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Insights into immigration and social class at Machu Picchu, Peru based on oxygen, strontium, and lead isotopic analysis

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ABSTRACT

The Inca Empire (AD 1438–1532) made common practice of relocating individuals, households and entire communities throughout their expansive realm for different reasons depending on subjects' assigned social class. Reconstructing patterns of immigration at Inca-period sites could therefore permit some estimation of the social class(es) among their constituents, and thereby provide insights into the functional dynamics of Inca political economy. However, this is a difficult endeavor using only archaeological lines of evidence. This study presents oxygen, strontium and lead isotopic results from the well-preserved, well-contextualized skeletal population ($N = 74$) from the Inca site of Machu Picchu, Peru. Isotopic data are used to reconstruct patterns of immigration at the site, which are in turn used to directly estimate the social class of the population. The resulting isotopic data are widely distributed with no apparent modality, matching the expected distribution of a particular class of nonelite retainers. A novel application of multivariate statistics coupled with geological and faunal isotopic reference data also permits tentative estimation of individuals' regions of origin. This study provides empirical and analytical frameworks for future research in reconstructing residential movement and class dynamics in the late prehistoric Andes.

1. Introduction

The potential for non-local immigrants among the individuals in skeletal populations is significant for interpreting paleodemographic characteristics, interpreting the distribution of skeletal pathologies, characterizing subsistence and paleodiet, and even identifying social class. However, developing empirical evidence for individual mobility and immigration in the archaeological record remains difficult. Due to the indirect nature of much available data, the variation in residential backgrounds of individuals in skeletal populations is seldom explicitly characterized and the insights gained from bioarchaeological analyses are limited.

Isotope analyses provide useful tools in assessing mobility in ancient skeletal populations, using individuals as the units of analysis within an ecological and geological context, both in the Andes (Andrushko et al., in press; Hewitt et al., 2008; Knudson and Price, 2007; Knudson et al., 2004; Slovak, 2007; Verano and DeNiro, 1993) and elsewhere (Bentley and Knipper, 2005; Carlson, 1996; Chiaradia et al., 2003; Evans et al., 2006a,b; Montgomery et al., 2003; Price et al., 1994; Valentine et al., 2008; White et al., 2004, 2000, 2002, 1998).

One region that would benefit from empirical, isotopic studies of individual backgrounds and population dynamics is Andean South America, where state-mandated migration occurred in a degree and manner not documented in other ancient states. According to ethnohistorical sources, the Inca imperial state (in Quechua, *Tawantinsuyu*) of southern central Peru commonly and forcibly relocated individuals and even entire communities throughout the realm during the Late Horizon, ca. AD 1438–1532 (Fig. 1). This strategy helped to prevent secession or outright revolt and provided an enormous labor pool for state projects and military campaigns (Pease, 1982; Rowe, 1982; Wachtel, 1982).

Movement during the Inca imperial period was often linked to assigned social class (see below). The relative representation of various social classes at Late Horizon sites provides potential insights into the nature of the site and its significance in the Inca state system, because members of different social classes were moved around the realm in distinct ways for different reasons. Some classes, such as the *acllacona* and *yanacona*, were moved as individuals; and their presence at a site suggests prestige or Inca elite influence. Other classes, such as *mitmacona* laborers, were relocated as entire villages, and their presence at a site suggests increased Inca control. During the latter decades of the empire, the Inca elite may have also used these particular social classes, whose constituents were disconnected from kin-based *ayllu* networks, to

