



Microchemical characterization of ancient ceramics and raw materials using nuclear and conventional techniques



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ABSTRACT

A study about pre-Hispanic and ethnographic ceramic samples of the region of Los Reyes Metzontla, Mexico (where the ancient ethnos was the Popoloca), and about the regional raw materials such as clays, tempers, and pigment in rock, is presented. Nuclear activation analyses (Sc, Cr, Fe, Co, Rb, Sb, Cs, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Th and U), energy dispersion spectroscopy (O, Na, Mg, Al, Si, S, K, Ca, Ti, Cr, Mn, Fe and Cu), X-ray diffraction, and statistical treatment of data were applied. Two groups of ceramics were identified: one of them, including pre-Hispanic brown ceramic and present-day Los Reyes Metzontla samples, is rich in chromium and cobalt; the other, consisting of pre-Hispanic Popoloca orange ceramic, is rich in rubidium and rare earth elements. Two groups of raw clays were identified as well, one from the source of Agua San Antonio, and other from the sources of several hills surrounding the town of Los Reyes Metzontla. The main differences between these groups were their contents of chromium and rare earth elements; one temper is rich in iron, the other in chromium; the natural pigment is hematite (>90%) with ca. 7% manganese. Chemical and mineralogical results imply that the pastes for pre-Hispanic brown ceramic were prepared with clays of the hills surrounding the town of Los Reyes Metzontla and with the chromium-rich temper, as were the ethnographic ones; the pastes of the Popoloca orange, on the other hand, used clays of the Agua San Antonio source and iron-rich temper. This study proposes the proportions of raw materials for the manufacturing of these pastes and, regarding the chemical composition of the pastes, presents a comparison between Popoloca orange and Teotihuacan thin orange ceramics.

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1. Introduction

The town of Los Reyes Metzontla (Fig. 1) is located in the Municipality of Zapotitlan Salinas, Puebla, Mexico (18° 13' 26.8" North, 97° 29' 7.58" and 1800 m above sea level) [1]. The town occupies a little valley and is surrounded by several hills, Metzontla and La Coronilla being the highest. The pottery manufactured in this town is recognized as being made by traditional methods that are quite possibly pre-Hispanic. Several sources of raw clay (natural material composed of clay itself, slime, sand, and fragments of rocks) are found in this region; mainly at the aforementioned hills and on Castillo Hill as well. Another source is located at Agua San Antonio (20° 33' 41.4" North, 97° 58' 44.5" West), where used to be a spring. The temper (a non-plastic material added to the clay in order to improve the ceramic paste) is a metamorphic schistose rock extracted mainly from a source called La Peña, which is located very close to Los Reyes Metzontla. The pigment used for the ceramic's finish is extracted from Tabache Hill and consists of a red powder rich in iron oxide. The geological description

of the Los Reyes Metzontla region [2] and the physical and chemical characteristics of the sources of raw clay for ceramic manufacture are given in the literature [3,4].

In pre-Hispanic times, Los Reyes Metzontla (place of dry magueys) region formed part of the Popoloca *Señoríos*; this culture was described for the first time at the beginning of the 20th century [5], and subsequently few studies were carried out about the region's archeology, history and present ethnography. In the middle of the XX century, the Popoloca people were suggested as the manufacturers of thin orange ceramic [6,7], which will be mentioned later. The archeological remains are pyramidal buildings on the hills and ancient houses that are spread over a wide area [8]. The founding of the Popoloca archeological sites of Metzontla and Buenavista (both in the Municipality of Zapotitlan Salinas, Puebla, Mexico; 19° 45' 24.6" North, 97° 34' 44.2" West and 1800 m above sea level) and Iglesia Vieja (Municipality of Tehuacan, Puebla, Mexico; 18° 28' North, 97° 24' West and 1780 m above sea level) was a consequence of the studies carried out on the potter community of Los Reyes Metzontla. Both sites, Metzontla and Buenavista, date back to the epi-classic (from ca. 650 yr. to ca. 900 yr. A.P.), whereas Iglesia Vieja dates to the post-classic (from ca. 900 yr. to ca. 1500 yr. A.P.).

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Fig. 1. Map of Puebla State. 1. Town of Los Reyes Metzontla and Metzontla and Buenavista Sites. 2. Iglesia Vieja Site. 3. Agua San Antonio Source. 4. Puebla City.

At Los Reyes Metzontla, the technique for the manufacture of fine pottery is the following [4,9]: the raw clay in small pieces is dried in the sun for several days and, still hot, is put into water in order to eliminate stones and organic material. The cleaned clay sits for 8 days or more. Independently, the temper must be first crushed and ground up into a fine powder, which is sieved twice. The cleaned clay and the temper are mixed together, and then water is added. The paste is kneaded until it attains adequate plasticity, and then it is separated into portions, which stand in dark and humid conditions for 1 to 15 days. On the other hand, the pigment is mixed with water and sits until it becomes a viscous liquid. Once the pieces have been formed and dried in the sun, a coat of pigment is applied on the surface, and then the polishing begins. Finally, the pieces are fired, whether in closed or in open-air kilns, the latter being the ancestral technique. The proportion of the clay–temper mixture, the standing times for the paste, the firing technique, and even the temperature depend on the kind of pottery to be manufactured. All processes are usually by hand.

