

# Geomorphology and stratigraphy of the Ambrona site (central Spain)

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**SUMMARY:** The Ambrona archaeological site, which lies at the bottom of a senile anticlinal polje of Iberian structural direction NW-SE, is represented by several stratigraphic members (AS1 to AS6) of the Lower Complex, composed of fluvial and lacustrine deposits. The site was formed before the southern capturing of the polje by the Masegar river, an affluent of the upper Jalón river. Geomorphologic analysis of the subsequent polycyclic development of the Masegar valley indicates that Ambrona and Torralba occupy chronologically different positions and that Ambrona is older than the Torralba site. The age of Ambrona is estimated to be older than 350 ka, once its position is correlated with dated travertine terraces of other fluvial valleys in the area.

## 1. INTRODUCTION

The Lower Acheulian site of Ambrona (Fig. 1A)–like the Torralba site 2.5 km south–occupies a singular position in the NW Iberian Range due to its relation with an Tertiary and Quaternary karstic landscape and with three large hydrographic basins of the Iberian Peninsula: those of the rivers Duero and Tajo (both Atlantic) and the Ebro-Jalón Mediterranean basin. Since the Lower Pleistocene, the river Jalón and tributaries draining the upper basin, have captured the headwater areas of the Tajo and Ebro valleys, due to their lower position base level.

## 2. GEOLOGY AND GEOMORPHOLOGY

Outcropping materials in the immediate surroundings of Ambrona, are continental and marine deposits Triassic in age, in their Germanic Buntsandstein (conglomerates and sandstones), Muschelkalk (dolomites and limestones) and Keuper (marls, limestones and gypsums) facies. Top beds are composed of carbonate deposits corresponding to the transition

to the Jurassic comprising of the Formations Dolomías tableadas de Imón and Carniolas de Cortes de Tajuña, along with other limestone units of the Upper Lias. The Cretaceous (Albian-Coniacian) is preserved to the NW of Ambrona in the syncline of La Ventosa del Ducado, and composed by sands, gravels, limestones and dolomites.

From a geomorphological point of view, the sites of Ambrona and Torralba have been related to the development of the Conquezueta-Ambrona-Torralba anticlinal polje (Pérez-González *et al.* 1997). Three general erosion surfaces were recognised, the oldest (M3, dated Miocene) and topographically highest, lies at an altitude of 1200 m. The most relevant process occurring during the Lower Pleistocene was the chemical and physical degradation of the M1 surface (1150 m). Weathering residues were drained by the Bordecorex river (Duero tributary), whose southern watershed possibly followed the Torralba village parallel, about 5 km south of its current position.

Denudation of the carbonate M1 surface led to the development of an erosion level, which coincides with the stratigraphic contact

