Sequence stratigraphy of the Guadiana river estuary (SW Iberian Peninsula): correlation between high-resolution seismics and sediment cores

FRANCISCO LOBO [1], JOÃO MANUEL ALVEIRINHO DIAS [1], RAMÓN GONZÁLEZ [1], JAVIER HERNÁNDEZ-MOLINA [2], & VÍCTOR DÍAZ DEL RÍO [3]

[1]*CIACOMAR-Univ. Algarve, Avenida 16 de Junho, s/n, 8700-311 Olhão, Portugal (* mailto:pacolobo@ualg.pt *)*
[2]*Dpto. de Geociencias Marinas y Ordenación del Territorio, Univ. Vigo, 36200 Vigo, Spain*
[3]*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero s/n, 29640 Fuengirola, Spain*

INTRODUCTION

The underground sedimentary structure of a narrow, bedrock-controlled estuary, the Guadiana estuary (SW Iberia), was surveyed using a high-resolution seismic stratigraphy approach (Fig. 1). Most studies of estuarine infillings have been conducted in areas dominated by one type of hydrodynamic agent, either tide-dominated [1, 2], wave-dominated [3] or estuaries characterized by large fluvial supplies [4]. In contrast, the Guadiana estuary does not show a clear dominance of any hydrologic agent. Instead, its peculiar bedrock-controlled morphology (narrow, relatively straight estuary) is supposed to exert a control over these hydrodynamic agents during most of its recent evolution. Another distinctive characteristic of this estuary is that the fluvial supply is dominated by episodic, seasonal flooding events, in contrast to many temperate river basins. Furthermore, this area seems to be a good one in order to test the influence of late Quaternary sea-level fluctuations on the preservation of older estuarine sequences, and recent small-amplitude sea-level changes on recent estuarine sedimentation processes. The existence of sediment cores obtained from the Portuguese channel margin [5] will permit the correlation with seismic profiles.

SEQUENCE STRATIGRAPHY APPROACH

The sedimentary infill of the estuary is composed of five seismic units (SU 1 to 5 from bottom to top) bounded by laterally continuous seismic horizons (SH 1 to 5) which overlie some units (Basal Units) that only locally can be identified. It was possible to correlate these with the channel margin stratigraphy, and to make a sequence stratigraphy interpretation of the incised valley.

In the sedimentary infilling of the Guadiana estuary, the basal fluvial deposits seem to be linked to late Quaternary highstand intervals of Isotopic Stages 5 and 3 [5]. We suggest that the record of those highstand intervals is represented in the Guadiana main channel by Basal Units and SU 1, which would represent the final phase of a 5th order sea-level fluctuation (Fig. 2). Therefore, they constitute four depositional sequences, which correlate with equivalent depositional sequences defined in the adjacent shelf [6]. Inside these deposits, the last glacial maximum is recorded by a distinct stratigraphic surface (SH 2), representing simultaneously the Sequence Boundary and the Transgressive Surface. This evidences a sudden facies change attributable to a Bay-line surface.

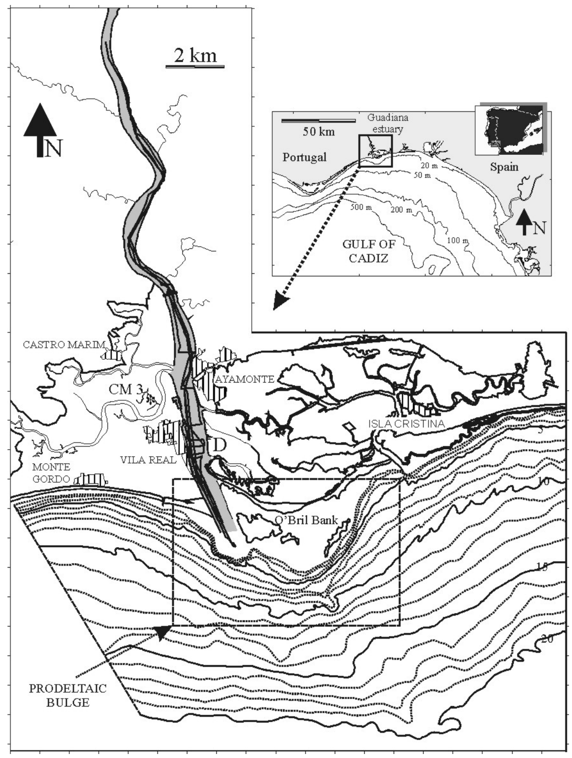

Fig. 1. Geographic location of the Guadiana river estuary, also showing position of seismic lines inside the estuarine main channel.

The basal part of the Transgressive Systems Tract (TST) in the estuarine Guadiana channel is represented by SU 2, which can be considered a muddy transgressive unit (Fig. 2), due to its low reflectivity, whereas prominent reflectors suggest coarse intercalations [7]. This stratal pattern is correlated in the channel margins with a thick clayey unit (Unit II) with intercalated layers of fine-medium sands [5]. The upper component of the TST (estuarine sand plug) is represented by SU 3 (Fig. 2), characterized by a high reflectivity indicative of a coarse-grained composition, whereas the dominance of landward prograding clinoforms can be attributed to landward coastline migration. This interpretation is also supported by channel margin stratigraphy [5]. Here, coarser sediments overlie the clayey unit, which is related to the change of reflectivity observed in the estuarine channel from SU 2 to the upper units (SU 3 to 5). A Tidal Ravinement Surface has been recognized in the estuarine sedimentary infilling (SH 3), being characterized by strong ravinement and tidal channel formation in the outer zones (Fig. 2). This surface represents the boundary between both transgressive deposits (SU 2 and 3).

