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Clay materials from antique pottery

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Abstract

We have studied a lump of clay found at the archaeological site located in the hill of 'La Campana' near the town of Yecla, Province of Murcia, Spain. The lump is part of an unused crushed coil. The X-ray diffraction analysis has shown the presence, mainly of illite, poorly crystalline smectite and, in a reduced proportion, of kaolinite. We can thus presume that exposure to a heat source was rather accidental. All minerals found in the lump of clay have a low degree of crystallinity and they coexist with amorphous material, especially iron oxide and even quartz and carbonates. © 1997 Elsevier Science B.V.

Keywords: Archaeological; Clay; Dilatometric analysis; X-ray diffraction

1. Introduction

The hill of 'La Campana' is an archaeological settlement of the Bronze Age, located in the vicinity of the town of Yecla, Province of Murcia, Spain. The hill belongs to one of the mountain ranges that form the physiographic unit known as the 'Altiplano Jumilla-Yecla' (Fig. 1). The Altiplano landscape includes a series of isolated hills, produced by recumbent anticline-shaped parallel alignments in a SW–NE direction, which stands out from a sequence of intermediate plains created by clogging of synclinal basins. On the other hand, these alignments have a great influence on all the natural passes of the area.

Lithologically, the land is monotonous, alternating chalks, limestones and dolomites, usually covered by Quaternary deposits which form the plain. Metallogenetically, the areas is quite sterile, at least as far as metallic ores are concerned.

Although, at present, permanent waterways are practically nonexistent, it has been proven that in past times there were humid areas SE and NE of the settlement. Until recently, there were thermal and freshwater springs in the region.

The strategic location of the site, besides the possibility of exploitation of the natural resources of the environment and the visual control of the territory, seems to have been taken into account when the place was chosen as a settlement. Settlers not only looked for good soil for crops, pastures, water and raw materials for their houses and tools, but also for the vicinity of communication routes and a high place to control and defend their land [1].

At present, the hill of La Campana is a huge rocky bulk covered, except at its summit, by a layer of brown earth mixed with rocks produced by drift terracing, leveling for dwellings erected during the time it

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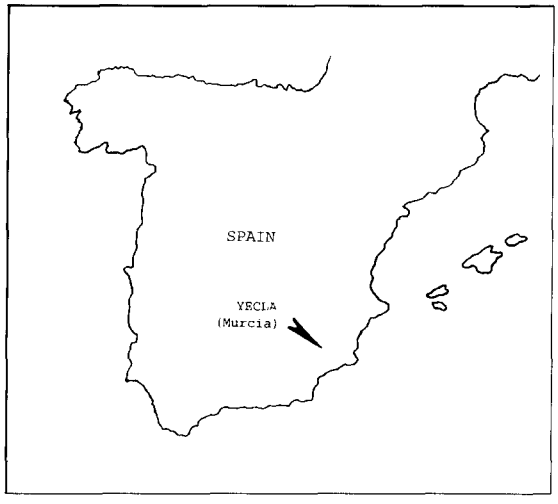

Fig. 1. Location map of the Yecla, Murcia, Spain.

was inhabited, and great blocks displaced by natural slides.

Fortunately, and in spite of the later construction of terraces for reforestation, some archaeological remains have been found 'in situ'. Among these, the one in the northern slope of the hill – with which this communication is concerned – is of special interest. The northern profile showed evidence of the existence of two pits incrusted in it, hence it was decided to extend the trench digging the temoin. There were positive results, and two pits named A and B were uncovered (Fig. 2).

Once they were excavated, it was discovered that pit A was completely filled with earth and some pottery fragments, while pit B had a successive accumulation of layers of earth mixed with ashes and charred residues, including pottery fragments, bone tools and ornaments that quantitatively, and qualitatively, may be considered significant, such as smoothers, punchers and perforated wild boar tusks used as pendants.

