Drainage system inversion in the Guadalentin Depression during the Late Pleistocene – Holocene (Murcia, Spain)

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RESUMEN

Este artículo expone los resultados de los estudios realizados en el sector central de la Depresión del Guadalentín (Murcia) respecto a la acumulación anórmala (mas de 17 m) de los depósitos pleistocenos y holocenos aguas arriba del umbral tectónico de Romeral (Librilla). Dataciones ^{14}C, restos y yacimientos arqueológicos, junto con su análysis estratigráfico muestran que las tres secuencias detríticas holocenas que constituyen el relleno de la Depresión, se encuentran superpuestas y progradan sobre los travertinos del Pleistoceno superior aguas arriba de la confluencia del río Guadalentín con la Rambla de Librilla. Entre el Librilla y el umbral de Romeral, solo parecen los depósitos holocenos a lo largo de la margen izquierda (15-17m). Por el contrario, la margen derecha muestra levantamiento significativa de los travertinos pleistocenos hasta la zona del umbral de Romeral, donde aflora el sustrato neógeno. En este escenario, no solo las fluctuaciones climáticas (cambio de régimen de precipitaciones) han jugado un papel importante, sino que fue más determinante la actividad de la falla ciega de Romeral entre 6340±60 BP y 3885±60 BP provocando cambios de nivel de base intracuencales que aceleraron el proceso de erosión remontante e inversión del drenaje en el interior de la Depresión, facilitando el tránsito entre las condiciones endorreicas a las exorreicas, ya durante el Holoceno reciente.

Palabras clave: Evolución fluvial, Cuaternario reciente, paleoclima, falla activa de Romeral, Depresión Guadalentín, Cordillera Bética.

INTRODUCTION AND METHODS

Numerous investigations have analyzed alluvial deposits along the Guadalentin Depression in the context of Late Pleistocene and Holocene climatic change, active tectonics and land use impact on changes in fluvial behaviour and drainage evolution (Walker and Cuenca-Payá,1985 ; López Bermúdez F. and Thornes J.B. 1986; Silva *et al*., 1992, 1996, 2008; Calmel-Avila, 1999, 2000, 2002, 2007). This paper is focused on the analysis of the El Romeral Fault and its impact on drainage inversión/diversión within the Guadalentín Depression.

The Guadalentin River drains an intramontane basin of 60 km long from Lorca to its eventual junction with the Segura River (Murcia) and 6-10 km wide. The present climate is semi-arid with pronounced yearly dry periods (c.a. 5 months) and with an average rainfall of 290 mm/yr at the Librilla Sector, generating a relevant hydrologic déficit with impact on the high. irregularity in river discharges. The Guadalentin Depression is a tectonic basin defined by some of the more prominent active left lateral strike-slip faults (Lorca-Alhama and Carrascoy Faults, Fig.1) of the Betic Cordillera displaying evidence of activity for Late Pleistocene-Holocene times (Silva et al., 1992, 2004). A third fault cross transversally the Depression intersecting the Guadalentin drainage at the El Romeral sector (Fig.1). It corresponds to a buried fault detected by geophysics and geomorphologic methods (Martínez Díaz and Hernández Enrile, 2000; Calmel-Avila, 2007).

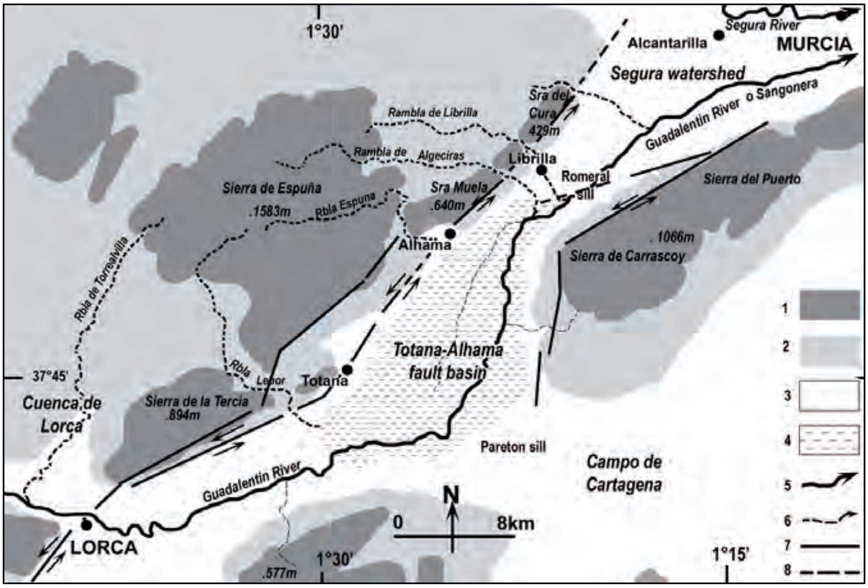

Figure 1. Map of the Guadalentin Depression showing the Romeral Fault zone at the Librilla sector. 1: Mountains; 2: Foothill; 3: Lowlands (Depressions); 4: Palaeolacustrine environments; 5: Guadalentin River; 6: Torrential semi-arid drainage (*ramblas)*; 7: Faults; 8: Buried faults.

The Depression is segmented in two different sectors separated by El Romeral rock bar developped on uplifted Tortonian conglomerates along a presently buried fault (Calmel-Avila, Fig.1). Upstream the Rambla de Algeciras-Guadalentín junction, the valley floor width increases from c.a. 6 km to 10 km, with a total incision of about 10-11 m (Alhama basin). Between the junctions of the Algeciras and Librilla ramblas, the thickness of alluvial deposits increases (up to 15-20 m thick) until Romeral rock bar. Eventually, downstream El Romeral, embanking and deep river incision of disapear after a relevant river gorging onto the uplifted Neogene bedrock. These data indicate that El Romeral rock-bar played a relevant role on the Pleistocene-Holocene drainage evolution of the studied area.

