



A diachronic study of pre-Hispanic vessels from the middle basin of Paraná River (South America) using a petrographic approach



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ARTICLE INFO

Article history:

Received 15 April 2016

Received in revised form 28 June 2016

Accepted 14 August 2016

Available online xxxx

Keywords:

Pre-Hispanic vessels

Petrography

Temporal analysis

Northeastern Argentina

South American archeology

ABSTRACT

This paper presents a petrographic study of pre-Hispanic vessels from archaeological sites located in the middle basin of the Paraná River, a geographical area where this analytical technique still has very limited application in ceramic studies. Within this framework, a first approach to the chronological variability of pottery through the analysis of 58 ceramic thin sections is carried out. The samples correspond to vessels made by complex hunter-gatherer groups between 625 ± 46 and 1.380 ± 100 ^{14}C years BP. The pottery was recovered from three archaeological sites: Arroyo Arenal 1, Arroyo Largo I, and La Palmera II (Entre Ríos Province, northeastern Argentina), which are linked to an archaeological unit locally called Goya-Malabrigo. The results show, among other chronological variations, an increasing trend in the use of grog temper over time. These data allow the expansion of knowledge about the ceramic technology of human groups who occupied the area of the Paraná River during the Late Holocene.

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1. Introduction

This paper focuses on the ceramic technology of the pre-Hispanic human groups that occupied the middle basin of the Paraná River during the pre-Hispanic period. Unlike the upper Paraná basin, where human occupation has been detected from the Early Holocene, in the middle Paraná basin it has only been recorded from the Late Holocene. Most of the archaeological sites registered in this area are associated with the archaeological unit generically called Goya-Malabrigo, which is identified in South America over the entire middle basin of the Paraná River and on a part of the lower river (Ceruti, 2003). The regional presence of these groups has been apparent on the archaeological record since 2050 ± 60 years BP (Echegoy, 1994) until the European contact period. However, it is considered that their occupation of this area became more intense during the last millennium before present (Ceruti, 2000), a time from which the number of Goya-Malabrigo sites increased significantly on the regional archaeological record.

The carbon and nitrogen levels obtained from the human bones of Goya-Malabrigo individuals show a mostly carnivorous diet, based on depleted $\delta^{13}\text{C}$ proteins linked to the C_3 photosynthetic pathway, which is in turn consistent with the isotopic values detected in the main food sources of these human groups: freshwater fish and continental mammals (Ottalagano and Loponte, 2016). Freshwater fish such as *Pterodoras granulosus* and *Pimelodus* sp. were an important part of their diet. Their subsistence also included the exploitation of

rodents (mainly *Myocastor coypus*) and some deer such as *Blastocercus dichotomus* and *Mazama gouazoubira* (e.g. Ceruti and González, 2007; Nóbile, 1993; Ottalagano et al., 2015a; Santiago, 2004; Tonni et al., 1985). Their diet was probably supplemented with some minor intake of C_3 plants (Ottalagano and Loponte 2016) such as *Cucurbita* sp., *Prosopis* sp., *Phaseolus* sp., *Ipomea* sp., and various grasses, whose micro-remains have been reported in ceramic and lithic artifacts of these groups (e.g. Bonomo et al., 2011; Colobig and Ottalagano, 2015; Cornero and Rangone, 2015; Sánchez et al., 2013).

Ceramics played an important role in their subsistence. Their use was strongly associated with processing and cooking food, also including the case of decorated vessels, which usually record traces of use, such as soot and fatty acids, as well as plant micro-remains (Colobig and Ottalagano, 2015; Ottalagano, 2013a). Predominately hemispherical shapes with simple contours are a common feature of pots, bowls, and dishes. The most usual decorative techniques are incising and painting (generally red, but in some cases white), but the main diagnostic feature of the Goya-Malabrigo style is the presence of pottery with zoomorphic appendages, usually representing parrots (Caggiano, 1984; Ceruti et al., 1980; Ottalagano et al., 2015b; Serrano, 1950). These modeled ceramic figures may have constituted symbols of group identity within a context of growing social complexity (Ottalagano, 2013a).

At the regional level, an important continuity in the morphology of the vessels and in the decorative style of the Goya-Malabrigo ceramics can be observed over time. In particular in the archaeological sites considered in this work, where technological, morphological, and stylistic studies have been carried out in detail, has been identified a generally stable pattern of the decorative, technical, and formal attributes of

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potteries in the temporary block of the 1380–625 years BP (Ottalagano, 2013a). However, little is known so far with respect to the microscopic characteristics of these ceramics, and even less about the aspects of their chronological variability. Ceramic technology related to the archaeological Goya-Malabrigo contexts has been studied extensively based on macroscopic studies (Caggiano, 1984; Ceruti et al., 1980; Ottalagano et al., 2015b; Ottalagano, 2013a; Piccoli and Barboza, 2013; Serrano, 1950, among others), but generally it lacks a systematic microscopic analysis. Petrography, which is currently considered one of the essential analytical techniques of archaeological ceramic studies (Peterson, 2009), has begun to be applied to the analysis of pottery from the lower Paraná in relation to Guaraní horticulturists and hunter-gatherer groups (Capdepon and Bonomo, 2010–2011; Loponte, 2008; Pérez et al., 2009; Pérez, 2010; Tapia, et al., 2013), and very rarely in relation to human occupations clearly regarded as being Goya-Malabrigo (Ottalagano, 2013b, 2015).

