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Application of geoarchaeological evolutionary models for the interpretation of complex archaeological structures in the central Ebro Basin (Spain)

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ABSTRACT

In landscapes that are extremely sensitive to small environmental changes, like some Mediterranean areas, archaeological contexts could present some problems to their interpretation and evolutionary reconstruction. This is the case of Los Pedregales archaeological site, located in the Hoya de Huesca (NE of Spain), where several stone mounds of unknown age and function were found in an extensive badland. The geomorphological, edaphological, and archaeological study, together with radiocarbon and OSL datings and contextualization into the geomorphological regional framework, made it possible to interpret these structures and to establish an evolutionary model. It was determined that they were silos excavated in Pleistocene sands and silts (Unit 1) during the Visigothic and Early Muslim epochs (6th-7th centuries), and that they were later filled with limestone blocks. Successive aggradational and degradational stages (Units 2, 3 and 4) during MCA (Medieval Climatic Anomaly) and LIA (Little Ice Age) periods covered and incised the area, leaving the shape of positive structures included in the badland.

1. Introduction

Archaeological sites in drylands are always subject to conservation problems that make the interpretation of their records and paleoenvironmental reconstructions difficult. This is much more evident when a harsh environment is compounded with steep slopes, erodible lithologies, and a long and complex history of human occupation. The Tertiary depressions of the Iberian Peninsula are a clear example of this combination of unfavorable factors, especially in the Ebro Basin (NE Spain). The highly vulnerable landscapes, abrupt climate changes, and the soil misuse of this environment have frequently caused hydrological responses in aggradational/degradational phases on the slopes, valleys, and alluvial fans (Peña-Monné et al., 2004; Constante and Peña-Monné, 2009; Constante et al., 2010, 2011; Pérez-Lambán et al., 2014). These anthropogenic dynamics was also observed in historical times in other areas of the eastern Mediterranean (Bintliff, 2005; Butzer, 2005; Fuchs, 2007; Zielhofer et al., 2008; Bellin et al., 2013; Dusar et al., 2011; Ackermann et al., 2014), in the SW of the United States (Huckleberry et al., 2013; Onken et al., 2014), and in the drylands of South America (Peña-Monné and Sampietro-Vattuone, 2016).

In some cases, the occurrence of multiple processes on the landscape produces particular morphologies that can be misinterpreted. This is because the degradational processes generate anthropogenic features that prompt simplistic ideas of the archaeological site genesis. Only a detailed analysis of multiple components ina geomorphological perspective, will lead to valid interpretations and a geoarchaeological reconstruction (Peña-Monné and Sampietro-Vattuone, 2014). These interpretations will also be much more complex than those initially produced. An understanding of the regional evolutionary geoarchaeological model

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facilitates a genetic interpretation, which makes it possible to articulate all, or almost all, of the components of the system in a coherent way (Peña-Monné and Sampietro-Vattuone, 2014).

The purpose of this paper is to present an application of this reconstructive process in order to solve a complex archaeological problem discovered in the Ebro Basin. This area is characterized by the presence of a large number of individual accumulations of stones ('pedregales'). These accumulations seem to be aligned and would initially appear to be stone tumuli partially collapsed by erosion. This paper presents a detailed geoarchaeological study of the structures and their environment. The identification of the type of structures, their functionality, and chronological location has shown the value of the proposed technique.

From the geoarchaeological point of view, this paper constitutes the first approach to the study of detailed complex evolutionary processes of the Mediterranean area. Archaeologically, is the first notice of this nature to the study of the transition between Visigothic and Early Muslim times, almost unknown in the NE of Spain.

2. Geological and geographical background

Los Pedregales archaeological site is located to the south of the villages of Lupiñén and Ortilla (province of Huesca), in the northern central section of the Ebro Basin, to the west of the city of Huesca (Fig. 1). The study area is part of the Pyrenean piedmont, traversed by the network of the Sotón River (a tributary of the Gállego River and part of the Ebro Basin). In this area, the Sotón River runs across a depressed plain known as the Hoya de Huesca (490 masl). This basin is cut by a fluvial network over soft Tertiary sediments. To the north, the basin is bordered by the Pyrenean front and the Tertiary conglomerates located to the margin of the Ebro River. To the south, the border is a Miocene limestone mesa (Saso Plano 584 m, La Atalaya 440 m). This type of relief (known as 'muela') is typical of the center of the Ebro basin (Gutiérrez-Elorza & Peña-Monné, 1998).

