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Geographic variation in bone carbonate and water $\delta^{18}O$ values in Mendoza, Argentina and their relationship to prehistoric economy and settlement

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ABSTRACT

Questions of mobility, settlement pattern, and their relation to economic organization and resource use are central to ongoing work in central-western Argentina. Here we analyze geographic patterns in the distribution of 178 human bone carbonate $\delta^{18}O$ samples, 46 human tooth enamel carbonate $\delta^{18}O$ samples, and 48 water $\delta^{18}O$ samples from throughout the Andean Cordillera and Monte Desert and evaluate their implications for prehistoric mobility and economy. We confirm and refine previous generalizations regarding a highland/lowland dichotomy in water $\delta^{18}O$ values and show that the range of human carbonate $\delta^{18}O$ values generally reflect available water sources. While there is little within-lifetime change in patterns of water use, we show that most individuals have stable isotope signatures consistent with water use from multiple areas or areas other than where they were ultimately interred. These data indicate high levels of residential mobility, and we conclude by discussing their implications for our understanding of regional prehistory.

1. Introduction

Questions of mobility, settlement pattern, and their relation to economic organization and resource use remain central to archaeological studies of human adaptation (Bettinger, 1991; Binford, 2001; Kelly, 1995; Zeanah, 2004). They are particularly relevant to work in the province of Mendoza in central-western Argentina (Fig. 1), where debate continues over ethnohistoric and archaeological evidence for the presence, distribution, and interaction of hunter-gatherers and agriculturalists during the last two millenia (Durán, 2000; Gil, 2006; Johnson et al., 2009; Neme, 2007). Historic records and early archaeological work originally suggested a sharp division in prehistoric economies, with sedentary agriculturalists to the north and mobile hunter-gatherers to the south (Lagiglia, 1974, 1999; Michieli, 1983). This view has been undercut by more recent archaeological work, supplemented by stable carbon isotope analyses of human remains (Gil et al., 2006, 2009, 2010). Rather than a distinct break in economy and mobility, these studies suggest a fluid arrangement grading from greater sedentism and domesticate use in the north to more mobile hunting and gathering economies in the south.

In an effort to refine this picture, Gil et al. (in press) recently analyzed stable oxygen isotope ($\delta^{18}O$) data from 71 late Holocene burials throughout the region. Given reported variation in the $\delta^{18}O$ values of water sources in the region, the authors hypothesized that changes in economy and residential mobility would be mirrored by changes in the use of locally available water sources and the human bone carbonate $\delta^{18}O$ values derived from them. Interestingly, the study found no regional differences with either latitude or altitude, and suggested that prehistoric occupations throughout central-western Argentina were more variable and mobile than

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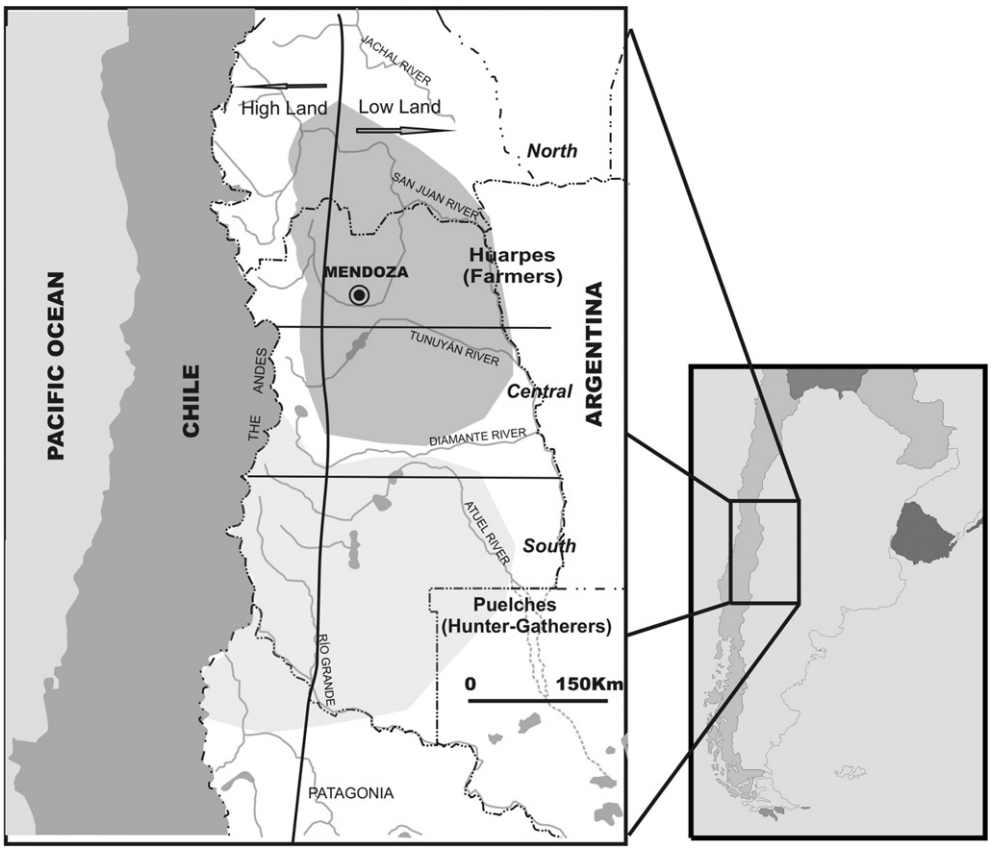

