

FINE SCALE SEDIMENTARY SEQUENCES OF DOURO MUDDY COMPLEX (NORTHERN PORTUGUESE CONTINENTAL SHELF) (POSTER)

Olivier **Weber**¹, Teresa Drago², Filipa Naughton^{1,2,3}, Jean-Marie Jouanneau¹, Selma Gabriel² & Sílvia Serina²

¹ DGO, UMR-CNRS EPOC 5805, Bordeaux 1 University, 33405 Talence, France; o.weber@epoc.u-bordeaux1.fr

² INIAP, IPIMAR, CRIPSUL, Instituto Nacional de Investigação Agrária e Pescas, Av. 5 de Outubro, 8700-305 Olhão, Portugal

³ Departamento de Geologia -Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Introduction

The Douro muddy complex is located 20-30km offshore Douro estuary. It is constituted essentially by terrigenous particles, mainly sourced from Douro river (Vitorino *et al.*, 2002). It is an active sedimentation zone, tectonically depressed and thus making an efficient sediment trap, partly limited by reliefs of different magnitude (Drago *et al.*, 1999). This sedimentary body is therefore an excellent feature for studying the sedimentary pattern in the continental shelf throughout the last millennia.

Methods

A gravity core (POS27-13-2G) 3.70m long was taken at 81m depth in the central part of Douro muddy complex. One half of the core was sub-sampled for several analyses: sedimentological (water content, grain-size - laser diffractometry, carbonates, organic matter), palynological, foraminiferal and nanoplankton studies (the latter two are subject of separate papers in this Conference). ¹⁴C AMS dating and excess of ²¹⁰Pb were determined in four selected levels. In the symmetric half a 1cm – thick slab was sampled along the whole core length and X-radiographed using Scopix system (Migeon *et al.*, 1999). The study of X-ray imagery supported definition of sedimentary sequences, and using systematic determination of grey levels, profiles of mean-grain size and carbonates have been obtained. Sediment classification followed Flemming (2000) criteria.

Results

Four sedimentological units can be distinguished, according to sedimentological parameters, with boundaries at 3.20m and 1.80m and 0.3m below sediment-water interface. The sedimentary sequences found within each unit contrast in thickness and number and follow those limits; in general, they are made of 2-3 sub-units showing fining-upward trend.

The lowermost unit consists of muddy sand and develops between *circa* cal AD 650 and cal AD 1010. Mean grain-size has a modal value of about 80µm but can reach 126µm. It is the coarsest unit in the core. Carbonate contents shows the highest values suggesting that the sediments are predominantly biogenic; inversely, organic matter has the lowest values. Five sedimentary sequences, 2-19cm thick (average 8cm) were defined in this unit. Taking into account the ages and number of sequences, it was found that, on average, one sequence formed every 45 years.

The intermediate unit has an age between cal AD 1010 and cal AD 1625, this last one interpolated. The monotonous character of the slightly sandy mud that constitutes this unit is only interrupted in the top by an 8cm thick muddy layer. The mean grain size is in general smaller than 40µm, carbonates content are <4% and organic matter is usually about 10%. Sedimentary sequences present a higher frequency than in the lower unit; about 23 sequences were defined, which thickness varying between 2 and 12cm (average ~ 6cm). Using the same criterium one sequence formed on average in this unit every 27 years.

The following unit corresponds with the interpolated ages of cal AD 1625 and cal AD 1937. Mean grain-size is higher than in the underlying unit, close to 40µm, but frequently exceeding this value. The content in carbonates is also slightly higher. Sediments are represented slightly sandy mud. Sedimentary sequences defined in this unit are much thicker, presenting a mean of 11cm (3 to 33cm). From the base to the top of this unit 15 sequences were identified (rate of emplacement estimated in 20 years).

Finally, the top unit is characterized by a mean grain size that becomes coarser towards the surface, reaching 60µm, which is accompanied by increasing carbonate content. Sedimentary sequences present again a high frequency with an average thickness of 4cm. In this unit, the excess in ²¹⁰Pb yielded a sedimentation rate of 0.24cm/year.

