

INTRODUCTION TO THE PLEISTOCENE SITES OF BARRANCO LEÓN,
FUENTE NUEVA 3 AND OTHER SITES FROM THE ORCE AREA (GUADIX
BAZA BASIN, SPAIN).

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1-GEOLOGICAL FRAME

The Guadix-Baza Basin is located in the Betic Ranges (Southern Spain, see figure 1) and covers a large extension (approximately 3000 km²). This basin is located in the contact area between the External Zones (mainly Mesozoic cover rocks) and the Internal Zones (Mainly Paleozoic basement rocks) of the ranges. This basin (see general sedimentary schemes by Fernández et al., 1996, Soria et al, 1998) was filled by marine sediments during part of the Tertiary. Several changes that took place by 8 Ma (Hüsing, work in progress) led to the continentalization of the basin.

The Plio-Pleistocene continental sediments of the basin display thick sections with abundant paleontological sites in well exposed outcrops with horizontal bedding and scarce tectonics. Such sediments can clearly be differentiated belonging to either a proximal or distal paleogeographic domain. The alluvial Guadix Formation (Viseras, 1991) and the lacustrine Baza Formation are the most extensive within the proximal and distal domains, respectively. The lacustrine environments also include the Gorafe-Huélago and Solana formations, restricted to the Guadix sub-basin (Vera, 1970). The location of the lacustrine environments (Viseras, 1991) was the result of changes in the drainage fluvial system (including an axial system and transverse systems). The stratigraphic study of the sedimentary formations (particularly in the north east of the basin, see figure 2) allows a high resolution physical frame for the Plio-Pleistocene faunal succession (see Oms et al., 2000a, among others). Paleontological and archaeological sites are mainly located in shallow lacustrine facies of the Baza Fm, close to the basin margin. This is the case for Venta Micena, Barranco León, Fuente Nueva III and Cúllar Baza sites. In the lacustrine Solana Formation, the archeological and paleontological site of La Solana de Zamborino is also found. Apart from the basin fluvio-lacustrine fill, the karstic ranges bounding the Guadix-Baza depression host important Pliocene-to present day cave-fill sites (Moreda, Píñar, Cueva Horá etc.).

2-STRATIGRAPHY AND PALEOENVIRONMENT OF THE BARRANCO LEON AND FUENTE NUEVA PALEONTOLOGICAL-ARCHAEOLOGICAL SITES

The Lower Pleistocene paleontological-archaeological open air sites of Barranco León (Turq et al., 1996) and Fuente Nueva-3 (Turq et al., 1996; Martínez-Navarro et al, 1997) are located in the Orce area, NE Guadix-Baza Basin. In this area the lacustrine deposits of the Plio-Pleistocene Baza Formation (Vera, 1970) crop out extensively and are arranged in three members (Vera et al., 1985; Oms et al., 1998): Lower Member (lacustrine, calcareous deposits), Middle Member (alluvial, detrital deposits) and Upper Member (lacustrine, silty calcareous deposits). Figure 2 (up) provides a map of this areas and figure 3, most representative sections with significant sites.

The Upper Member in the Orce - Fuente Nueva area originated basically during the Lower Pleistocene as a result of a major expansion of the Baza lacustrine system. This age is based on the abundant mammal sites (Oms et al. 2000a) together with paleomagnetic data, which record deposition under reverse magnetic polarity(Oms et al. 2000b, among others). Lithologies are lacustrine carbonates and mudstones and clastics to the top (sands and gravels with abundant ostracods). In this member, abundant pedogenic features related to shallow lacustrine and palustrine environments that underwent episodic emersions are found. Salinity changes are also well recorded in these marginal lacustrine deposits by changes in the invertebrate fauna and the geochemistry of biogenic carbonates, mainly from ostracods (Anadón et al., 1986, 1987, 1994; Anadón and Julià, 1990, Gabàs and Anadón, 1998, Anadón and Gabàs 2009). During some episodes the salinity was very low due to freshwater inputs derived from the surrounding prominent reliefs of Mesozoic carbonates. The Upper Mb of the Baza Fm includes several paleontological levels such as Fuente Nueva 2 and 3, Barranco León, Venta Micena, Barranco de Los Conejos, Orce D, etc. Some of these sites, which also have yielded some lithic artifacts (Barranco León and Fuente Nueva 3) are located very close to the ancient lake margin.