Apart from the great interest in these findings, we were especially surprised by an amorphous lump of clay. Once it was cleaned, it turned out to be a clay coil, like the ones used for manufacturing pottery, following the method of spiral or 'colombinos', but it seemed never to have been used and only appeared deformed by hand pressure. It may even be said that it might have been pressed by a small hand as can be deduced by the impression left by the fingers on its surface. This discovery made us think that it may have been part of the raw material used for manufacturing pottery in the hill of La Campana. Our working hypothesis was conceived following this idea.

To confirm or reject this hypothesis, it was decided to compare the composition of the lump of clay with some of the pottery fragments found in the area surrounding the pit which being 'in situ', and at the same level, might be contemporary.

Three fragments were selected from pottery containers used by the settlers of the hill of La Campana for different purposes (Fig. 2). Fragment No. 1056 – container for cooking food; fragment No. 1053 – container for eating food; and fragment No. 1093 – container for storing food.

2. Methods

Analyses have been performed on the lump (sample 1), in the mamelon of a similar pottery fragment (sample 2 – 1056) and in two other fragments belonging to black containers found nearby (samples 1053 and 1093). It is also of interest to emphasize that both the unshaped fragment and the mamelon have a different colour than the other two samples studied which have a black inner surface and the material is softer, while in the outside surface they all have a similar reddish colour.

Analyses performed on pottery fragments were aimed at discovering their mineral composition for a first approximation. Organic matter was determined also through gravimetry, prior calcination at 650°C [2]. The mineralogical composition was determined through X-ray diffraction using a Phillips PW-1035 diffractometer working with CuK_{α} radiation. In the quantification of the mineral components, we used the areas of the following peaks: quartz (4.26 Å), calcite (3.03 Å), dolomite (2.88 Å), feldspars (3.24–3.18 Å) and phyllosilicates (4.49 Å), [3,4].

A dilatometric study CRH has been performed, as a dynamic assay in which the material was treated under a constant heating rate, on a cylinder, once the sample was moltured and compressed (100 MPa), with alumine patron, in the dilatometer Adamel Lhomargy Di-24 of furnace of silicon carbide and LVDT.

Phyllosilicates continued to be identified on previously extracted fine fractions. Diffractograms were