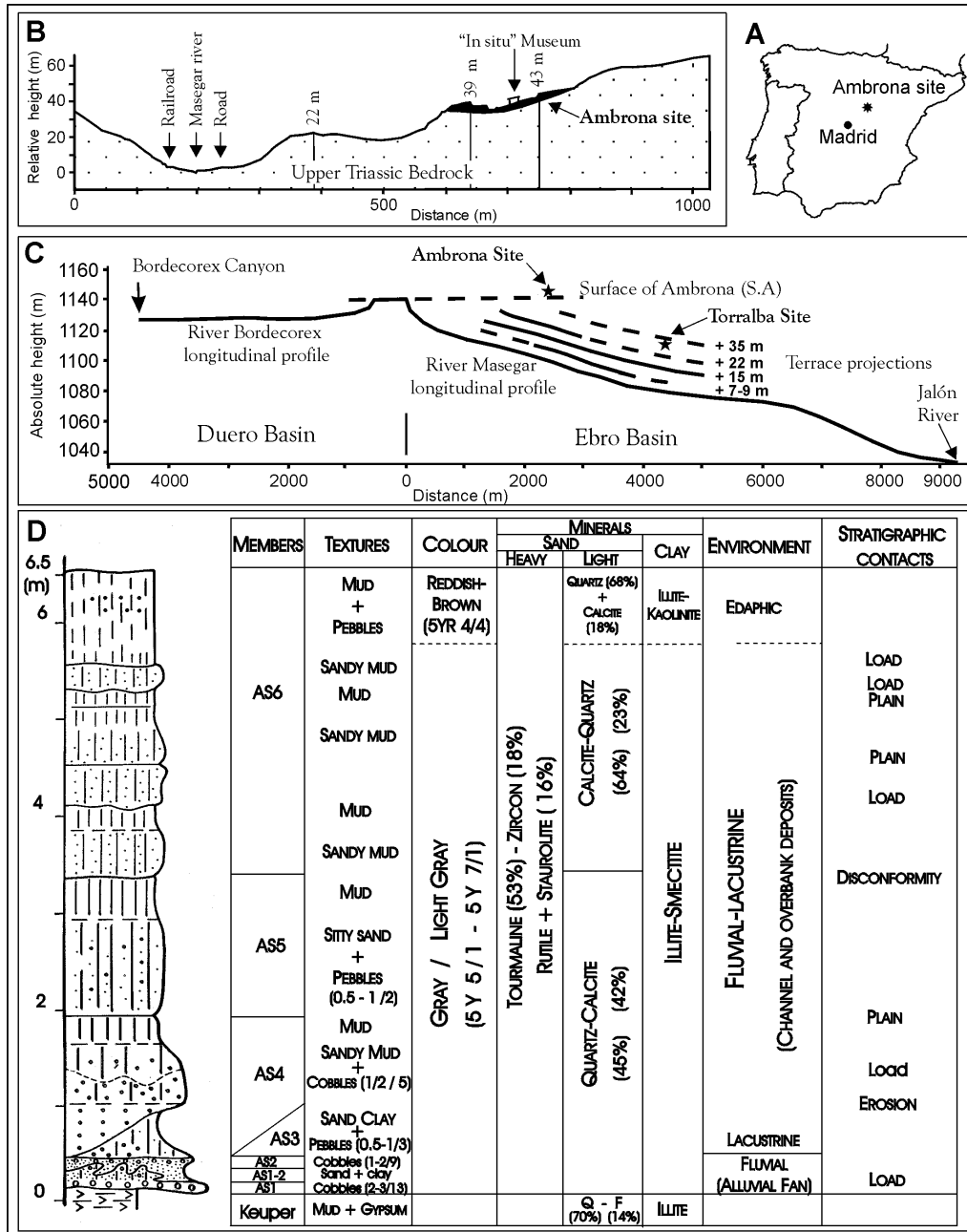


Fig.1 - Ambrona site in its geographical (A), geomorphological (B and C) stratigraphic context (D). In figure D, gravels in cm (mode/larger). Minerals: Q (quartz), F (feldspar).

between the Keuper facies and the dolomite Upper Triassic unit of the Imón Formation.

This level of local erosion at about 1140 m is known as the Surface of Ambrona (SA). The Middle Pleistocene saw the accumulation of alluvial fans and lacustrine-like deposits in Ambrona, associated with fauna and early Acheulian industry. In this setting of relative stability, the Masegar tributary of the Jalón river began its new course, capturing the valley of the Bordecorex river and progressing towards the current watershed, to the North of the village of Ambrona. This process left the Ambrona site at a relative height of 39-40 m above the channel bed of the Masegar river, at an absolute altitude of 1145 m (Fig. 1B). The development of the Masegar river valley has followed a polycyclic pattern, with bed-rock terraces at +7-9 m, +15 m, +22 m, and +35 m, and an alluvial plain at 1 m. The Acheulian site at Torralba (Fig. 1C) occupies an intermediate morphological position between the terraces at

+35 m and +22 m. It lies about 6-7 m into the +35 m terrace, with its bottom 28 m above the floodplain of the Masegar river, at an absolute height of 1115-1116 m. This means that the Torralba site is younger than the Ambrona site and, therefore, they fail to show the same stratigraphic formation.

### 3. LITHOSTRATIGRAPHIC AND CHRONOLOGICAL APPROACHES

Previous stratigraphic works (Butzer 1965, Howell *et al.* 1995) established two lithostratigraphic units, defined as the Lower and Upper Member Complexes. In the present paper, we only refer to the stratigraphy of the Lower Member Complex, which provisionally includes the top unit AS6, according to the stratigraphic division proposed by Pérez-González *et al.* (1999). Investigations underway will define a new informal Ambrona

Terrace Sequences	Atlantic Basin			Mediterranean Basin						
	Upper Henares river (Benito <i>et al.</i> , 1998)			Upper Jalón river		Arroyo Hocino		Masegar river (Pérez-González <i>et al.</i> , 1997)		
	Relative height (m)	Terrace type	Chronology (ka)	Relative height (m)	Terrace type	Relative height (m)	Terrace type	Relative height (m)	Terrace type	Site
+1-2	●	6.65±0.13 <sup>(1)</sup>	+1-1.5	●	+1-1.5	●	+1-1.5	●		
+4	● ○ ■		+7-9	●	+7-9	■	+7-9	○		
+9	● ○		+15	●	+13-15	● ○	+15	○		
+12-15	● ○ ■	120 <sup>(2)</sup>	+19-20/25	● ■	+20-25	● ○ ■	+22	○		
+20-25	● ○ ■	200-240 <sup>(2)</sup>	+42-45	●	+32-35	● ○ ■	+35	○		★ Torralba
+30-35	● ○ ■	>350 <sup>(3)</sup>	+50	● ■	+38-44	● ○				
+40-45	● ○ ■					+70	● ■			
+50-55	● ○ ■					+84	■			

Fig.2 - North-occidental Iberian Range fluvial terrace correlations and morphological and chronological position of Ambrona and Torralba. Chronologies according to: (1) Gladfelter (1971), (2) Howell *et al.* (1995), (3) Ordóñez *et al.* (1990).