The archaeological level at Barranco León (BL-5 Turq et al., 1996; Oms et al., 2000a, see figs 3 to 5) is 0.05 to 0.65 m thick. It is formed, to the base, by sandy gravels which have yielded lithic artifacts and mammal bones. The upper part is formed by grey sands. This level is included in a sequence of grey to yellow sands, mudstones and limestones. The gravels in BL-5 are mainly formed by angular pebbles to small cobbles of palustrine, intrabasinal limestones. Pebbles from Mesozoic rocks are rare. The invertebrate fauna of BL-5 indicates a fresh to oligosaline shallow lacustrine environment. This level is included in a shallow lacustrine sequence which also records some fluvial inputs, and local emersions. The recorded salinity ranges from fresh-oligosaline in the underlying levels to mesosaline in some overlying levels.

The Barranco León site is located in a larger section (see Figs 3 and 4) which provides an excellent record of the paleoenvironmental conditions in the lake margin. The lower unit (Middle, red detrital Mb of the Baza Fm) is formed mainly by alluvial deposits, 30-40 m thick, which consist of red to yellow carbonate lutites with interbedded sandstones and conglomerates, and minor gypsum. Lacustrine deposits, 25 to 30 m thick, mainly form the Upper, silty calcareous Mb of the Baza Fm. They include limestones, dolostones, lutites, sandstones and conglomerates. The Plio-Pleistocene marginal lacustrine deposits at Barranco León, contain rich limnic faunas, including the presence of foraminifers and molluscs of thalassic affinity, that record saline and freshwater environments (Anadón et al. 1987; Anadón and Gabàs, 2009). Stable isotope and trace element contents of ostracod valves from the Barranco León allowed reconstructing the geochemical record of environmental changes in this marginal area of the basin (Anadón and Gabás, 2009). The hydrochemical features recorded in the upper levels of Barranco León have been influenced by changes in water source, solute composition, and water level during the past. Three water types that underwent a complex mixing in the marginal area were deduced from the studied intervals: 1) waters of the main Baza lacustrine system that underwent large precipitation - evaporation changes, 2) dilute, meteoric water inputs (surface and shallow groundwaters), 3) saline groundwater inputs of meteoric origin that acquired their salinity by halite and gypsum dissolution.

Concerning the paleolimnological record of Barranco León, four stages have been differentiated in Anadón and Gabàs (2009). Stage I records a lacustrine expansion phase from the Pleistocene inner saline-lake system (type 1 water) to the marginal, alluvial mud flat zones in the Orce–Venta Micena area (highstand episode). This is

recorded by the lower beds of the carbonate sequence. Stage II corresponds to an overall retraction of the lacustrine system leading to shallow ponds in the marginal areas that were probably fed by bicarbonate-rich springs (type 2 water) derived from the Mesozoic carbonate ranges. A major emersion event is recorded in the BL area by a top paleosoil. Stage III is characterized by wide ranges in the trace element data and isotopic composition of the ostracod valves, reflecting evaporation (concentration) and dilution episodes in a shallow, closed-lake environment. The transition from stage III to IV corresponds to a major hydrochemical change and significant lowering in the isotopic composition of the ostracod valves. Stage IV is characterized by a strong influence of isotopically dilute waters and a through-flowing open lake environment that accounts for the small variation in geochemical features of the ostracod calcite. This through-flowing open lacustrine system in the marginal area of the Baza Basin was fed by groundwater and streams and it was connected to a larger, inner closed saline lacustrine system. The BL 5 mammal site with lithic tools corresponds to a particular episode within this stage of the environmental evolution of this marginal zone of the Baza Basin.

The stratigraphic succession in the FN-3 site (see figures 2 down, 3 and 6) is formed by a basal limestone level which is overlain by calcareous mudstones with pedogenic features. The mudstones, 3.7 m thick, are overlain by limestone beds up to 1m thick. The basal limestone consists of nodular lithofacies, with abundant pedogenic features and pseudomicrokarst, and conglomerate lenses. All these features indicate a palustrine environment of deposition. The mudstone beds contain, apart of mammal bones and, in some levels lithic artifacts, an abundant invertebrate fauna, mostly ostracod valves and mollusc shells and opercula. The invertebrate fossils record some minor changes in water salinity from fresh water to oligosaline and low mesosaline, in a shallow lacustrine-palustrine environment (Anadón et al., 2003).