Fig. 1. Map of Mendoza, Argentina and surrounding region. Shaded areas show the approximate distribution of Huarpe agriculturalists and Puelche hunter-gatherers at the time of Spanish conquest.

previously supposed. While these conclusions are appropriate given the data, the analysis had some limitations. The number of human samples in some regions was small, no direct data from local water sources were available, and human carbonate values came solely from bones. This paper attempts to rectify these issues.

In the following sections we summarize the archaeological issues motivating the original analysis and the logic underlying the use of oxygen isotopes to study questions of prehistoric mobility. We then provide a direct analysis of deuterium and oxygen isotopes for 48 water sources throughout the Andean Cordillera and Monte Desert, confirming and refining previous generalizations regarding the distribution of water $\delta^{18}O$ values. We then analyze geographic patterns in the distribution of bone carbonate $\delta^{18}O$ values from 178 individuals in central-western Argentina, more than doubling the size of the original sample. We further show that the range of human carbonate $\delta^{18}O$ values generally reflects available water sources. Finally, we use matching enamel and bone carbonate date from 46 sets of human remains to identify within-lifetime changes in $\delta^{18}O$ and water use. We conclude by showing how these data continue to support the original inference of high residential mobility throughout the province and review their implications for our understanding of regional prehistory.

2. Background

At the heart of the current debate over late-Holocene economies in Mendoza are historic records that suggest that residential mobility in the region varied with latitude and economy. At contact, sedentary or semi-sedentary Huarpe agriculturalists occupied Southern San Juan Province and Mendoza north of the Rio Diamante (35°S; Fig. 1; Lagiglia, 1978; Michieli, 1983; Prieto, 1997–1998; but see García, 1998; Parissi, 1992, 1995 for a discussion), while Puelche and Pehuenche hunter-gatherers occupied the areas from the Diamante south to the province of Neuquén (35–40°S) (Durán, 2000; Lagiglia, 1978; Michieli, 1977). Archaeologists projected this division back 2000 years, associating its origin with the arrival of maize agriculture in the region (Lagiglia, 1974, 1999).

Recent work has complicated this picture, highlighting variability in prehistoric economies of northern and especially central Mendoza (Gil et al., 2010; Johnson et al., 2009). The late Holocene archaeological record from northern Mendoza and southern San Juan, for example, contains a variety of evidence for maize-based agriculturalists (Gambier, 2000; Johnson et al., 2009; Lagiglia, 1978). This includes maize macrofossils, more substantial architecture, more substantial internments, and larger quantities of decorated and simple ceramics from a range of vessel forms and sizes (Bárcena, 2001; Cortegoso, 2006; Rusconi, 1962). Nonetheless, isotope data from human remains in the north indicate that maize and other C_4 plants played a minor role in the diets of some and may have declined in importance after 500 years BP (Gil et al., 2006, 2009, 2010).

The archaeological record of central Mendoza accords well with more mobile hunters and gatherers, with little evidence for long term residences or substantial investment in residential structures, storage, or ceramics. There is clear, although limited, evidence of domesticated maize macrofossils however (Gil, 1997–1998, 2003, 2006; Llano, 2011). This is also reinforced by the isotopic evidence for human diet. Various collagen $\delta^{13}C$ values indicative of mixed C_3–C_4 diets ($\delta^{13}C$ −18 to −14‰) occur within the same span of time