The purposes of this research were the following: (a) to obtain chemical and microchemical information of pre-Hispanic Popoloca and present-day ceramics, as well as of regional raw materials such as clays, tempers, and pigment, through neutron activation analysis, energy dispersion spectroscopy, X-ray diffraction, and statistical treatments applied to the data so acquired; (b) to carry out a comparative study in order to establish continuity of materials and techniques for ancient and contemporary ceramics, which continuity could represent a link for a process of regional identity; (c) to contribute to the knowledge of the micro-regional history of Los Reyes Metzontla region.

2. Materials and methods

The 55 exemplars for this study include the following: (a) archeological ceramics recovered from the drilling shafts of the following sites: Metzontla ($n = 8$), Buenavista ($n = 10$), and Iglesia Vieja ($n = 8$); (b) ethnographic ceramics ($n = 8$) and one sample of prepared and unfired paste, all of them from Los Reyes Metzontla;

(c) raw clays from the hills surrounding Los Reyes Metzontla ($n = 13$) and from the Agua San Antonio source ($n = 4$); (d) two tempers, each of a different vein, from the La Peña source; and (e) one pigment in rock from Tabache Hill. These samples are described in Table 1 and some ceramic samples are shown in Fig. 2.

The outer layers of pottery samples were removed by means of a drill with a tungsten bit, whereupon samples of the pastes were taken

Table 1

Description of the samples. B: Clays; C: Archeological ceramics from the sites: Metzontla¹, Buenavista² and Iglesia Vieja³. E: Ethnographic samples from Los Reyes Metzontla. D: Tempers. P: Pigment in rock.

Key	Description	Group
B2	Prepared and unfired paste from Los Reyes Metzontla town	1
C7	Brown pot ^{*1}	
E16	Ethnographic sample Nr. 3	
E17	Ethnographic sample Nr. 6	
E20	Bottom of a light brown pot	
E22	Handle of an <i>apaxtle</i>	
E23	Body of a light brown pot	
E32	Red polished <i>cajete</i>	
E33	<i>Comal</i>	
E35	Bottom of a <i>comal</i>	
C40	Handle of a brown smooth pot ^{*1}	
C41	Body of a brown smooth pot ^{*1}	
C43	Brown smooth pot ^{*2}	
C51	Bottom of a brown polished pot ^{*3}	
C53	Rim of a brown smooth pot ^{*3}	
C58	Body of a brown polished pot ^{*3}	
C6	Gray <i>cajete</i> ^{*1}	2
C8	Orange <i>cajete</i> ^{*1}	
C9	Stamped bottom of a <i>cajete</i> ^{*1}	
C10	<i>Cholula Inciso cajete</i> ^{*2}	
C11	Popoloca Orange ceramic ^{*2}	
C12	Gray rim ^{*2}	
C39	Handle of an orange smooth pot ^{*2}	
C42	Orange polished pot ^{*2}	
C44	Body of an orange smooth pot ^{*2}	
C45	Orange polished <i>cajete</i> ^{*1}	
C46	Body of an orange fine smooth <i>cajete</i> ^{*2}	
C47	Body of an orange polished pot ^{*2}	
C48	Body of an orange polished <i>cajete</i> ^{*2}	
C49	Body of an orange smooth pot ^{*1}	
C50	Body of an orange smooth <i>cajete</i> ^{*3}	
C52	Gray smooth pot ^{*3}	
C54	Brown fine smooth pot ^{*3}	
C55	Body of an orange pot with brown slip ^{*3}	
C56	Body of an orange smooth <i>cajete</i> ^{*3}	
B1	Clay from El Barro Hillock	3
B13	Clay from Los Reyes Metzontla town	
B14	Light brown clay, Metzontla Hill, Profile 4	
B15	Light brown clay, Metzontla Hill, Profile 5	
B19	Dark reddish brown clay, La Coronilla Hill, De la Hierba Gully, Northern Hillside, Profile 2B	
B21	Gray clay, La Coronilla Hill, De la Hierba Gully, Horizon A, Profile 1,	
B24	Dark reddish brown clay, La Coronilla Hill, De la Hierba Gully, Northern Hillside, Profile 2A	
B26	Gray clay, Castillo Hill, Northeastern Hillside, Horizon A, Profile 3,	
B27	Dark reddish brown clay, La Coronilla Hill, De la Hierba Gully, Northern Hillside, Profile 2A, Rock mother #6	
B30	Gray clay, La Coronilla Hill, De la Hierba Gully, Horizon Rock mother, Bag 2, Profile 1,	
B31	Gray clay, Castillo Hill, Northeastern Hillside, Horizon C, Rock mother #8, Profile 3	
B34	Gray clay, Castillo Hill, Northeastern Hillside, Rock mother #9, Profile 3	
B36	Gray clay, La Coronilla Hill, De la Hierba Gully, Horizon C, Rock mother #2, Bag 2, Profile 1	
B25	Yellow clay, Agua San Antonio, Profile 7, Southeastern Hillside, Horizon C	4
B28	Yellow clay, Agua San Antonio	
B29	Yellow clay, Agua San Antonio, Horizon A2	
B38	Yellow clay, Agua San Antonio, Source 7	
D3	Temper, light greenish gray rock from La Peña Source	-
D4	Temper, greenish gray rock from La Peña Source	-
P5	Pigment in rock from Tabache Hill	-

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