Quaternary International 356 (2015) 27–38

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Trends in thermoluminescence date distributions for the Angostura micro region in Central Chile

Fernanda Falabella [a, *], Luis E. Cornejo [b], Lorena Sanhueza [a], Itací Correa [c]

[a] Departamento de Antropología, Facultad de Ciencias Sociales, Universidad de Chile, Ignacio Carrera Pinto 1045, Ñuñoa, Santiago, Chile
[b] Departamento de Antropología, Facultad de Ciencias Sociales, Universidad Alberto Hurtado, Almirante Barroso 10, Santiago, Chile
[c] Programa de Doctorado en Arqueología, Facultad de Filosofía y Letras, Universidad de Buenos Aires, Carampangue 153, piso 3, Valparaíso, Chile

ARTICLE INFO

Article history:
Available online 17 July 2014

Keywords:
Thermoluminescence chronology
Early Ceramic period
Central Chile
Bato
Llolleo

ABSTRACT

This article presents a series of thermoluminescence dates obtained from archaeological sites in the Angostura micro region, at the southern edge of the Santiago basin, an area occupied by Bato and Llolleo groups during the Early Ceramic period (200 BC–AD 1300). This series of dates, which cover a time span of around 1500 years, shows moments when dates are abundant and others when they are remarkably scant. We propose that a comparison of the relative frequency of dates can be used as an indirect measure of variations in the intensity of occupation of each of these groups in the zone. We used a summed probability analysis by decade to evaluate sets of dates according to cultural context and sectors of the study area. The results show that while the Bato and Llolleo were irrefutably contemporaneous, the Bato emerged slightly earlier, and that both –but especially the Llolleo– coexisted in later times with Aconcagua groups. At a micro regional scale significant differences as well as changes in Bato and Llolleo population dynamics were made clear. While the Bato display a natural growth curve and then declines, Llolleo increased their population significantly after AD 700, probably because of their reliance on maize crops. Not only did the chronological curves differ; the sectors where they placed their settlements varied over time depending on their specific horticultural practices, local climatic fluctuations, and each other's proximity.

1. Introduction

Since Rick (1987) proposed using dates from the pre-ceramic period in Peru to explore occupational patterns and trends, several studies have demonstrated the usefulness of using "dates as data" (Gamble et al., 2005; Smith et al., 2008; Steele, 2010; Williams et al., 2010; Bamforth and Grund, 2012; Méndez, 2013). Having a sizeable set of dates available gives the chronology new dimensions and enables the exploration of population dynamics and changes in occupational intensity over time (Kuzmin and Keates, 2005). To carry out this exploration, we present a series of thermoluminescence (TL) dates obtained from archaeological sites in the Angostura micro region, then explore their structure and discuss whether changes in the chronological record observed over time can be linked to human population dynamics at the micro regional level. This case differs in at least three ways from applications more commonly found in the literature. First, the dates were obtained using the thermoluminescence method, which has not been as widely used as radiocarbon dating worldwide, and which has different assumptions and challenges for defining the occupational probabilities of sites than ^{14}C dating. Contrary to its underutilization abroad, Chile has a longstanding tradition of TL chronology since it was introduced for dating archaeological ceramics at the Radioactivity and Thermoluminescence Laboratory of the Pontificia Universidad Católica de Chile (Román et al., 1983). Second, our scale is smaller than in the majority of studies, as the series of dates obtained for the sites analyzed comes from a limited area in Central Chile measuring around 200 km^2 and includes samples from all residential sites identified within that area. Lastly, the timeframe of 1500 years is comparatively short, and refers to a period of great diversity in which at least two distinct regional groups with different cultural identities coexisted in Central Chile, the Bato and Llolleo. These groups have been the focus of archaeological research for decades, showing that each is represented by specific cultural contexts characterized by certain types of archaeological remains constantly recurring together, as differing material expressions of everyday practices, representations, and intra-group shared ways of doing things that were reproduced over time

* Corresponding author.
E-mail address: ffalabella@vtr.net (F. Falabella).

http://dx.doi.org/10.1016/j.quaint.2014.06.049
1040-6182/

(Falabella and Planella, 1979; Planella and Falabella, 1987; Falabella and Stehberg, 1989; Sanhueza et al., 2003; Falabella et al., 2007). Differences in subsistence practices, burial patterns, and bodily ornaments, types of smoking pipes, pottery, and lithic artifacts are distinctive, although ceramic styles are especially diagnostic. While the Llolleo people were sedentary horticulturists, and the crops they grew (maize, quinoa, beans, squash) were an essential part of their diet the Bato relied more heavily on hunting and gathering and small scale quinoa horticulture, and were well adapted to semi-sedentary or mobile settlement systems (Falabella et al., 2008). Both lived in dispersed farmsteads, each of which was likely based on an extended family group (Falabella and Sanhueza, 2005–06). No significant degree of hierarchy appears to have existed among settlements. This social landscape began to change around AD 1000–1200 when a new cultural scenario, known as Aconcagua in the local sequence, was introduced in some enclaves, until it came to dominate the so-called Late Intermediate period (Durán and Planella, 1989).