3-THE MICROMAMMAL SUCCESSION OF THE GALERA ORCE-FUENTE NUEVA SECTOR

The rich microvertebrate record from the Guadix-Baza Basin has enabled the establishment of a detailed biozonation, primarily based on rodents (Agustí, 1986; Oms et al., 2000a; Agustí et al., 2007). Therefore, for the time-span covering the late Pliocene and the early Pleistocene, up to five biozones can be distinguished. The late Pliocene includes the biozone with *Kislania gusii* (localities of Galera 2 and Zújar 14; Agustí et al., 1993 a and b) and the biozone with *Mimomys cf. reidi* (localities of Alquería, Galera 1H and Fuente Nueva 1).

The lowermost Pleistocene is represented by the biozone with *Tcharinomys oswaldoreigi*. It includes the sites of Barranco Conejos, Orce 2 and Orce D (Agustí, 1992; Agustí et al., 1993a).

Following this biozone, the early Pleistocene sequence continues with the biozone with *Allophaiomys ruffoi*, which includes the famous site of Venta Micena and other levels such as Cañada de Murcia 1, Fuente Nueva 2 and Orce 7 (Agustí et al., 1987 a and b). The second half of the early Pleistocene starts with the biozone with *Allophaiomys aff. lavocati*, which includes the sites of Barranco León 5 and Fuente Nueva 3, where the first evidences of human presence have been reported (Martínez-Navarro et al., 1997; Oms et al., 2000b; Toro et al., 2003). It includes also the site of Orce 3.

Following this biozone, the early Pleistocene ends with the levels included in the biozone with *Iberomys huescarenensis*, which includes the sites of Huéscar 1, Puerto Lobo and Loma Quemada (Mazo et al., 1985; Agustí et al., 1987 c).

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FIGURES

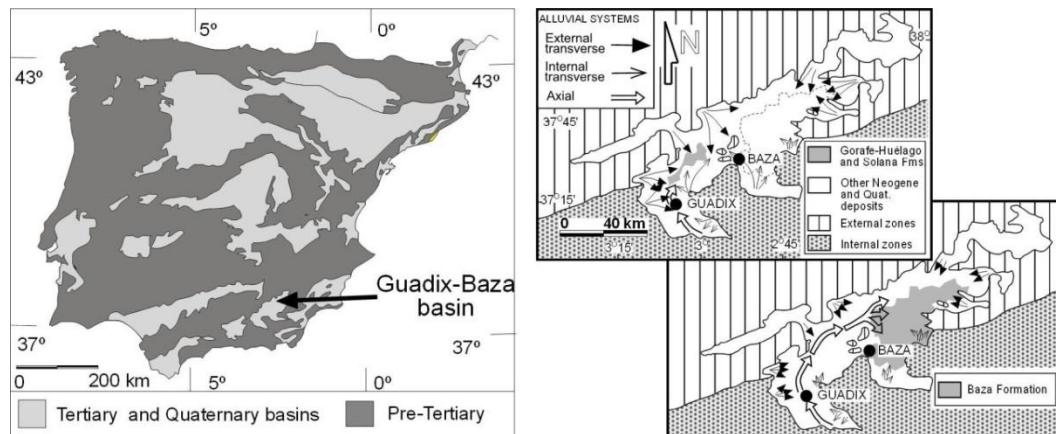


Figure 1. Left: the Guadix Baza Basin in the Context of Tertiary and Quaternary basins of the Iberian Peninsula. Right: extension of the lacustrine sedimentation (Gorafe-Huélago, Solana and Baza formations) according to the dominant alluvial system (after Viseras 1991).