Near-vertical cut-slopes in alluvial deposits along the river and its tributaries (Algeciras and Librilla ramblas) have been examined. The stratigraphic observations were complemented by detailed grain-size analyses of numerous samples taken in every studied section. Remains of human settlements, archaeological artifacts, and C^{14} dating of charcoals helped to establish a temporal sequence of fluvial aggradation-incision within the Guadalentin Depression.

RESULTS AND DISCUSSION

The analyzed stratigraphic sections record six different alluvial units (fig.2). *The oldest* (**unit 1**) constitutes the valley floor which outcropping downstream the Algeciras junction. It is mainly constituted by differentially hardened travertine deposits. Gley processes associated with a fluctuating water table favoured the precipitation of iron oxides and carbonates along the dense root-mat systems generating a travertine unit of c.a. 7 m thick (Fig. 2b). Downstream the Librilla junction, this unit overtakes 15 m thick, but only along the right bank of the river. This unit terminates against El Romeral rock bar, where the top of this unit is +20 m above the present river bed (Fig. 2c). ^{14}C dating indicates that the top of this unit holds a Late Pleistocene age between 32,890±140 BP and 31,115±160 BP, and sedimentary facies suggests a low energy and relatively humid lacustrine environment. **Unit 2** cuts these older deposits and only outcrops from the Algeciras junction, upstream El Romeral. This unit is 3 m thick, displaying sandy and gravel facies with cross-bedding structures and cobbles providing evidence for a high energy torrential environment. It was presumably deposited during a period of higher river discharge after a long time of incision. There are not available dating for this unit, but can be tentatively ascribed to the Terminal Pleistocene (≤16-14 Kyr BP). **Unit 3** cuts and overlaps by aggradation the previous unit 2, with a maximum thickness of 6-7 m. It is constituted by laminated silty clay with interbedded fine sands providing evidence for a low energy alluvial distal plain environment. Several Neolithic settlements has been dated within this unit (from 6340±60 BP to 4305±55 BP; Fig. 2c; Calmel-Avila, 2002; Silva et al. 2008). **Unit 4** also cuts and overlies the previous unit 3, displaying a thickness of 8 m with clear torrential sedimentary facies, suggesting partial exoreic drainage from the Librilla Rambla to the Sangonera-Segura Rivers in the north. This unit contains Chalcolitic artifacts and paleosoils horizons with archaeological settlements giving ^{14}C 3885±60 BP. In El Romeral site this unit is affected by an anomalous flexure (30°) in relation to an active fault at this place (Fig. 2c). **Unit 5** is the last large manifestation of aggradation of Holocene Period filling paleovalleys carved in the previous units and even overlapping the previous surface of unit 4 between the Algeciras and Librilla junctions (Fig. 2). This unit yields a ^{14}C age between 2520±50 BP and 2505±BP and corresponds to Final Bronze and Old Iron Age. Related sedimentary facies indicate relevant and rapid water discharge around the Algeciras and Librilla area junctions.

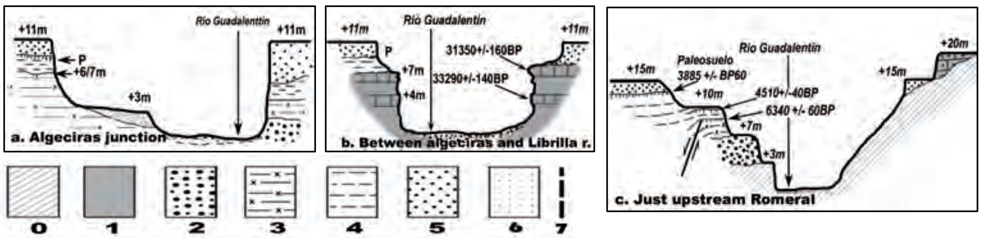

Figure 2. Cross sections (a, b, c: usptream to downstream) along the Guadalentin River displaying the assemblage of the different Late Pleistocene-Holocene alluvial units described in this paper. 0: bedrock; 1: Late Pleistocene *unit 1*; 2: Terminal Pleistocene-Holocene *unit 2*; 3: Meso-Neolithic Age *unit 3*; 4: Copper Age *unit 4*; 5: Final Bronze and Old Iron Age *unit 5*; 6: Medieval Age *unit 6*; 7: Buried active Fault.

CONCLUSIONS

The stratigraphic sequence within the Central sector of the Guadalentin Depression records relevant drainage changes from the Late Pleistocene. Late Pleistocene conditions led the development of large lacustrine to palustrine environment with production of travertine deposits. From this badly drained environments the present exoreic drainage system were established along several different stages. First evidence of incision of the travertine levels during the Late Pleistocene are only evidenced at the Librilla-El Romeral sector. Subsequent evolution illustrates the reestablishment of endoreic (Algeciras) to semi-endoreic (Librilla) conditions during the Early to Middle Holocene. During this period distal alluvial aggradation were punctuated by short incision period controled by paleoclimatic fluctuations. During the Late Holocene fluvial drainage has been conditioned by two main factors: a) Activity of El Romeral Fault during the Chalcolithic period resulting in intrabasinal base-level change backfeeding accelerated headward erosion upstream; b) Climatic deteriorations with an intensification of sporadic rainfalls capable to support headward erosion over the time. Both processes gave place to the initial capture and limited coupling of the Guadalentin-Librilla zone drainage and the Segura River watershed throughout the narrow gorge carved throughout the uplifted rock bar at El Romeral.

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