 1) were reported to yield evidence of painted ceramics. But resulting from a current re-examination of the assemblages by the author in autumn 2006 it turned out, that evidently no ceramic item older than of a Final Neolithic or Copper-Age origin (due to typo-morphological criteria) showed any traces of painted decoration, although many fragments bore traces of engobe (with many examples of black engobe predominantly applied to the interior sides of the vessels).

[12] The date was obtained on charcoal. Due to the fact that datations on charcoal may differ from those obtained on bones or other short-lived material for about 200 – 500 years (Zilhão 2001) or even more, the absolute chronology of the site may shift towards an earlier datation as soon as further dates on the apatites become available (see [1]). Such a shift in absolute dates for the site of Vale de Rodrigo may affect the chronology of the Middle Neolithic in Central and South Portugal in general.

[13] There may be a close relation to the general abandonment of decorations on pottery, which is significant of ceramic assemblages dating to the transition from the Early to Middle Neolithic in south Central and South Portugal (Armbruester in print). Such a broad-scale change in material culture is always suspect of reflecting a major change in ideas, conventions, and often also in conditions, which ruled human existence at certain stages throughout (pre-)history.

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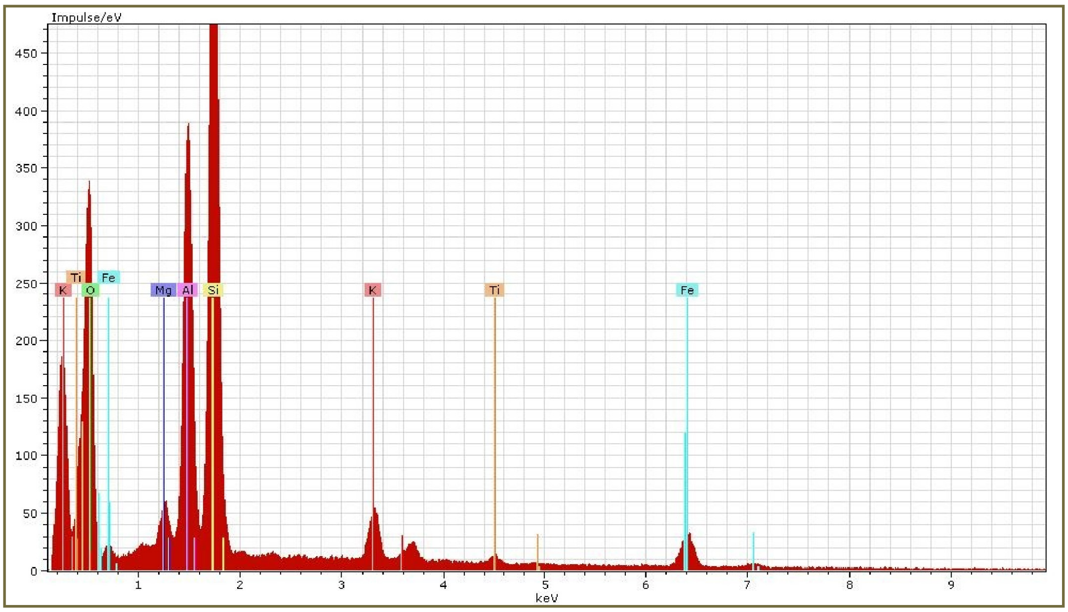

Fig. 12 EDX spectra of specimen F1b: detectable minerals and quantitative analysis.

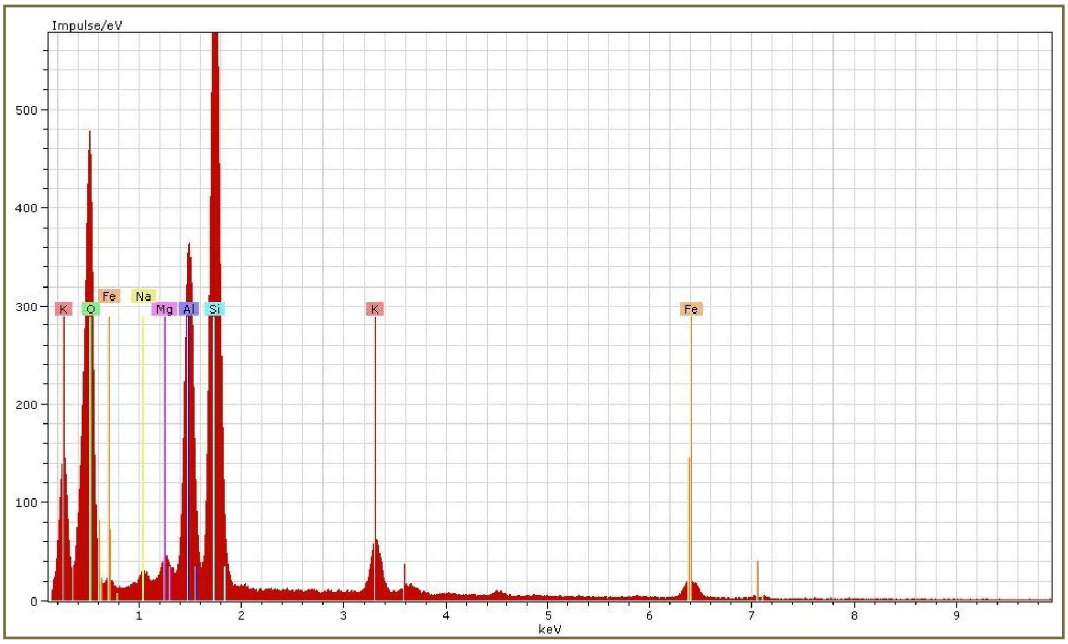

Fig. 13 EDX spectra of specimen F1a: detectable minerals and quantitative analysis.