The Holocene Highstand Systems Tract (HST) would be constituted by SU 4 and 5 (Fig. 2), because: a) The common identification of seaward directed prograding inner estuarine facies related to SU 4 constitute a change from the underlying unit (SU 3), as they are indicative of the construction of a bay-head delta [1]; b) Their highly reflective pattern indicates that they are globally characterized by a dominant sandy sedimentation [8]. In addition to this, channel margin stratigraphy shows the dominance of coarse sedimentation (unit III) during this final stabilization interval, characterized by progradational phases dominated by lateral accretion of point-bars and tidal bars [5]. The Maximum Flooding Surface (SH 4) is identified by change of stratal patterns between sandy transgressive deposits and downlapping highstand deposits.

CONCLUDING REMARKS

The estuarine geomorphology seems to have greatly controlled the estuarine hydrology during the late Quaternary: a) Fluvial influence: low channel river gradients and fluvial supply determined a lack of fluvial deposits associated to the Last Glacial Maximum lowstand. During the estuarine flooding, sediments preferentially accumulated on medium-scale depressions generated by pre-Holocene tectonic activity. The narrow morphology of the valley led to an increased sediment export during the Holocene highstand period; b) Tidal influence: it was maximum during the estuarine flooding, when a process of flood-currents enhancement close to basement elevations and leading to the upstream introduction of sandy sediments has been described; c) Wave influence: it seems to have been reduced in the estuarine channel.

The influence of late Quaternary and recent sea-level oscillations has been focussed on the following aspects: a) The lower part of the estuarine infilling seems to be constituted by four 5th order depositional sequences, composed by HST whose generation has been linked to late Quaternary highstands; b) The last 5th order sea-level cycle is represented by Transgressive (TST) and Highstand Systems Tracts (HST). Transgressive deposits record the final part of the post-glacial transgression. Two cycles of highstand progradation possibly controlled by small sea-level fluctuations have been determined in the Guadiana estuarine system.

REFERENCES

[1] Allen, G.P. and Posamentier, H.W. (1993) Sequence stratigraphy and facies model of an incised valley fill: the Gironde estuary, France. *Jour. Sedim. Petrol*., 63, 378-391.

[2] Dalrymple, R.W. and Zaitlin, B.A. (1994) High-resolution sequence stratigraphy of a complex, incised valley succession, Cobequid Bay-Salmon River estuary, Bay of Fundy, Canada. *Sedimentology*, 41, 1069-1091.

[3] Lessa, G.C., Meyers, S.R. and Marone, E. (1998) Holocene stratigraphy in the Paranaguá Bay estuary, southern Brazil: *Jour. Sedim. Res*., 68, 1060-1076.

[4] Hori K., Saito, Y., Zhao, Q., Cheng, X., Wang, P., Sato, Y. and Li, C. (2001) Sedimentary facies of the tide-dominated paleo-Changjiang (Yangtze) estuary during the last transgression. *Mar. Geol.*, 177, 331-351.

[5] Boski, T., Moura, D., Duarte, D., Camacho, S., Veiga-Pires, C., Scott, D.B. and Fernandes, S.G. (2001) The record of postglacial sealevel rise within the sedimentary fill of the Guadiana Estuary. *Sedim. Geol*., in press.

[6] Somoza, L., Hernández-Molina, F.J., De Andrés, J.R. and Rey, J. (1997) Continental shelf architecture and sea-level cycles: Late Quaternary high-resolution stratigraphy of the Gulf of Cádiz, Spain. *Geo-Mar. Lett*., 17, 133-139.

[7] Larcombe, P. and Jago, C.F. (1994) The Late Devensian and Holocene evolution of Barmouth Bay, Wales. *Sedim. Geol*., 89, 163-180.

[8] Fenster, M.S. and FitzGerald, D.M. (1996) Morphodynamics, stratigraphy, and sediment transport patterns of the Kennebec River estuary, Maine, USA. *Sedim. Geol*., 107, 99-120.

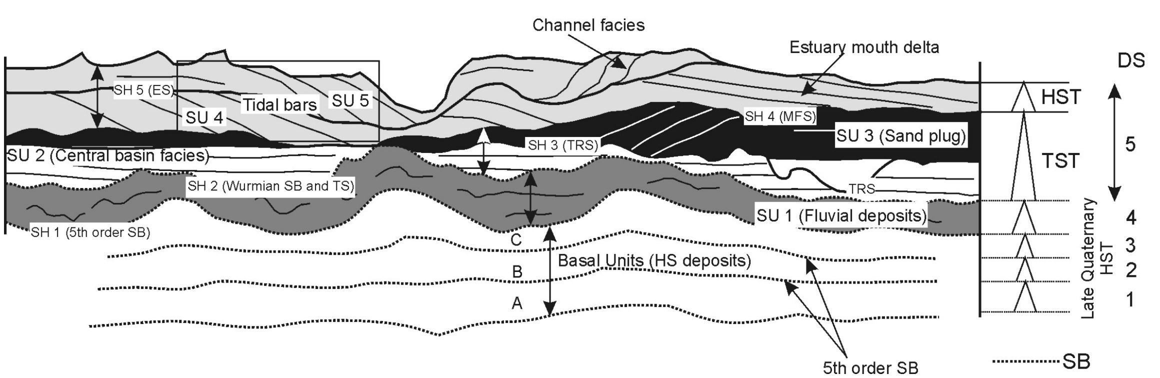

Fig. 2. Depositional systems and sequence stratigraphy approach of the Guadiana estuary sedimentary infilling. Legend: SU: seismic unit; SH: seismic horizon; TST: Transgressive Systems Tract; HST: Highstand Systems Tract; SB: sequence boundary; TS: transgressive surface; TRS: tidal ravinement surface; MFS: maximum flooding surface; ES: erosion surface; DS: depositional sequence.