Marine Geology 406 (2018) 12–26

Contents lists available at ScienceDirect

Marine Geology

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

Modelling the mid-late Holocene evolution of the Huelva Estuary and its human colonization, South-Western Spain

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ARTICLE INFO

Editor: E. Anthony

Keywords:
Mid-late Holocene
Palaeogeography
Huelva Estuary
SW Spain
Radiocarbon dating
Tempestite

ABSTRACT

The major changes that occurred in the southwestern estuaries of the Spanish Atlantic coast during the last 6500 yr BP were simultaneous to human settlement and therefore the understanding of their coastal evolution will help interpreting human patterns in these areas. The study of the morpho-sedimentary features of new outcrops appearing in the middle sector of Saltés Island (Huelva Estuary, Spain) has been used to develop a model to understand the complex evolution of sand barriers than can be applied to similar inlets along the Atlantic Iberian coast.

The first human settlements (6000–4000 yr BP) in the early Huelva Estuary (Tinto and Odiel rivers) were located in the ancient coastal banks or in the nearby hills. From 4000 yr BP onwards, the estuarine sediments started to emerge as sand barriers and chenier plains, prograding towards the mouth. As the littoral strands stabilized morphologically, they were colonized by human settlements in successive periods, the oldest inland (Almendral) and more recent outward (Cascajera). The study of the upper sedimentary layers of La Cascajera barrier display a tempestitic sequence of landward progradational washover-fans. The calibrated and modelled AMS dates in marine shells provide a storminess time range between the second half of first century BCE and the entire first century CE.

Sedimentary records are useful to evaluate environmental changes, either from natural or anthropogenic causes, such as global and climate change. The interrelationship between the archaeological findings (mainly salting fish factories and old ports) and the morpho-sedimentary evolution at the mouth of the Tinto and Odiel rivers allows us to highlight not only the Huelva Estuary's dynamics evolution, but also the possible regional patterns of human habitation from the beginning of the present sea-level highstand (middle Holocene).

1. Introduction

The confluence of the Tinto and Odiel rivers constitutes the *Marismas del Odiel* Natural Park (Fig. 1) and it represents an excellent example of a mid-late Holocene sedimentary infill system of a discrete tidal estuary known as the Huelva Estuary (southwestern of Spain, Western Europe). Many coastal changes have occurred after the last Postglacial sea-level highstand, including the stabilization of the coastal dynamics and the terrestrial environmental changes affecting run-off and sediment transport (c.f. Borrego et al., 1993; Zazo et al., 1994; Morales, 1997; Goy et al., 2003; among others). The coastal plain and near-shore environments offer a very dynamic geoarchive which holds the key evidence to better understand the relationships between marine and terrestrial records. The studied geoarchives include lagoonal,

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https://doi.org/10.1016/j.margeo.2018.08.008
Received 21 April 2018; Received in revised form 25 August 2018; Accepted 27 August 2018
Available online 31 August 2018