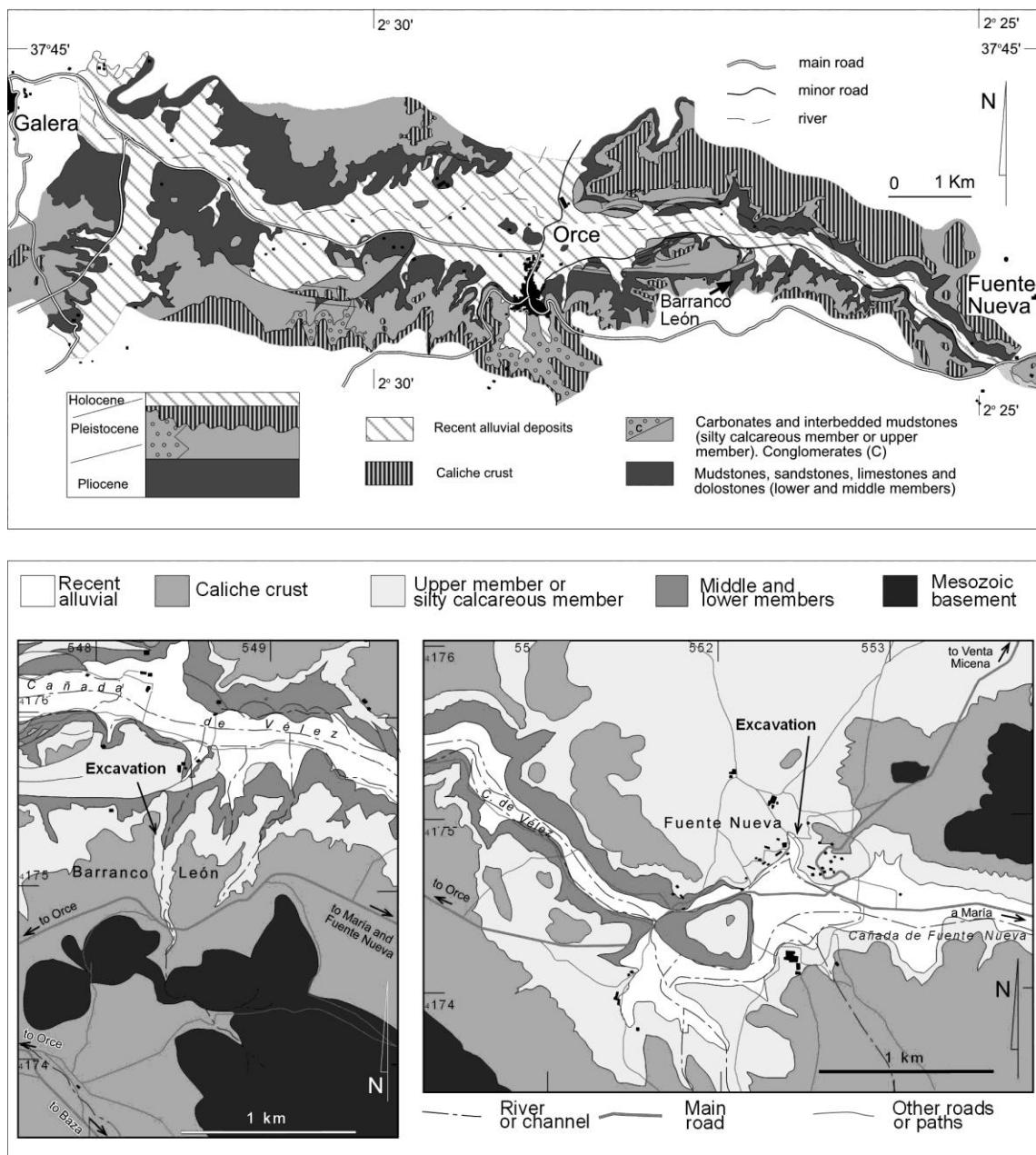


Figure 2. Up: Geological map of the Galera – Orce – Fuente Nueva sector (after Oms et al 2000a). Down: detailed geological location of the Barranco León and Fuente Nueva 3 sites (left and right, respectively).

