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Sediment accumulation rates and turbidite frequency in the eastern Algerian margin. An attempt to examine the triggering mechanisms

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ABSTRACT

From the analysis of seven new sediment piston-cores sampled in 2005 (MARADJA-2 French–Algerian cruise), this study aims to identify for the first time possible late Pleistocene to recent sedimentary instabilities controlled by seismicity off or close to the eastern coast of Algeria. The detailed lithologic study allows us to identify the frequency of the gravity events (turbidites, debrites) and to discuss their geographical sources and triggering mechanisms. Based on a chronostratigraphy of 24 ^{14}C AMS datings, sediment accumulation rates in zones extending off Bejaia and Annaba and, in particular, semi-quantitative analysis of the microfossils and lithogenic tracers of the origin of gravity flows was discussed. Two sediment cores, here considered as reference cores, enabled the estimation of palaeoenvironmental parameters that controlled sedimentation: (1) in the prodelta of Soummam Oued, after 2215 cal yr BP, floods were less frequent and sediment accumulation rates decreased because of a drier climate; (2) in the middle slope to the NE of Annaba, a location shielded from gravity flows, an increased sedimentation rate coincided with the passage of warmer waters leading to maxima of carbonate biogenic fluxes (particularly pteropods). Off Bejaia, two deep sediment cores show a spectacular increase in sediment accumulation rate between 2200 and 1000 cal yr BP while turbidites become more frequent. According to the eustatic and climatic stability of this interval, an episode of strong slope instability of the slope is suggested. Both sediment cores on the slope of Annaba indicate an increase in gravity flows during the same last thousand years, which is tentatively related to a regional increase of seismicity during this interval. This spatial distribution of gravity events is clearly different to that of the western margin where the sedimentation is less perturbed.
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1. Introduction

This work is a contribution to the more general goal of the MARADJA (MARge Active DJAzaïr). The programme consists of trying to better assess the role of active tectonics on depositional patterns in the Algerian Margin and deep basin. In 2005, the MARADJA 2 oceanographic cruise identified the main structural, morphological and sedimentological characteristics of the slope and the deep basin of the easternmost Algerian continental margin. Hitherto, only the morphological and structural evidence for active deformation at the sea floor has been explored (Kherroubi et al., 2009). Thus, the objective of this study is to define for the first time the late Quaternary sediment deposition pattern and sedimentary processes taking place along the margin from Great Kabylia to the border between Algeria and Tunisia (Fig. 1) which is apparently seismically more active in the instrumental time span than the western margin (Buforn et al., 2004).

Most well documented turbidite successions are interpreted to be deposited during or shortly after a lowstand systems tract episode (Mitchum, 1985; Mutti, 1985; Den Hartog Jager et al., 1993; Pickering et al., 1995; Rothwell et al., 1998). However, this concept has been questioned because some active gravity-induced deposition coincided with highstand systems tract conditions (e.g., Piper and Savoye, 1993; Dennielou et al., 2003; Carvajal and Steel, 2006; Giresse et al., 2009; Covault and Graham, 2010). Another trigger may be climate controlled changes in sediment discharge as in a canyon system offshore the hyperarid Western Sahara (Henrich et al., 2010). Lastly, seismicity could have been important at a regional scale. The correlation between mapped seafloor instabilities and seismicity is not straightforward (Camerlenghi et al., 2010), mainly because attributing an identified mass movement to a given earthquake requires careful and local-scale multiproxy analysis (Nouguès et al., 2010). In addition, tectonic and igneous events or associated diapirism may trigger enhanced periods

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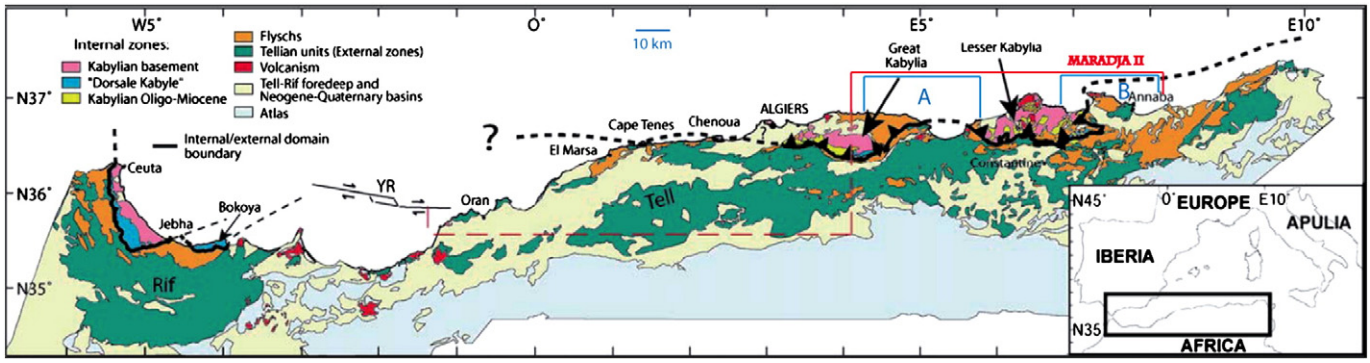

Fig. 1. Main geological units of the Maghrebian Chain (after Domzig et al., 2006) and study zone of MARADJA 2.

of mass transport deposits and turbidite deposition (Gamboa et al., 2010, for Brazil; Alves and Lourenco, 2010, for E Crete).