The relationship between the Bato and Llolleo peoples is an ongoing debate (Sanhueza, 2013). The main drawback has been a lack of research at the micro spatial scale and low chronological resolution for occupation durations of sites. Recent research in the Angostura micro region provided data on the distribution of a significant number of sites whose dates cover the whole time span of the Early Ceramic period. The direct dating of ceramic sherds with thermoluminescence technique provided an ideal method for determining occupation durations in Angostura, where archaeological deposits are located within the plough zone, scarce organic remains are recovered, and pottery is ubiquitous and abundant.

The objectives of this paper are to analyze the series of TL dates from Angostura a) to compare trends in date distributions and intensity of occupation during the Early Ceramic period, focusing on Bato and Llolleo differences, and b) to discuss population dynamics over time in relation to socio-cultural and environmental factors.

2. Regional setting

Central Chile (32–35° S) is a narrow land, 120 km at its widest point, situated between the Andes Mountains and the Pacific Ocean (Fig. 1). The region is characterized by two north to south trending mountain ranges: the Andes to the east, reaching altitudes of 6000 m asl, and the Coastal Range to the west, with an average height of 2000 m asl and a few peaks around 3000 m asl. West of the Coastal Range is a coastal plain that can reach 5 km in width. Lying between these two ranges sits an alluvial plain, which is interrupted by foothills connecting the Andes and Coastal mountains. One of these foothills shapes the Angostura region, and delimits the Basin of Santiago to the south.

The region has a temperate Mediterranean-like climate characterized by climatic fluctuations associated with the El Niño Southern Oscillation (ENSO), and well defined seasons: cold-rainy winters (May to September) and warm-dry summers (October to March). Paleoclimatic evidence indicates that the current climate came into effect ~3200 cal BP (Villa-Martínez et al., 2003). Studies of sediment, geochemistry, diatoms (Jenny et al., 2002) and pollen (Villa-Martínez et al., 2004) at Laguna de Aculeo, adjacent to the Angostura micro region, show that beginning in approximately AD 200 the lake was affected by a series of flood events that were likely caused by abundant rainfall of up to 1300 mm annually, a sharp contrast to the 500 mm estimated for a normal year. These events alternated with drier periods in which rainfall did not surpass an estimated 250 mm annually, representing moments during which El Niño episodes were either less frequent or on a smaller scale. Three intense periods of repeated large flood events have been documented (AD 200–400 cal, AD 500–700 cal, and AD 1100 cal and following (in Jenny et al., 2002)). In another study of Laguna de Aculeo, von Gunten et al. (2009) suggest that there was a period of "hot summers" between AD 1150 and 1350, which can be associated with times of drought. In other words, the climate of this zone presents periodic fluctuations that are manifested in multi-year time spans with abundant precipitation and others of intense drought.

2.1. Angostura micro region

The micro region of Angostura lies in the southern end of the Santiago Basin. The area is dominated by the confluence of the Maipo and the Angostura rivers, and by several streams descending from the Andes mountain range that attract a diversity of plant and animal communities. Three sectors can be distinguished in terms of their natural features. Valdivia de Paine to the west, Colonia Kennedy to the east, and Águila-Peuco to the south (Fig. 1). Colonia Kennedy and Valdivia de Paine are very humid sectors, in which the saturated zone reaches near the surface. In recent times, despite the drainage systems implemented by industrial farming operations, the water table is still found at an average depth of just two meters or less, with some areas inundated year round and others with groundwater upwelling just 50 cm beneath the surface (Venegas, 2006). Geological and sedimentological studies demonstrate that in several places more or less permanent lakes have formed in the past (Rauld and Flores, 2012). One of these, at the confluence of La Berlina and Cardonal streams, was confirmed by test pits showing a well-defined organic silt layer that represents a lake deposit dated between AD 180 and 1620 (Maldonado and Abarzúa, 2013). These conditions, coupled with the presence of several freshwater springs in these zones, make the area very sensitive to changes in groundwater levels and precipitation. In contrast, in the Águila-Peuco sector, from the western bank of the Angostura River southward, there is no upwelling of subsurface water, but the sector does have a permanent supply of water as it lies along the banks of the rain- and snow-fed Peuco and Angostura Rivers.

3. Archaeological background

The micro region of Angostura presents several residential sites from the Early Ceramic period distributed spatially in the three sectors (Fig. 1). Archaeological data show that these sectors not only differ from one another in terms of their natural features, but also in the distribution of settlements and networks of social interaction. The distribution of settlements is based on archaeological investigations with systematic full-coverage surveys (Parsons, 1990) along transects spaced every 100 m that covered approximately 60% of the study area, as roads and urbanized land were not surveyed, as well as on excavations of test pits and surface collections in places with identified human occupations (Cornejo et al., 2012). These occupations correspond only to residential areas as evidenced by artifact assemblages and garbage recovered from what is left of midden deposits. Clusters of high-density concentrations of artifacts were delineated within the archaeological sites, and separated from one another by lower density buffers (Falabella et al., 2014). As Fig. 1 shows, most of the clusters are assigned to Bato or Llolleo occupations; a few of them ($n = 5$) have mixed Bato–Llolleo deposits and three have only an Early Ceramic period (ECp) affiliation. Three aspects of the archaeological information from Angostura are particularly interesting. First, the evidence shows that these groups were remarkably interlaced: their settlements were adjacent, in some cases adjoining or even overlapping. Second, residential Bato and Llolleo occupations vary widely, and include a) artifact scatters with two or more high density concentrations covering 6 ha or more that suggest permanent residence