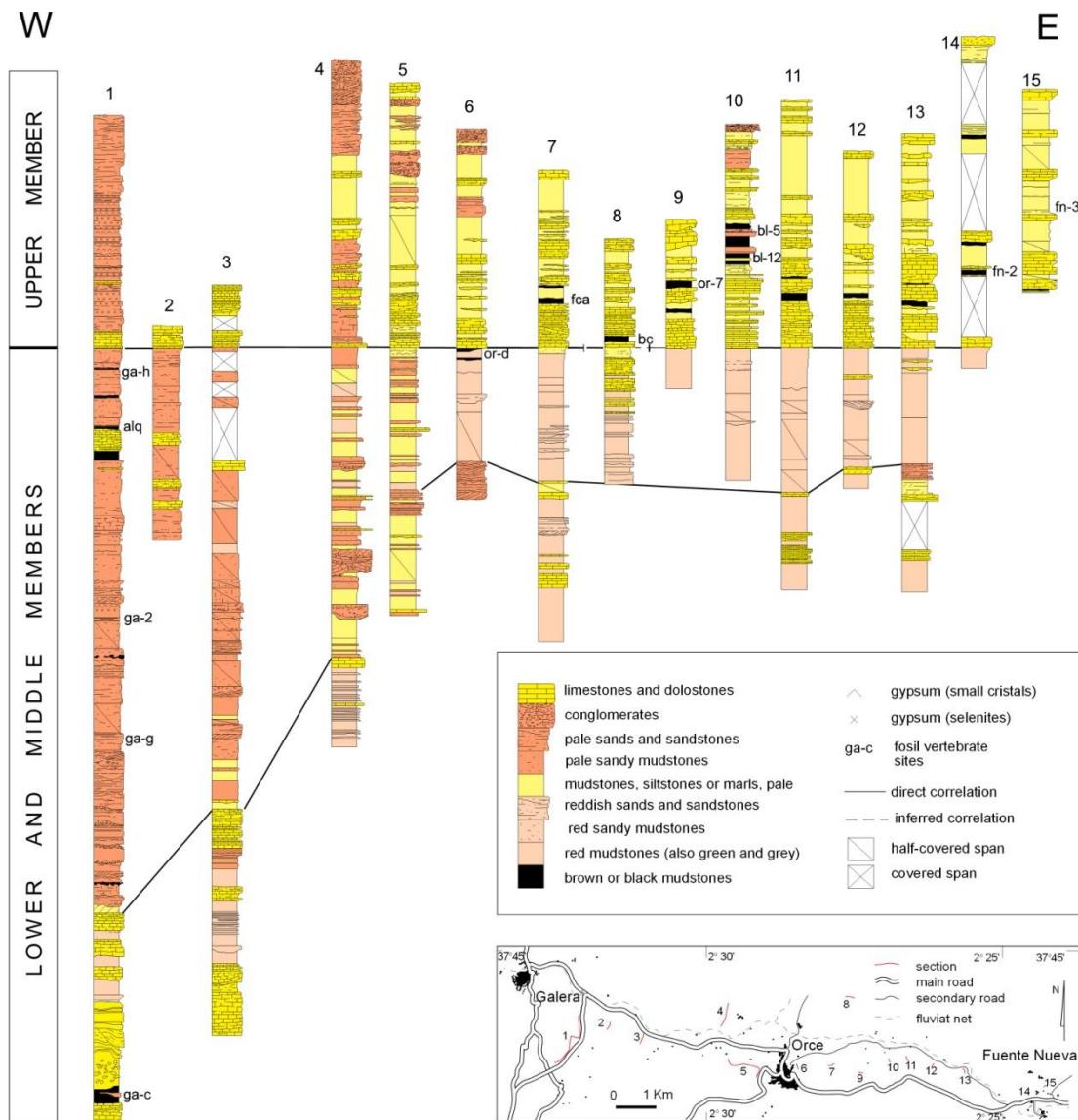


Figure 3. Selected stratigraphic section from the Galera – Orce – Fuente Nueva sector (adapted from Oms 1998, Oms et al., 1998 and Oms et al 2000a). Section 10 and 15 contain the Barranco León and Fuente Nueva 3 sites, respectively.

