Sediment dynamics and hydrodynamics on the inner part of the Aquitanian shelf (France) : Preliminary results

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Abstract

Inner shelves constitute a zone of transition where large quantities of sediments are stored. Sediment exchanges occurring within these zones are of primary importance considering the evolution of neighbouring areas (i.e. continental shelf and intertidal zone). The aim of this study is to understand the morphodynamics of the inner shelf and the connections prevailing with adjacent zones: i) the shoreface and the beach; and ii) the external shelf. We focus on the aquitanian shelf constituted of the accumulation of terrigenous clastic material exhibiting a well developed system of nearshore longshore bars.

Bathymetric surveys permit to describe the morphology of the bedforms located on the shoreface. Hydrodynamic measurements of tide- and waves- generated currents were carried out. Sediment dynamics is determined using the Gao and Collins procedure (1992) and through direct measurements.

Introduction

The shallow marine environment is a setting for the accumulation of terrigenous clastic material washed down from the continents. Considering coastal zones, inner shelf is a key area where sediment exchanges take place between: i) intertidal zones (beaches, estuaries, tidal inlets); and ii) continental shelves (Cacchione and Drake, 1990; Kosro et al., 1991).

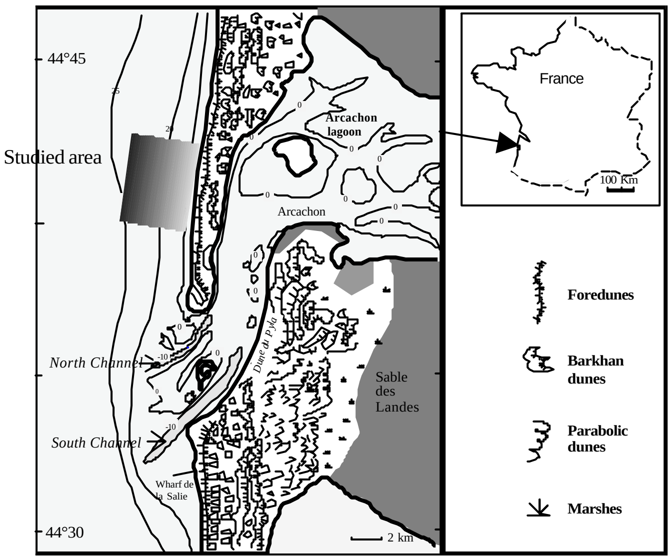
This present paper discusses some preliminary results from a recent oceanographic cruise on the inner part of the aquitanian shelf where an integrated approach was used to study bedforms morphology, hydrodynamic conditions and sediment dynamics.

The long-range goals of this program are to improve our understanding of the physical processes responsible for shoreface morphology changes and patterns of erosion and deposition in the nearshore zone.

Experimental site and instrumentation

The study area is located within the southern part of the French Atlantic coast (Fig. 1).

Figure 1: Study area



This is an unconsolidated, low coast, bordered by high aeolian dunes. Westerly winds are dominant and represent 58% of the directions, on an annual basis; they are also typical of storm conditions. The tide is semi-diurnal with a mesotidal range. This tide causes only weak rotational currents on the inner continental shelf (Michel and Howa, 1999). The wave climate is characterised by swell with a mean period of 12 s and a significant wave height (Hsig) of 1.45 m. The maximum wave height during normal storm conditions is 6 m. The wave direction is predominantly WNW, yelding a southerly longshore drift of about $6.89x10^5$ m^3 per year (Michel and Howa, 1994).

During the field campaign, various data were collected:

1- bathymetric surveys were conducted covering an area of 4x5 km from a depth of -30 m to -6m in order to explore the general morphology of bedforms;