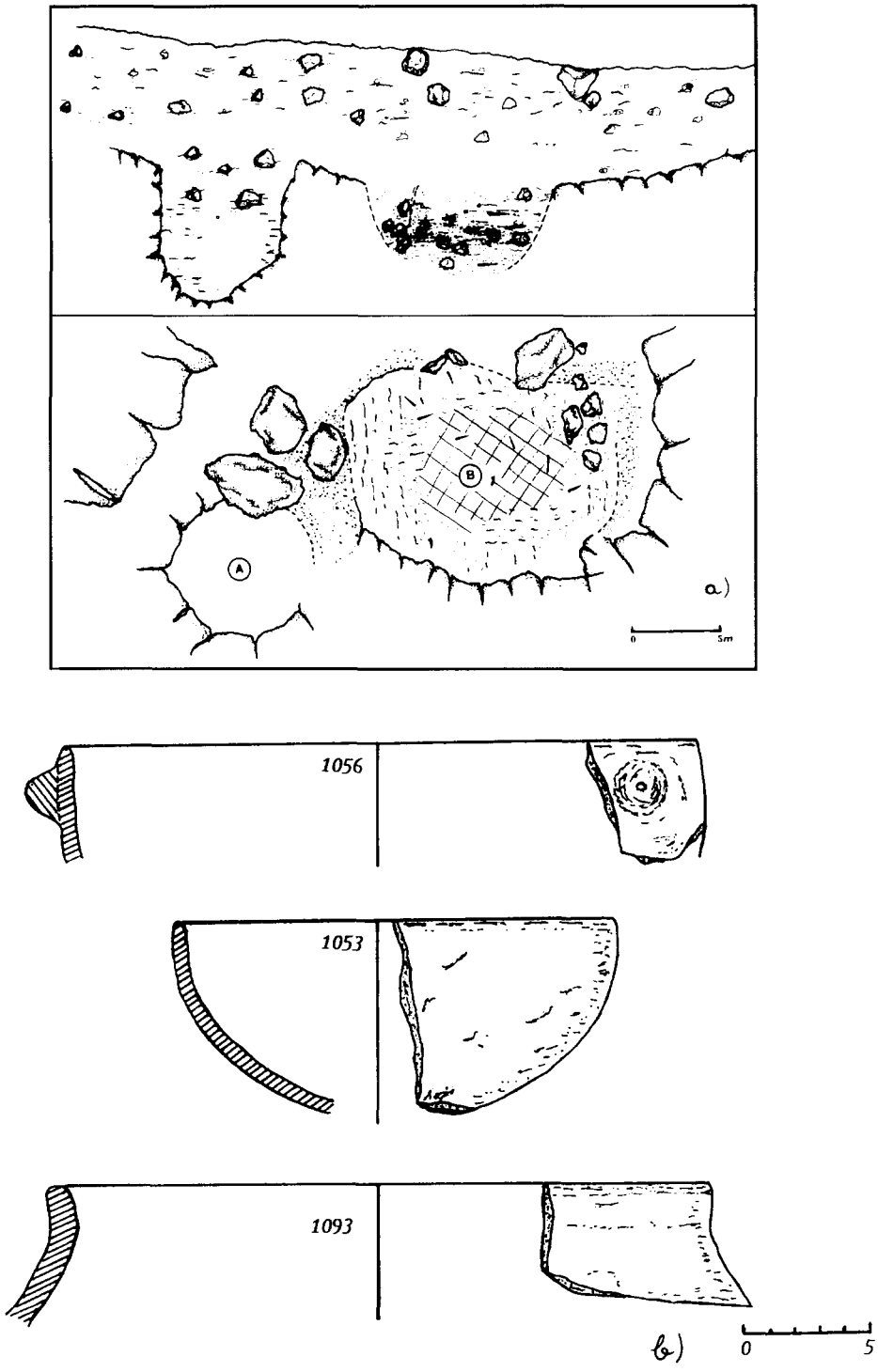

Fig. 2. (a) Section and plant of the pits A and B; (b) Detail of the ceramic samples.

performed from oriented aggregates and also after ethylene–glycol solvation and heating at 550°C [5].

3. Results and discussion

The results obtained from mineralogical composition are shown in Table 1. All samples show the presence, in significant proportions, of clay minerals, almost exclusively illite, 10 Å type (Fig. 3). The black materials are perhaps those of low-temperature heating exposure. It can be said that the basic component of original working clay was of sericitic character in which artificial mixtures with crushed quartz (clearly observed by polarizing microscopy on thin sections) had been imposed. Its processing temperature was not higher than 450°C as the black colour, developed in relation to organic matter contents, disappears at this temperature. This can explain the reddish colour outside this form and in the mamelon in terms of an external heat source exposition during cooking. Clay minerals in the lump of reddish colour, are composed of low crystalline illite, a very low crystalline smectite and probably traces of interstratified minerals difficult to determine. A trace of a 7 Å phase, kaolinite, which expands with ethylene–glycol treatment is also observed, pointing to low crystalline halloysitic mineral type. The mamelon exhibits very similar features than the lump except for kaolinite. The mineral composition described here could be explained by later weathering of the forms in the pit. The low crystallinity of illite in the reddish materials may reflect its more prolonged exposure to heat and the higher temperatures reached, which changes the original mineralogical composition to a more alterable oxide/amorphous phase constitution.