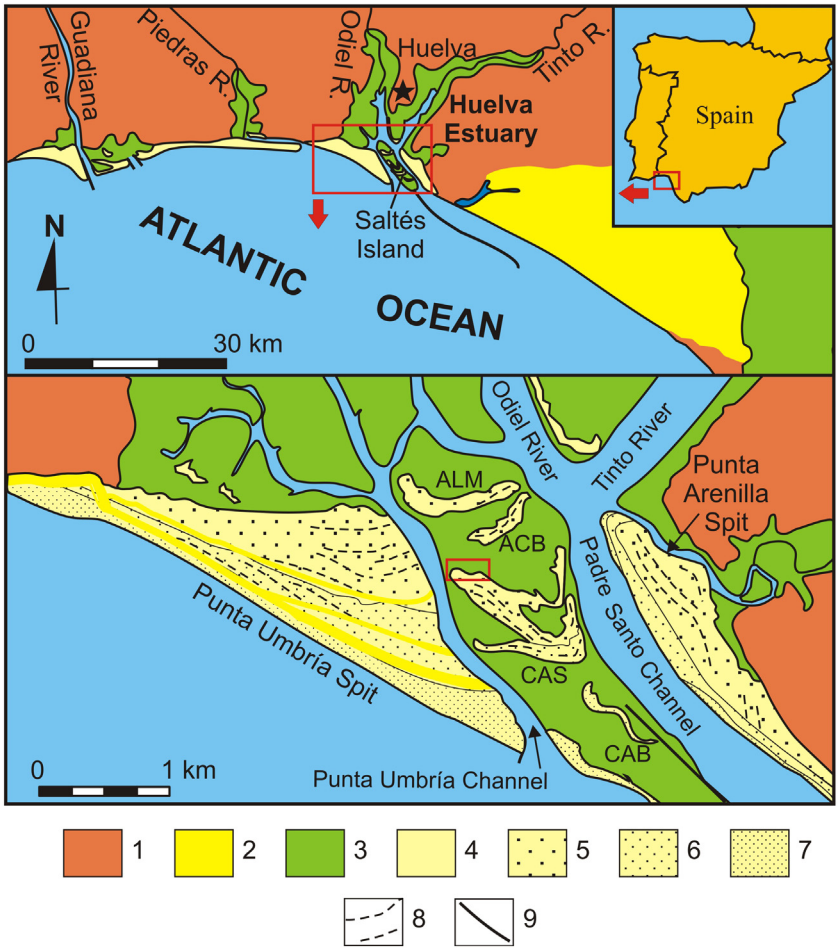

Fig. 1. Geographical setting of the Huelva Estuary, showing both Tinto and Odiel rivers and Saltés Island. Sandy barriers in Saltés Island: ALM, El Almendral; ACB, El Acebuchar; CAS, La Cascajera; CAB, Cabezo Alto. The third red rectangle is the location of the Fig. 2. Key: 1. Pre-Holocene substrate, 2. aeolian units, 3. marshland, 4. sand barrier and spits (general), 5. H_2 unit of sand barrier and spits progradation, 6. H_3 unit, 7. H_4 unit, 8. beach ridges, 9. jetty. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

aeolian, intertidal and marine sediments preserved within a diversity of geomorphic features including dunes, spit-barriers, back-barriers and estuaries. On the other hand, as many significant archaeological sites are placed in coastal locations, understanding the land-sea interaction is key to better comprehend human settlement patterns (c.f. Campos et al., 1999, 2002; Alonso et al., 2007, 2009; Silva et al., 2009; Rodríguez-Vidal et al., 2011, 2014; Grützner et al., 2012; among others).

In this context, the Holocene geological record of littoral areas has experienced an increasing multi-disciplinary research over the last decades. Thus, there has been considerable improvement in the knowledge related to the evolution of these environments including sea-level changes (at the regional and global scale), palaeoclimatology and the human settlement pattern vs environment interaction (Borrego et al., 2004; Vilanova et al., 2006; Selby and Smith, 2007). This has favoured the continuous development of coastal geoarchaeology in many countries. However, geomorphological, sedimentological and palaeoenvironmental approaches in these types of geoarchaeological studies frequently lack the integration of archaeological and historical data (Rodríguez-Vidal et al., 2015). This work aims to provide a multi-disciplinary platform to define the relationship between the coastal environmental evolution and human settlement patterns in the Huelva Estuary since the mid to late Holocene, as an example of strategic research approach for other Atlantic Iberian estuaries along the Gulf of Cádiz.

2. Study area

2.1. Physiographic and geomorphological setting

The Huelva Estuary is located in the central sector of the South Iberian Atlantic coast (Fig. 1). Nowadays this estuary is completely filled with sediments and has started to prograde to build a delta (Morales et al., 2014). This silting has resulted in the development of either tidal flats with salt marshes along the edges of the estuary or islands inside the estuary. The largest of these islands, named Saltés Island, is located on the outer area of the estuary between Punta Umbría and Punta Arenillas spits (Fig. 1), isolated from the mainland by Punta Umbría tidal channel and Padre Santo channel, the main outlets of the Tinto and Odiel rivers. Saltés is the only island in the estuary that contains isolated remains of past sand barrier systems that abruptly contrast with the surrounding muddy marshlands. These sandy systems are, from N to S: El Almendral, El Acebuchal, La Cascajera and Cabezo Alto. This investigation focuses on the northwest edge of the largest sand barrier, La Cascajera, where well exposed stratigraphic sequences were identified.

The origin of these sandy formations is still an issue as different interpretations have been proposed. Initially, Rodríguez-Vidal (1987) proposed a rapid growth model for these estuarine sand barriers as a consequence of the advancement of Punta Umbría spit towards the E and SE, by littoral drift, and the subsequent development of sand hooks sheltering marsh and tidal flats. The erosive action of the 218–209 BCE