Discussion

Sediments transport in continental shelf is intimately related with hydrodynamic regime. In the case of Douro muddy complex, sediment seems to be essentially sourced in the Douro river, contemporaneously to storms episodes, when downwelling processes combine with northwards currents to produce a resulting transport trend towards NW (Drago *et al.*, 1999; Vitorino *et al.*, 2002). This idea implies that the sedimentary sequences defined are the expression of the short-term sediment availability (related with precipitation, floods) and/or with the energy of the carrying hydrodynamic episode (storms).

As observed, sedimentological units are also typified by differences in the character of sedimentary sequences, and this must have an environmental significance.

The time interval recorded in this core is comprehended between cal AD 650 and the year of core sampling (AD 2002). Contemporaneous environmental conditions include mesoscale climatic changes such as the Medieval Warm Period (MWP) and the Little Ice Age (LIA). Pollen analysis indicates a time period for the MWP between *circa* 1010 and 1500 AD, and for LIA, between 1500 and 1850 AD. Earlier than MWP, the time period between 850 AD and 600-750 AD is characterized by the advance of alpine glaciers, characterized by strong inundations and storms (Lamb, 1997). The thick sedimentary sequences of the basal unit, constituted by coarser sediment may correspond to this time period. However, the sediments are mainly biogenic and may represent open shelf sedimentation before the emplacement of the muddy patch.

Upwards, between *circa* 1010 and (interpolated) 1630 AD, sedimentary sequences become thinner. This set of sequences may be the expression of frequent sediment input, probably related with the humid conditions of the MWP climatic event (Lamb, 1997), from 1000 AD to 1500 AD. This set, accumulated until the lower half of LIA (1500-1800AD); the high frequency of sediment arrival at the muddy patch may be related with the persistency of humid conditions along this period; during the last half of this climatic stage and part of the “recent warming” period - until 1937 AD, sedimentary sequences are thicker. This might be the expression, at least in LIA, of retreat of highland glaciers and consequent high sediment supply into the shelf. From 1909 onwards, the known history of floods of the Douro may bear some relationship with the defined sedimentary sequences, a hypothesis at present being investigated.

Acknowledgments

This work was undertaken as a part of the ENVI-CHANGES project (PLE/12/00) funded by FCT (Portugal). Gravity core was collected in mission Poseidon 287, in the scope of collaboration with the INETI Marine Geology team (many thanks to Fátima Abrantes). Thanks also to Saint-Paul of Bordeaux University for slabbing and X-ray processing and finally, to my colleague Francisco Fatela and César de Andrade for the results discussion and the carefully revision of this paper.

References

- Drago, T., Oliveira, A., Magalhães, F., Cascalho, J.P., Jouanneau, J.-M. & Vitorino, J. 1998. Some evidences of northward fine sediment transport in the northern portuguese continental shelf. *Oceanologica Acta*, 21(2): 223-231.
- Drago, T., Araújo, F., Valério, P., Weber, O. & Jouanneau, J.M. 1999. Geomorphological control of fine sedimentation on the northern portuguese shelf. Proc. 2nd Symposium on the Atlantic Iberian Continental Margin, Cadiz, *Publicação Especial do Instituto Español de Oceanografía*.
- Flemming, B.W. 2000. A revised textural classification of gravel-free muddy sediments on the basis of ternary diagrams. *Cont. Shelf Res.*, 20: 1125-1137.
- Lamb, H.H. 1997. *Climate History and the Modern World*. London and New York, Routledge, 433p.
- Migeon, S., Weber, O., Faugères, J.C. & Saint-Paul, J. 1999. SCOPIX : a new X-Ray imaging system for core analysis. *Geo-Mar Letters*, 18: 251-253.
- Vitorino, J., Oliveira, A., Jouanneau, J.M. & Drago, T. 2002. Winter dynamics and the transport of fine sediments on the northern portuguese shelf. Part I - physical processes. *Progress in Oceanography*. 52, issues 2-4: 129-153.