Geologically, this section of the Pyrenean piedmont is composed of Late Oligocene continental deposits (Ageniense). These deposits belong to the distal area of the alluvial fans and are formed by clays and marls with sandstone channels, as well as some limestone levels. The materials belong to the Sariñena Formation (Quirantes, 1978; Riba et al., 1983) and are part of the Torrente del Cinca-Alcolea de Cinca Unit (Del Olmo et al., 1995).

The climate of Lupiñén village, located two km from Los Pedregales, is Mediterranean continental (type Csb) according to the Köppen classification. The annual average temperature is 12.0 °C (4.3 °C in January and 20.4 °C in July). Average annual precipitations are 499 mm, spread throughout the year with small equinoctial maximums and high intensity events during the summer.

The scarce vegetation is steppe type, with common species such as *Tymus vulgaris*, *Brachypodium retusum*, *Lygeum startum* and *Stipa* sp. pl. . *serpentina is* found inside the gullies— having adapted to ruderal environments and temporally flooded areas with salty clays (Longares, 2004).

Los Pedregales archaeological site is located to the south of the Sotón River (42º09′24″N; 0º35′41″W). It is a sector crossed by several streams leading down from the southern limestone platforms and forming deep incisions in the marly clay substrate. Badlands are developed in some places. This erosion is intensified by the occasional presence of Quaternary loamy sand fluvial accumulations found in the valley of the Sotón River. The archaeological site is located inside one of these gullies, where erosion processes are increased by sand and gravel extraction, and its present use as a debris and garbage dump. These activities, along with the combination of circumstances, negatively affect site conservation. In fact, it is possible to observe a progressive degradation of the soon-to-disappear archaeological structures.

3. Methodology

This research work was developed in two simultaneous studies: a geomorphological study of Los Pedregales surroundings, from the Tertiary platforms to the Sotón River, aimed at establishing the context; and an archaeological dig aimed at determining the nature, chronology, and function of the structures.

For the geomorphological study, we first prepared a geomorphological map using ortho images from the Servicio de Información Territorial de Aragón (SITAR, 2012), aerial photographs from a 1956 American flight, and Google Earth images (2013). During the fieldwork, transversal and longitudinal profiles were made using two GPSs (Trimble Geoexplorer GNSS and Garmin Montana 650). These profiles include the slopes of La Atalaya platform and accumulation levels of the lower areas of the Sotón River. A sample of the silty sand substrate (Fig. 2) was took for OSL

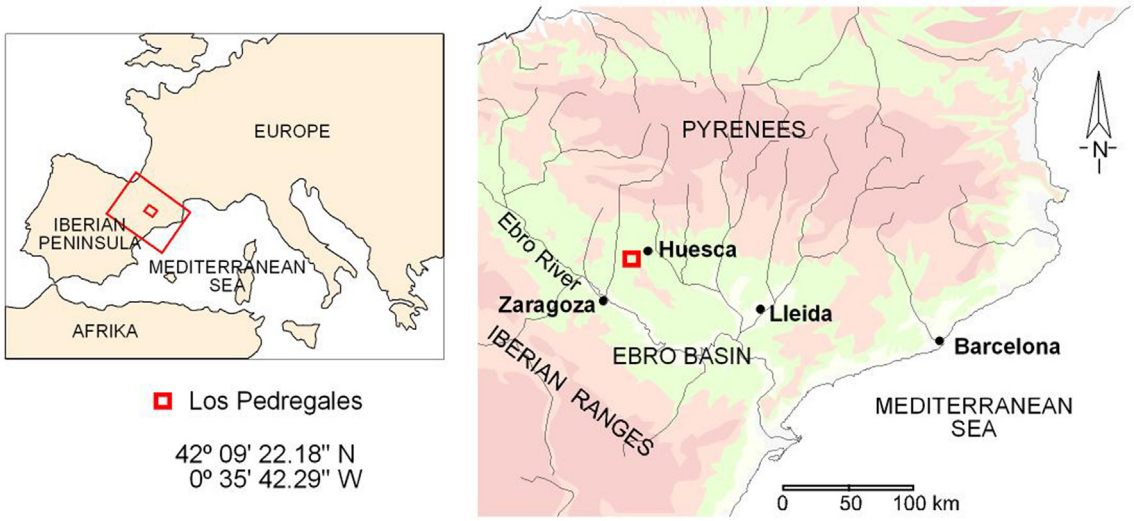

Fig. 1. Location map.

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