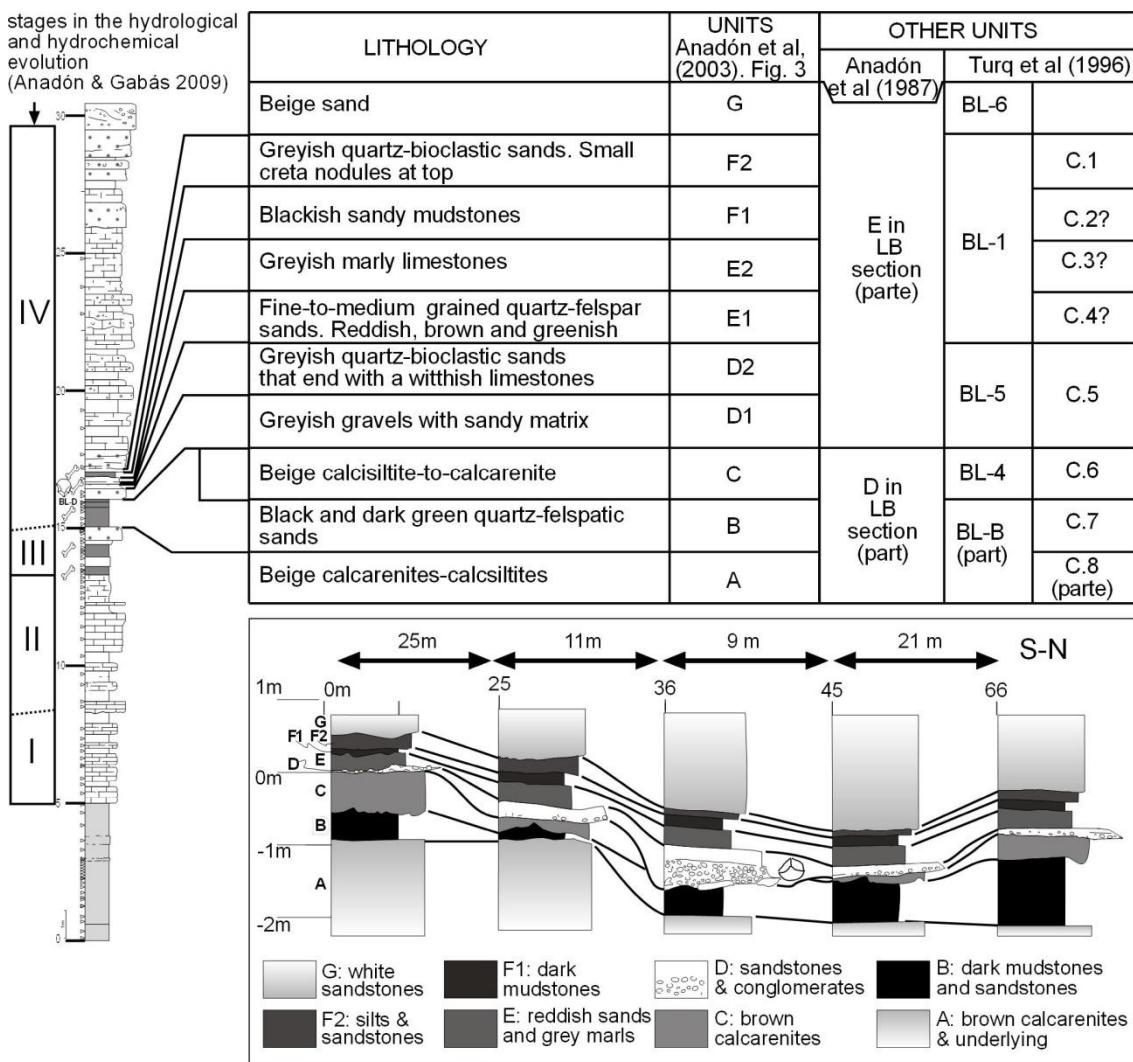


Figure 4. Vertical stratigraphy of the Barranco León section and site. From left to right: Stages in the hydrological hydrochemical evolution (Anadón and Gabás, 2009), lithological section and nomenclature in several other works. The stages boundaries by Anadón and Gabás (2009) are in solid (exact) or dashed lines (approximate), since these units are projected from a section studied some 100 meters to the south of the site.