This study is based on the analysis of ceramic samples from archaeological and environmental contexts that are very similar to each other. They come from Goya-Malabrigo sites located within the same ecoregion, which includes the floodplain of the Paraná river: a sector with azonal features, where the many existing water courses generate conditions of high humidity as well as reduced levels of daily and seasonal temperature variations, aspects that facilitate the development of flora and fauna typical to the subtropical areas of northeastern Argentina (Burkart et al., 1999). This paper proposes focusing on the application of a scientific method, such as petrographic analysis, for the purpose of increasing the knowledge about the ceramic technology of the Paraná River basin, and trying to begin to establish regional temporal trends as a basis for new research questions.

2. Materials and methods

This paper includes the information generated from the analysis of 58 ceramic samples recovered from three archaeological sites located along the middle Paraná River basin (Entre Ríos Province) (Tables 1 and 2, Fig. 1). The vessel fragments from Arroyo Largo I and Arroyo Arenal I sites were recovered by Ceruti (1989), while those from La Palmera II site were excavated by Ottalagano et al. (2015a). The Arroyo Arenal I (AAI from here on) and Arroyo Largo I (ALI from here on) sites are located very close together, separated by the Paraná River course. The La Palmera II site (LPII from here on) is located ca. 70 km to the south of both sites (Fig. 1).

AAI and LPII were considered unicomponent sites, where multiple activities were performed (Ceruti, 1989, 2003; Ottalagano et al., 2015a). AAI has an AMS dating on human remains indicating a late occupation, close to the time of European contact (Table 1). Two radiocarbon datings have been obtained from the LPII site: 1056 ± 47 years BP on human remains and the other 1032 ± 47 years BP based on *Myocastor coypus* (Ottalagano et al., 2015a). ALI is also a multipurpose site, but bicomponent. Two Goya-Malabrigo occupations are recorded, which were dated, respectively, at 900 ± 120 years BP and 1380 ± 100 years BP, based on the carbon remains (Ceruti, 1989, 2003). The

later occupation of ALI, considering the standard deviation indicated by the datings, could become *cuasi* contemporary to the occupation of LPII. However, in this work it was decided to conduct an independent analysis of samples from both sites to assess any possible spatial differences of the ceramics, given the distances between the two sites and the location of ALI on an island. If we consider that the time lapse between the earlier occupation and the more recent ones is 600 to 900 years (considering the standard deviation of the datings), we can assume that several dozens of generations of artisans were involved in ceramic production, being able to generate continuities or variability on the features of the vessels.

The selected ceramics samples come from the same sectors and levels where the dated materials were recovered to ensure their association with the datings available for each site. The samples correspond to horizontal thin sections, that is to say they were cut parallel to the rims of the vessels (Woods, 1985). Macroscopic characteristics of samples from the AAI and ALI sites are presented in Table 2. Those from the LPII site were analyzed and published in Ottalagano (2015), and correspond to: plain vessels ($n = 14$), decorated vessels with red paint ($n = 9$), with incisions ($n = 8$), with red paint and incisions ($n = 1$), and with zoomorphic appendages ($n = 2$). It should be noted that the petrographic analysis carried out previously identified technological similarities between plain and decorated vessels; for this reason it was decided to group them into the same data set. On the contrary, the samples corresponding to the “coarse potteries” from LPII (locally known as *alfarerías gruesas* or *campanas*) are not considered in this analysis (samples 15, 16, 17 in Ottalagano, 2015), since these devices have pastes with specific characteristics (see also Loponte, 2008; Ottalagano and Pérez, 2013; Ottalagano, 2015; Pérez, 2010).

Thin sections were studied at magnifications of $\times 40$, $\times 100$, and $\times 400$ using a petrographic microscope, with both polarized and non-polarized transmitted light illumination. The petrographic analysis included aspects related to: (a) the matrix: percentage breakdown of the components of the paste; (b) the inclusions: type, frequency, sorting, orientation, shape, and size; and (c) voids: frequency, shape, size, and orientation. The Udden-Wentworth's granulometric scale was used to categorize the size of the inclusions (Adams et al., 1984), and Barraclough's graphics (1992) to determine their degree of sphericity and roundness, as well as their level of sorting. The density charts provided by Prehistoric Ceramic Research Group (PCRG) (2010) were used to calculate the frequencies of the various components identified. The real frequency of an element refers to their proportion in the paste, which is identified through the visual field of the microscope, while the relative frequency refers to the proportion of one particular type of inclusion in relation to the total nonplastic materials observed in a sample.

3. Results and discussion

The petrographic study of the selected samples established that the ceramics were characterized by pastes where the clay matrix was highly predominant in relation to inclusions and pores, except in few cases

Table 1
Samples considered in this study.

Samples	N	Site	Lab. code	^{14}C year BP (context)	cal AD age (1 sigma)	cal AD age (2 sigma)	Source
AAI-1 to AAI-10	10	Arroyo Arenal I (AAI)	AA102684	625 ± 46	1346–1393 ($p = 0.62$)	1284–1406 ($p = 1$)	This paper
ALI-1 to ALI-7	7	Arroyo Largo I (ALI)	INGEIS n/d	900 ± 120	1024–1224 ($p = 0.98$)	889–1299 ($p = 0.99$)	This paper
LPII-1 to LPII-14 and LPII-18 to LPII-37	34	La Palmera II (LPII)	AA102682/AA102683	1032 ± 47 1056 ± 47	966–1037 ($p = 0.91$) 961–1023 ($p = 0.82$)	893–1050 ($p = 0.88$) 882–1045 ($p = 0.97$)	Ottalagano (2015)
ALI-8 to ALI-14	7	Arroyo Largo I (ALI)	INGEIS n/d	1380 ± 100	563–724 ($p = 0.87$)	527–882 ($p = 0.92$)	This paper
Total	58						

Note: The radiocarbon dates for the Arroyo Largo I site was taken from Ceruti (2003). n/d = no data available with respect to the laboratory code.

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