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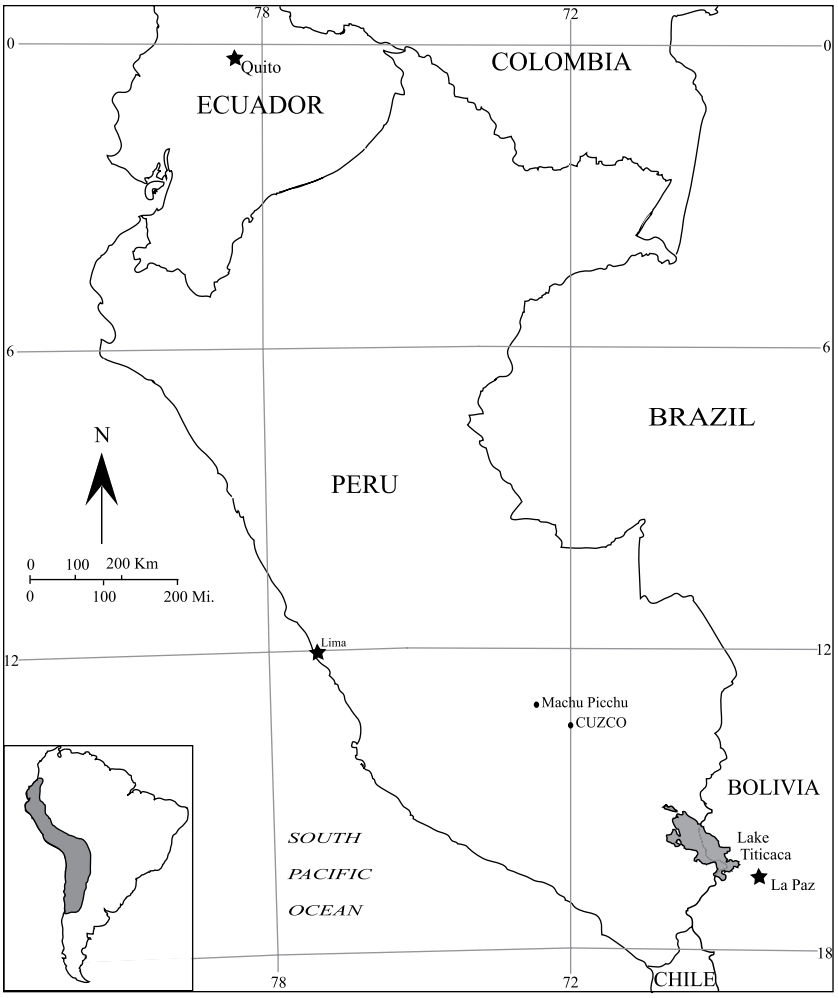

Fig. 1. Map of the Central Andes, showing the location of Machu Picchu.

circumvent traditional relationships of reciprocity with subject communities. Therefore, accurately reconstructing the movements of Inca populations is critical to understand ways in which Inca imperialism was carried out: who was moved, from where, to where, and why.

This study presents oxygen, strontium, and lead isotopic results from the well-preserved, well-contextualized skeletal population from the Inca site of Machu Picchu in the southern Peruvian highlands (Fig. 1). Oxygen isotopic ratios in preserved tooth enamel carbonate hydroxyapatite represent the isotopic ratios of imbibed water, with some enrichment through metabolic processes, during the time in which the tooth crown formed (see below). Ratios in imbibed water are in turn influenced by temperature, humidity, altitude, distance from the coast, and other aspects of the local environment. Variation in $\delta^{18}O$ across a population therefore suggests variation in sources of drinking water and indirectly, local environmental conditions. Similarly, strontium isotope ratios in preserved tooth enamel hydroxyapatite represent those of consumed foods, which in turn represent those found in local bedrock. Assuming minimal long-distance food imports, variation in $^{87}Sr/^{86}Sr$ in a population suggests variation in local geological context during the developmental period in which tooth enamel forms. Similarly, enamel lead isotope ratios represent those found in local geological sources; therefore, variation in three lead isotope ratios ($^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$, $^{20n}/^{204}Pb$ for brevity) suggests variation in local geological context during enamel formation as well, discussed in more detail below (Knudson, 2004; Price et al., 2002; Turner, 2008; White et al., 1998 present thorough discussions of O, Sr and Pb isotope systematics as they apply to bioarchaeology).

Machu Picchu was a royal estate constructed during the reign of Inca Pachacuti in the mid-fifteenth century, and was inhabited by a permanent servant population until its eventual abandonment by AD 1570, following the Spanish conquest of Peru in 1532 (Rowe, 1990). Archaeological excavations in the early 20th century recovered 177 individuals from cave interments in three major areas of the site (Bingham, 1979 [1930]; Eaton, 1916). The utilitarian nature of the associated grave goods suggests that the Machu Picchu population did not include Inca elites (Salazar, 2001); moreover, ethnohistorical accounts suggest that Inca royal mummies were attended as revered ancestors in Cuzco and other imperial centers, not interred at royal estates (Rowe, 1946). Therefore, the Machu Picchu population likely consisted of individuals from one or more nonelite social classes under the direct control of the Inca state. While several analyses of colonial documents suggest that royal estates such as Machu Picchu would have been managed by permanent *yanacona* and/or a mixed *yanacona/acllacona* population, others have suggested that *mitmacona* labor colonists or even local *hatun runa* (commoners) may have lived and worked on them as well (Rostworowski de Diez Canseco, 1999; Rowe, 1946). The analyses presented here aim to directly estimate the social class(es) present at Machu Picchu by comparing the distribution of isotopic ratios characterized in archaeological human and faunal tooth enamel hydroxyapatite to the expected isotopic distributions