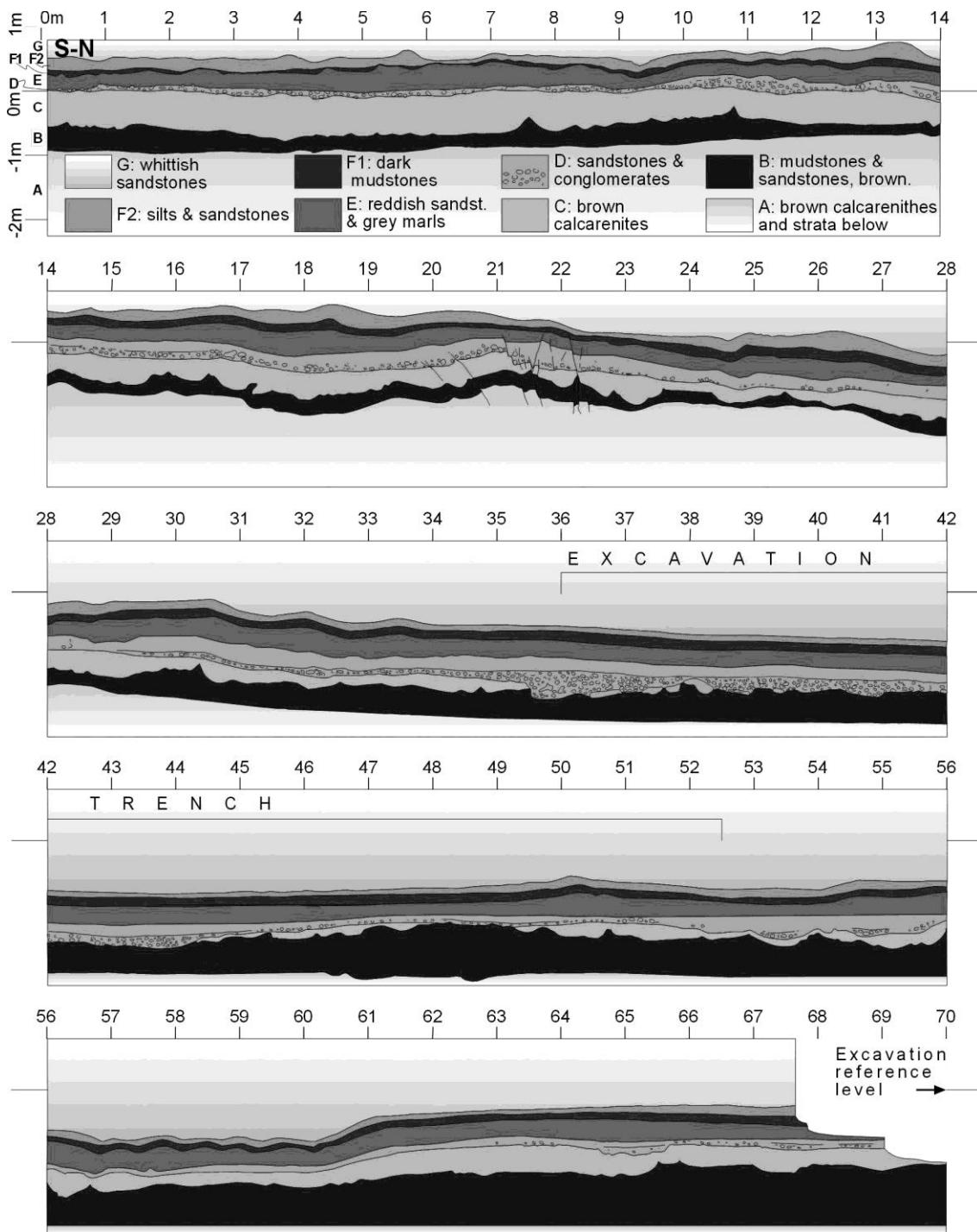


Figure 5. Geometry of BL-5 archaeological and paleontological site (level D) and stratigraphically related levels in a S-N section (adapted and improved from Anadón et al., 2003).