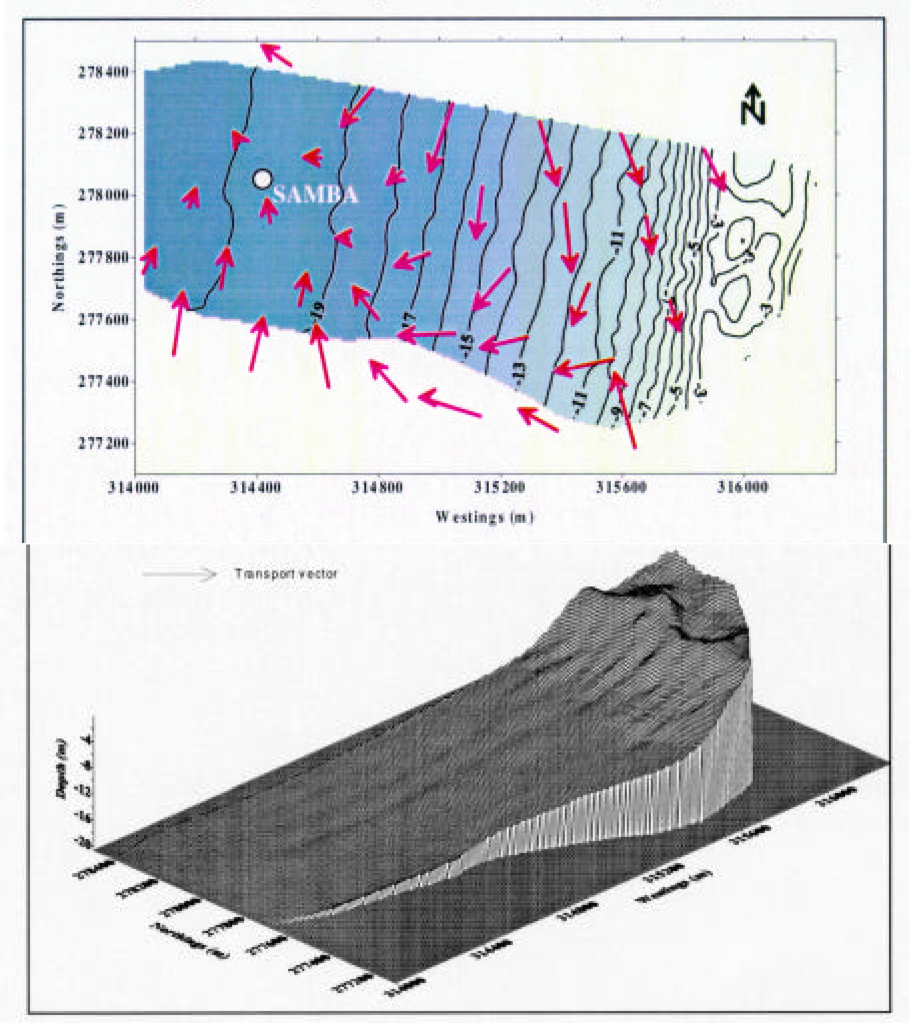
2- 35 surface sediment samples were collected using a grab following a regular (but staggered) grid of 300 m alongshore and 250 m cross-shore in order to determine the net sediment transport pathways with the aid of the Gao and Collins procedure (1992);

3- hydrodynamics (wave heights, tidal- and wave- induced currents) and sediment concentrations close to the seabed were measured using a benthic platform, SAMBA (Chapalain et al., 1999), deployed in mean water depth of 20 m (Fig. 2).

Main results

Bathymetric surveys (Fig. 2) show that, from a depth between -25 and -18 m, the slope is regular (0.2%), and no major bedforms can be recognised. From a depth between -18 and -7 m (lower shoreface), the slope is 1.4%. The upper shoreface (-7 to -2m depth) is constituted of a system of rhythmic crescentic longshore bars, according to the classification suggested by Goldsmith et al. (1982), Wright and Short (1984), Froidefond et al. (1990), Dronen and Deigaard (1998) among others. These bars consist of a linear middle section and wing-type end sections (horns) with a length scale between 400 and 600 m.

Figure 2 Bathymetry and sediment transport pathway



The analysis of hydrodynamics data is still in progress. Preliminary results show that Hsig. in deep water was 1.54 m, Tsig. was 9.6 s and the wave direction was WNW. Close to the longshore bars, mean currents of about 0.23 m/s were measured (1 m above the bottom) with a southward direction.

The analysis of spatial changes in grain size parameters (mean, sorting and skewness) permits the identification of net sediment transport pathways on a short-term basis (Petitjohn et al., 1972; McLaren, 1981; McLaren and Bowles, 1985). In this study, the methodology presented by Gao and Collins (1992) and Pedreros et al (1996), was used to calculate the transport vectors, representing a weighted average of the trends from neighbouring sites. The map of transport vectors, the residual transport pattern, permits recognition of the main transport directions. This method allows the determination of sediment transport pathways (Fig.2), however, it provides no information on transport rates. A longshore transport towards the south in the vicinity of the bar is identified. On the lower shoreface, no clear trend can be extracted.

Conclusions

This study shows that the upper shoreface of the inner aquitanian continental shelf is constituted by a system of rhythmic crescentic longshore bars also recognised by aerial photographs. These bars with a length scale between 400 and 600 m seem to be connected with the ridge and runnel systems developed on the intertidal zone. In the vicinity of the bar system, residual transport vectors are oriented towards the south.

Presented results are preliminary. Further analysis are in progress and additional field campaign are scheduled in the next future to improve our knowledge of this environment.

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