The dilatometric curve T°C vs. $\Delta l/l_0$ shows which of the material undergoes a slight shrinking up to

Table 1
Mineralogical composition (%W)

	Lump	Mamelon	1053	1093
Quartz	10	5	7	8
Calcite	8	38	10	41
Dolomite	–	6	–	5
Feldspars	<5	<5	<5	<5
Phyllosi.	82	52	76	24
Organic matter	–	–	17	20

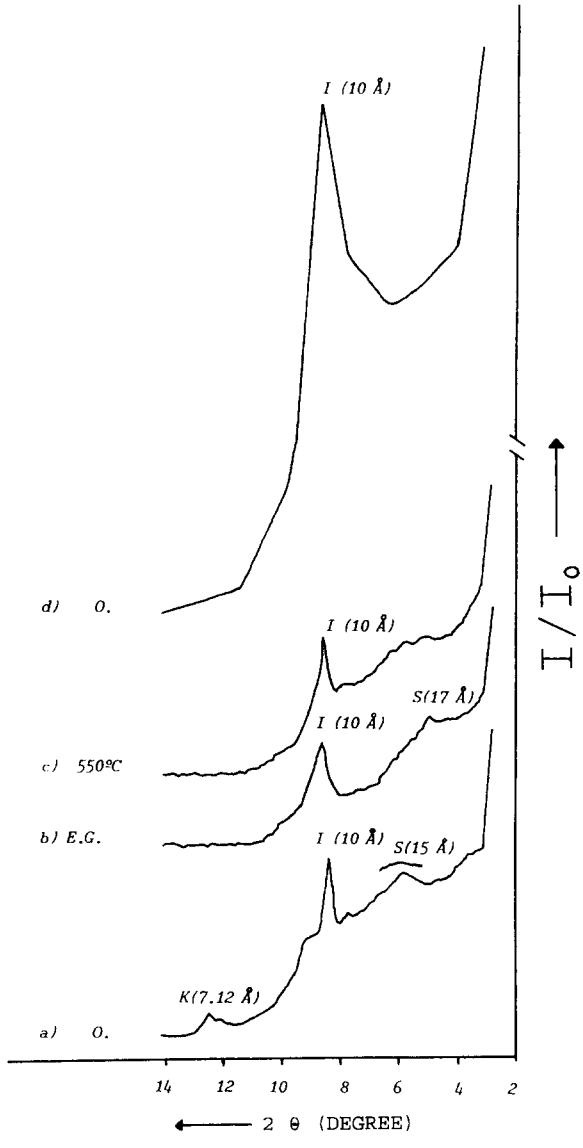

Fig. 3. X-ray diffraction patterns: (a) oriented aggregate of lump; (b) glycolated aggregate of lump; (c) calcinated aggregate of lump; and (d) oriented aggregate of sample 1093. I – illite; K – kaolinite; S – smectite.

750°C, when sinterization begins. From the curves $d(\Delta l/l_0)$ vs. T (Fig. 4), the quartz phase transition α/β, [6,7], in the cooling curve at 800°C, is observed in the lump of clay and the sample ceramic 1993.

The materials were possibly transformed and, because of dilatation or contraction process, their changes are not reversible. The carbonates do