This work focuses on two zones of this eastern margin offshore Algeria that were sampled by gravity cores: (1) the Bejaia zone between 5° and 5°22′E (Fig. 2) and (2) the Annaba zone between 7°40′ and 8°E (Fig. 3). The main aim was to analyse (1) how turbidite frequency and accumulation rates varied over time (during lowstand, transgressive and highstand system tract conditions; LST, TST, and HST), and (2) then infer what triggered the turbidites (earthquakes, sea level or climatic changes). To measure better the possible influence of sediment flux change linked to climate, two reference core sections were analysed on part of a slope sheltered from main gravity mechanisms where the measures of oxygen isotopes were coupled with micropalaeontological observations, and in the Soummam Oued prodelta.

Various proxies (as reworked bioclasts) of the erosion of the last LST deposits lying on the shelf edge are identified and semi-quantified, and should improve understanding of the origins of the different sediment sources. Finally, we intend to compare these deposition processes with those described previously in the western part of the Algerian margin.

2. Geological, seismological and environmental backgrounds

Northern Algeria is an orogen, namely the Maghrebian belt which is composed from south to north of (1) the External Domain or Tellian units; (2) the Cretaceous flysch nappes which thrust the External Domain and are composed of former sediment of the Tethys Ocean; and (3) the Internal Domain, composed of a Hercynian basement, sometimes associated with its sedimentary cover (Durand-Delga and Fonboté, 1980; Wildi, 1983; Piqué et al., 2010) (Fig. 1).

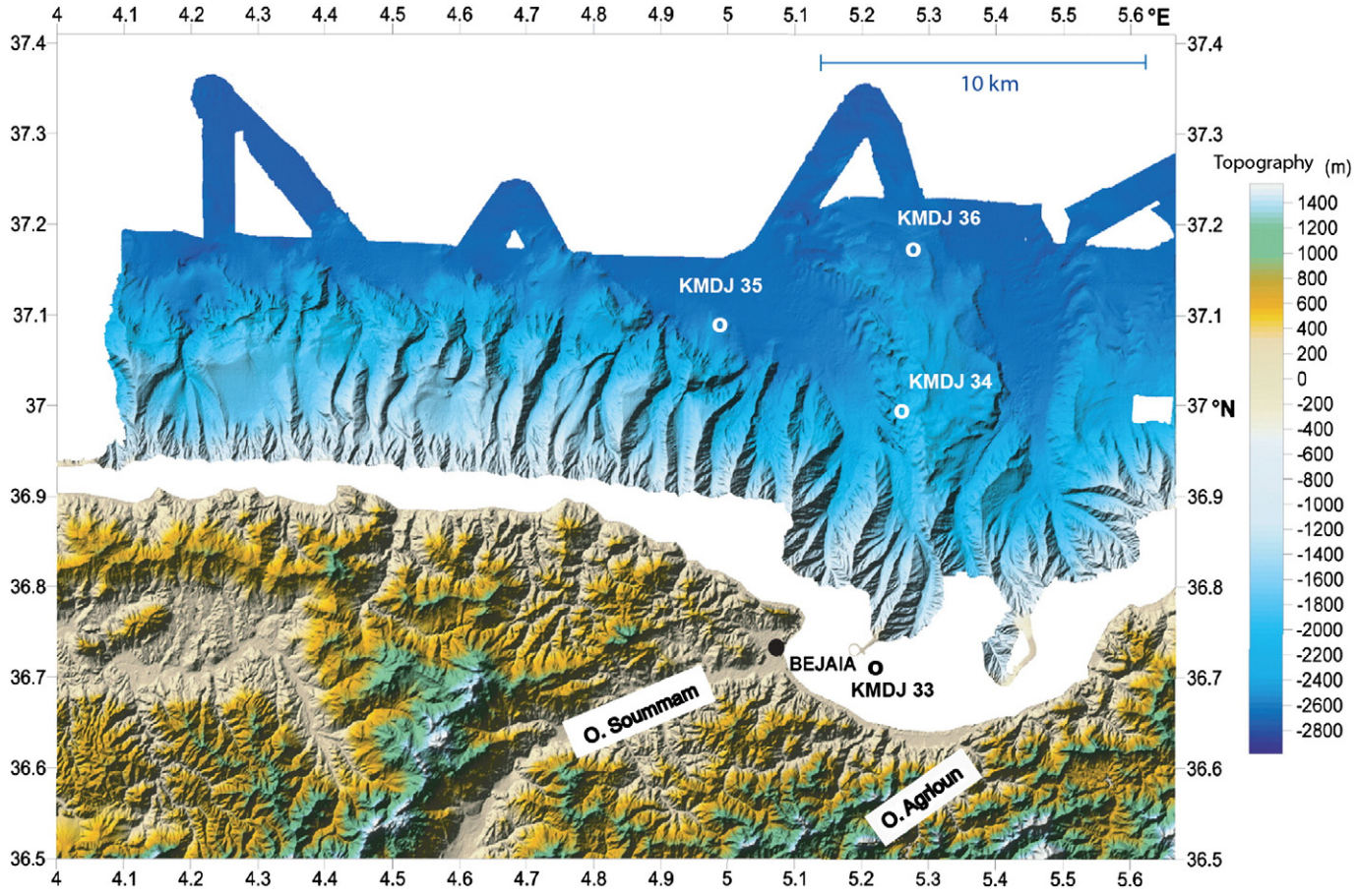

Fig. 2. Shaded bathymetry (50 m resolution DEM) of the Bejaia area and positions of four Küllenberg cores (KMDJ33–36).

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