Terrace type: = gravel, sand and mud, < travertine, ○ bed-rock.

Formation, composed of three member complexes (Pérez-González *et al.*, in prep.).

The lithostratigraphy of Ambrona presented in Figure 1D, corresponds exclusively to the central site area. In this sector, it is possible to define a stratigraphic column of about 6.5 m that has been subdivided into six members: AS1 to AS6. All the facies described in Figure 1D correspond to fluvial or shallow lacustrine environments. From AS1 to AS2, gravels, sands and clays facies, derived from the NE (AS1) or E (AS1/2-AS2) represent medial or distal positions of alluvial fans, in which individual fluvial channels may be identified in AS1. AS3 deposits indicate a less energetic, shallow lacustrine environment, with limits W and NW of the site. AS3 contains abundant *Elephas* fauna and artefacts. The fluvial-lacustrine deposits of AS4 erode the top of AS3, with coarse material derived from the NE, deposited at the stream mouth. Like AS5, AS4 is a fining-upwards succession. AS6 overlies AS5 presenting a stratigraphic discontinuity and is formed by the regular interbedding of two alternating lithologies with abundant gastropods. The top of the sequence is formed by a soil, of vertic type with A, Bw, and 2Cg horizons.

Faunal and Acheulian artefacts indicate middle Pleistocene age. Geomorphological correlations with travertine terrace sequences of the upper Jalón and upper Henares valleys, indicate that Ambrona is older than the terraces at +20-25 m, aged ca. 200 ka (Howell *et al.* 1995). Moreover, given its geomorphological position prior to the construction of the +30-35 m terrace, it must be over 350 ka old, although at present it is not possible to establish its age with greater precision.

#### 4. CONCLUSIONS

Excavations and detailed geomorphological analyses performed from 1993 to 2000 have provided a picture of the morphostratigraphic development of the Ambrona site and its surroundings. The lower stratigraphic levels of Ambrona are consistent with a sequence

of fluvial and lacustrine materials derived from near-by carbonates slopes of the Upper Triassic and Lower Jurassic. Moreover, Ambrona represents a cultural and environmental milestone of the last developmental stages of a morphostructural-karstic corridor, 15 km in length and 1 km wide, which interlinks Atlantic and Mediterranean basins. Further, the site is older than the capturing of this corridor by the Masegar river, a left bank affluent of the river Jalón. Ambrona may be broadly correlated with terraces at a relative height of +40 m above present channels that have been dated as over 350 ka.

#### 5. REFERENCES

- Benito, A., Pérez-González, A., Santonja, M. 1998. Terrazas rocosas, aluviales y travertínicas del valle alto del río Henares (Guadalajara, España). *Geogaceta* 24: 55-58.
- Butzer, K.W. 1965. Acheulian Occupation Sites at Torralba and Ambrona, Spain. Their Geology. *Science* 150: 1718-1722.
- Galdfelter, 1971. *Meseta and campiña landforms in Central Spain. A geomorphology of the Alto Henares Basin*. Research Paper 130. Univ. of Chicago.
- Howell, F.C., Butzer, K.W., Freeman, L.G., Klein, R.G. 1995. Observations on the Acheulean occupation site of Ambrona (Soria Province, Spain), with particular reference to recent investigation (1980-1983) and the lower occupation. *Jahrbuch des Römisch-Germanischen Zentralmuseum Mainz* 38: 33-82.
- Ordóñez, S., González, J.A., García del Cura, M.A. 1990. Datación Radiogénica (U-234/3-238 y Th-230/U-234) de sistemas travertínicos del Alto Tajo (Guadalajara). *Geogaceta* 8: 53-56.
- Pérez-González, A., Santonja, M., Gallardo, J., Aleixandre, T., Sesé, C., Soto, E., Mora, R., Villa, P. 1997. Los yacimientos pleistocenos de Torralba y Ambrona y sus relaciones con la evolución geomorfológica del polje de Conquezueta. *Geogaceta* 21: 175-178. Madrid.

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Pérez-González, A., Santonja, M., Mora, R., Soto, E., Sesé C., Ruíz Zapata, M.B., Aleixandre, T., Villa P., Gallardo, J. 1999. Investigaciones recientes (1990-1997) en los yacimientos achelenses de Ambrona y

Torralba (Soria, España). Aproximación al Complejo Estratigráfico Inferior de Ambrona. *O Arqueólogo Português*, 13/15 (1995-1997): 11-34.