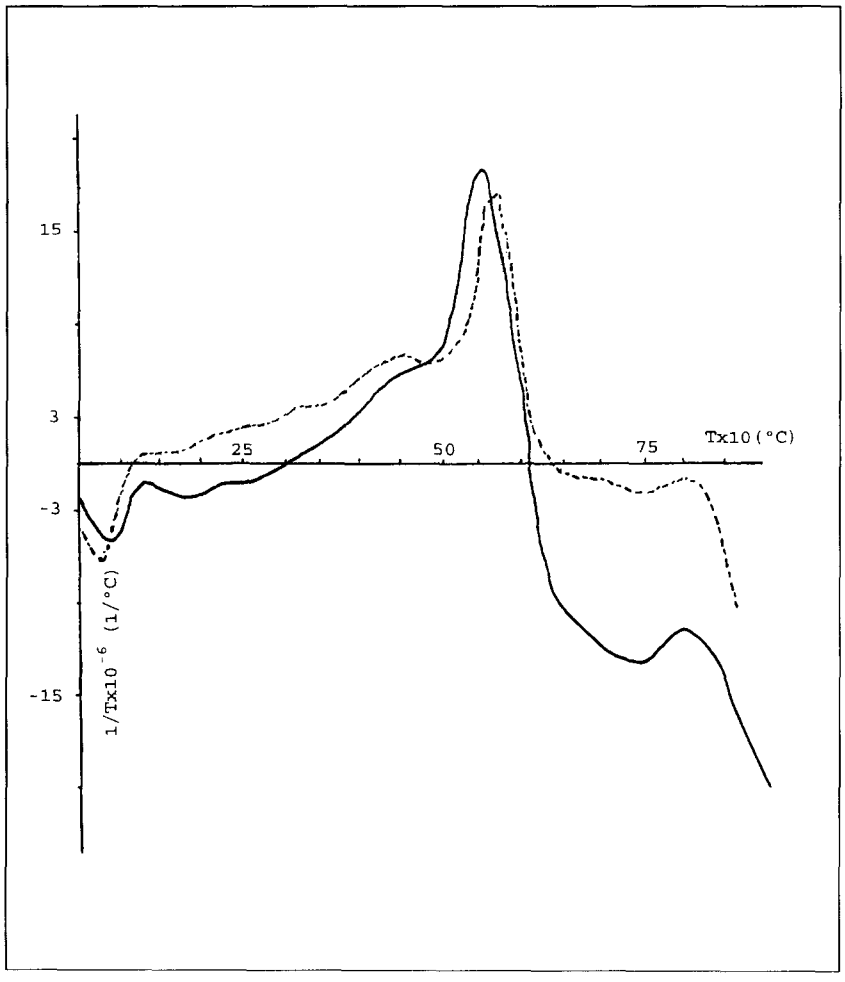

Fig. 4. Dilatometric curves: ——— lump of clay; - - - sample 1093.

not show the effects of the decomposition in the oxides.

4. Conclusions

The results obtained through the analysis performed corroborate, to a great extent, our initial hypothesis: the lump of clay found in the pit B has a composition quite similar to that of the material used for manufacturing ceramic containers found at the same level. However, these analyses have also brought up other characteristics that are related with archaeological investigations.

Although, qualitatively, mineral components of samples are the same, they are not so as far as their quality and grain size classification is concerned. Mineral analyses show that some of the minerals have been added on purpose, to do this they have been differentially ground to obtain various thicknesses, according to the requirement of the container; thus, they are very fine in containers used for eating, making them very compact and scarcely porous; for cooking containers the grains are a little thicker and the clay used has a greater proportion of mica and feldspar, making them more resistant to thermal impacts, while in storage containers the grains are still thicker, giving clays a greater consistency and making it possible to

increase the size of the container. This also corroborates the hypothesis raised in other studies performed on the functionality of ceramic containers during the Bronze Age [8,9].

Colours observed in the lump of clay and the finished container samples, which are darker, are related with the degree of oxidation of their components as well as the temperature reached. The analyses of components show a large percentage of organic matter that begins oxidation and loses its characteristic black colour at 450°C; hence, the samples studied show that the pottery containers, from which samples were taken, have not reached that temperature and they have kept their original dark colour, when the lump has exceeded 500°C; moreover, it seems that it has been subjected to repeated 'heatings' instead of continuous firing. This might be explained if the pit, in which the lump was found, was used to burn some kind of materials during ritual activities, as it can be deduced by the successive accumulations of ashes and the rather unusual concentration of bone artifacts and ornaments, The only idol found in the settlement was discovered nearby; a fact that should not be considered strange when concerned with the Bronze Age. This possibility will remain as a mere hypothesis until further analysis of the components of clay samples gathered from the various sources in the area and a comparison with the rest of the ceramic material, found in the settlement, carried out.

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