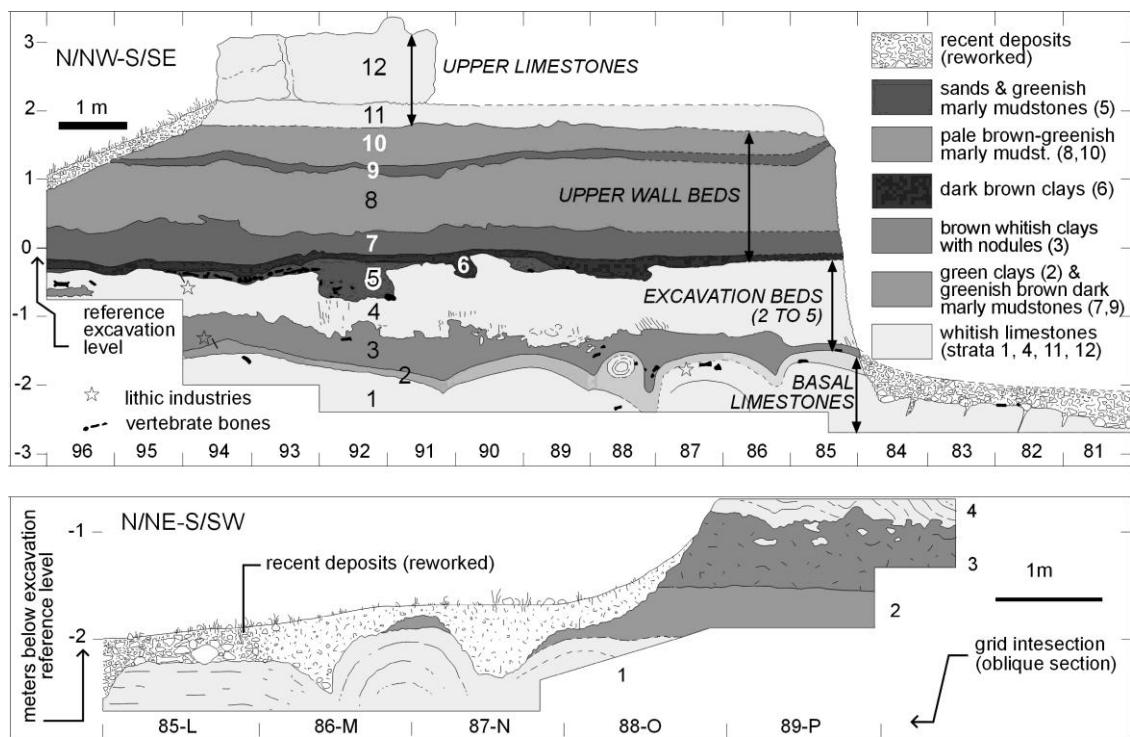


Figure 6. Stratigraphic units and lateral variations of Fuente Nueva 3 paleontological – archaeological level and section. Lower levels (basically from 1 to base of 4) are projected towards the rest of the section (see detailed description in Anadón et al., 2003).

		GUADIX-BAZA BASIN	NORTH-CENTRAL & EASTERN EUROPE
		SITE	RODENT SEQUENCE
PLIOCENE	PLEISTOCENE	Cúllar C	<i>Terricola arvalidens</i> <i>Stenocranius gregaloides</i>
		Huéscar Puerto Lobo	<i>Iberomys huescarensis</i> <i>Mimomys savini</i> (large)
		Barranco León 5 Fuente Nueva 3 Orce 3	<i>Allophaiomys aff. lavocati</i> <i>Mimomys savini</i> (small)
		Venta Micena Orce 7	<i>Allophaiomys ruffoi</i>
		Barranco conejos Orce 2	<i>Tibericola vandermeuleni</i> <i>Tcharinomys oswaldoreigi</i> <i>Mimomys n. sp.</i>
MIDDLE	LATE	Alqueria, Galera H	<i>Mimomys cf. reidi</i>
		Galera 2 Zújar 14	<i>Kislangia gusii</i> <i>Mimomys medasensis</i>
		Zújar 10	<i>Kislangia ischus</i> <i>Mimomys polonicus</i>
	EARLY	Tollo de Chiclana 1B	<i>Mimomys hassiacus</i>
		Galera 1C	<i>Dolomys adroveri</i>
		Gorafe A, 1	<i>Trilophomys</i> <i>Promimomys</i>

Figure 7. Late Pliocene to Middle Pleistocene Biozonation of the Guadix-Baza Basin based on rodents.