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Archaeometric contributions to agropastoral production research in Aguada society (Ambato Valley, Catamarca)

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ABSTRACT

This work shows the results of a series of recently conducted archaeometric studies (camelid skeletal remains nitrogen, carbon and strontium isotopes analysis, and silicophytoliths and starches analysis to sediment recovered from cultivation terraces), to study how the economy in Ambato Valley, Catamarca, Argentina was organized from 6th to 11th A.D. For this time period and region under study, we propose the existence of an intensive integrated agro-pastoral production model, limited to a small geographic area.

Thus, through cultivated plant species identification, knowledge about camelid origins and herds management, coupled with possible manure use as fertilizer to increase agricultural production, we will have new elements to analyze the proposed model feasibility. The results obtained from isotopic studies in the valley allow us to suggest the presence of locally raised camelids, as well as camelids from outside the valley. In addition, two distinct forms of herd management, and a low use of manure as fertilizer were identified. Additionally, microfossil studies results made it possible to record crop farming that had not been already identified in the area. Although these new data allow us to maintain the validity of the previously postulated integrated agropastoral system to the valley, it is certain that it also leads us to reconsider and/or to reflect on some of its operational aspects.

1. Introduction

A central theme in Argentinian northwestern valleys and bolsons archaeology is the role played by plants and animals in the different livelihood strategies as implemented by regional prehispanic societies. The structuring and interaction of these productions far from being homogeneous, were characterized by variations over time and area (Albeck, 1993; Belotti López de Medina, 2013; D'Altroy et al., 2000; Izeta, 2007; Korstanje et al., 2015; Madero, 2004; Mengoni Goñalons, 2008; Olivera, 2001; Puentes et al., 2007; etc.). From 2006 to the present the archaeological team from the Institute of Anthropology of Cordoba, National University of Córdoba-CONICET, has been doing research in Ambato Valley to arrive to an understanding of its agricultural and pastoral production organization between the 6th and 11th century A.D. This period was characterized by the presence of Aguada settlements, and with them the beginning of a socially differentiated and unique context never seen up to now for the region under study (Dantas, 2010; Dantas et al., 2014a; Figueroa et al., 2010; Laguens et al., 2013).

Geographically speaking, Ambato Valley is in the province of Catamarca, Argentina, and forms part of the northwestern Sierras Pampeanas. It is delimited by the Ambato-Manchao (4050 masl) mountainous cord to the west, Sierra Graciana-Balcozna (1850 masl) to the east, Catamarca Valley to the south, and Altos de Singuil to the north. Biogeographically, this region corresponds to the Chaco Province Chaco Serrano district (Chaco domain) Neotropical Region (Cabrera, 1976) (Fig. 1).

Starting from the 6th century A.D., a heterogeneous internally differentiated society, developed in this valley which was identified archaeologically as Ambato Aguada culture (González, 1998), based on the intensification of the economy, the accumulation of surpluses, a marked increase in population, diversification of social roles, craft specialization, and social and political inequalities (Laguens, 2004, 2006).

In this context, and as a result of the research conducted until 2010, we proposed, the existence of an integrated agropastoral production system which would have covered both slopes of the valley. The main function of this system would have been to provide food and raw

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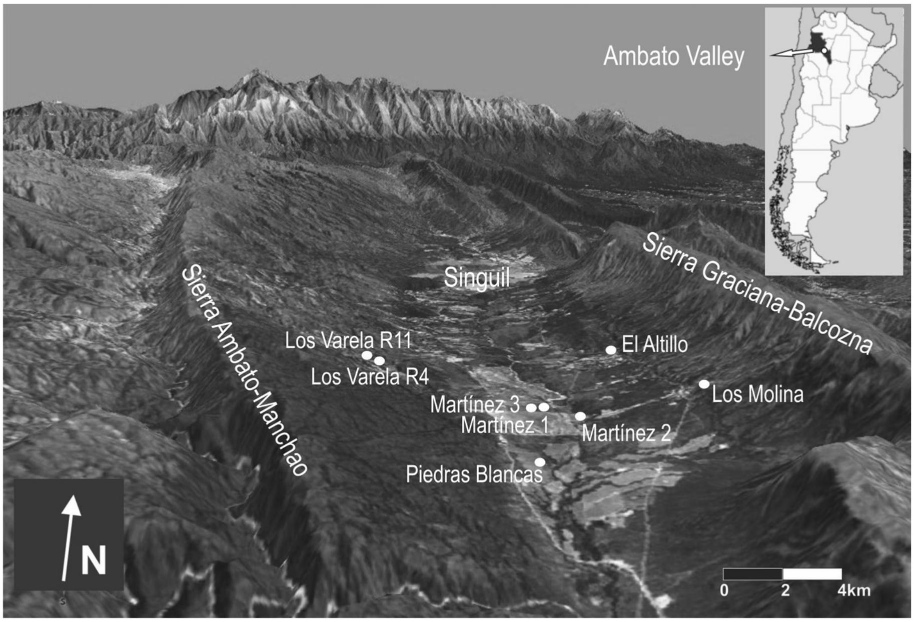

Fig. 1. Image of Ambato Valley, and the sites under study.

materials to the inhabitants of core villages located at the bottom of the valley, thus contributing to the maintenance of this new way of life (Figueroa, 2013). Such new way of production for the region, consisted of a unified camelid breeding and exclusive corn cultivation (*Zea mays*) system, targeting its infrastructure (cultivation terraces, dams, corrals, etc.) to maximize space, production, and crop production rate (Figueroa, 2012; Figueroa et al., 2010; Laguens et al., 2013; among others). The key to the system would have been based in the synergy between plants and animals, where benefits to one could not be achieved independently of the other. Some advantages to be obtained from its operation are: (a) soil improvement using fallow; (b) soil erosion prevention; (c) manure use as fertilizer for cultivated land; (d) stubble and agricultural waste use as herd food; (e) camelid use to transport agricultural products into other valley sectors or other areas; (f) livestock contribution to lessen nutritional stress during meager crops; and (g) agricultural use to resolve dietary needs in the event of a decrease in herd size.

This production system was proposed on the basis of results obtained in numerous prospecting, mapping and excavation work, ethnoarchaeological research, ceramic, stone and bone analysis, and a series of archaeometric studies were carried out such as radiocarbonic dating, experimental lythic work, microfossils (silicophytolith, starch, diatoms, etc.) and sediment physical-chemical studies (organic matter, calcium carbonate, phosphorus, etc.) (Figueroa, 2008, 2012), zooarchaeological remains carbon isotopes testing (Dantas, 2010; Dantas et al., 2014a; Izeta et al., 2009, 2010), among others.

However, despite all the information obtained, several questions still remain unanswered regarding how this model would have worked. Thus, we ponder: was exclusive maize farming throughout the entire valley, or only in limited sectors?, were all domestic camelids raised locally or were they raised elsewhere, and then taken to the valley?, were camelids obtained by trade or exchange?, was there a cyclical breeding and consumption arrangement in different areas, both inside and outside Ambato Valley?, are there different camelid consumption patterns in relationship to different consumers?, were there changes over time in camelids places of origin and breeding areas?

Following such line of thought, this work aims to address some of these questions and generate new data on discussing the feasibility of this model, and the general management of the economy developed in Aguada de Ambato. To achieve this purpose, the following pages present the results of new archaeometric studies (nitrogen isotopes), which are integrated to those previously obtained by this team (microfossils, carbon and strontium isotopes).

2. Archaeometric studies: the potential of radiogenic and stable isotopes, and microfossil analysis

Strontium is a trace element found in rocks, ground water, soil, plants and animals (Price et al., 2002). Strontium concentration and its isotope ratios vary according to local geology, i.e.: rock age and type, with the oldest rocks having the highest $^{87}Sr/^{86}Sr$ proportions, so it is used to test the paleomobility hypothesis (Bentley, 2006; Hedman et al., 2009; Knudson et al., 2004; Price et al., 2002). Strontium is incorporated into the food chain through soil, groundwater and air. In the case of animals and humans, since strontium chemical and atomic radio behavior is similar to that of calcium, it replaces the calcium in hydroxyapatite during teeth and bones development (Bentley, 2006; Knudson et al., 2004). Also, because the difference in mass between radiogenic strontium isotopes is very small, isotopic fractioning does not occur by biological processes (Knudson et al., 2010; Price et al., 2002). As a result, strontium isotopes relations found in bones reflect the isotopic composition of the geologic region where the person or animal lived (Knudson et al., 2004). Tooth enamel is formed during the first years of life, and does not change once formed, so isotope $^{87}Sr/^{86}Sr$ values obtained from tooth enamel reflect the geologic region that individual lived in during the enamel formation process. On the other hand, bones continuously regenerate, and thus indicate the last years of life. In this way, the different values between bones and teeth enamel strontium isotopes proportions in a same individual reflect changes in its geological environment, and therefore changes of residence (Knudson et al., 2004; Price et al., 2002; Thornton et al., 2011).

Just as radiogenic strontium testing is used to determine paleomobility, carbon and nitrogen stable isotopes testing allow us to study the paleodiet. Carbon is incorporated into the food chain through photosynthesis, through which plants incorporate the CO_2 present in the atmosphere (Tykot, 2006). The variability between stable carbon isotopes in plants is derived from the differences between C_3, Calvin-Benson, and C_4, or Hatch-Slack photosynthetic tracks. While tropical grasses, such as corn generally use photosynthetic track C_4, most of the terrestrial plants use photosynthetic track C_3. A third photosynthetic track: CAM or Acid Crassulaceae Metabolism characterizes succulents and cacti, which present intermediate values between C_3 and C_4 plants (Ambrose, 1993; Tykot, 2004). Bones and animal tissues isotopic composition is correlated with diet, expressing these higher values due to the assimilation process, and averaged depending on food sources from the food chain (Ambrose, 1993; Ambrose and Norr, 1993;