ELSEVIER

Marine Geology 246 (2007) 42–59

MARINE GEOLOGY
INTERNATIONAL JOURNAL OF MARINE GEOLOGY, GEOCHEMISTRY AND GEOPHYSICS

www.elsevier.com/locate/margeo

High resolution seafloor images in the Gulf of Cadiz, Iberian margin

V. Hanquiez [a,*], T. Mulder [a], P. Lecroart [a], E. Gonthier [a], E. Marchès [a], M. Voisset [b]

[a] *Université Bordeaux 1, CNRS, UMR 5805-EPOC, avenue des facultés Talence, F-33405 France*
[b] *IFREMER, Département Géosciences Marines, BP 70, Plouzané, F-29280 France*

Received 30 October 2006; received in revised form 26 July 2007; accepted 2 August 2007

Abstract

In the Gulf of Cadiz, the hydrodynamic process acting on particle transport and deposition is a strong density-driven bottom current caused by the outflow of the saline deep Mediterranean water at the Strait of Gibraltar: the Mediterranean Outflow Water (MOW). New high resolution acoustic data including EM300 multibeam echo-sounder, deep-towed acoustic system SAR and very high resolution seismic, completed by piston cores collected during the CADISAR cruise allow to improve the understanding of the hydrodynamics of the MOW in the eastern part of the Gulf of Cadiz. Interpretation of data corrects the previous model established in this area and allows, for the first time, the accurate characterization of various bedforms and erosive structures along the MOW pathway and the precise identification of numerous gravity instabilities. The interaction between the MOW, the seafloor morphology and the Coriolis force is presently the driving force of the sedimentary distribution pattern observed on the Gulf of Cadiz continental slope.

Keywords: Gulf of Cadiz; Mediterranean Outflow Water (MOW); Contourites; deep-towed SAR; acoustic facies; sedimentary processes; instabilities

1. Introduction

The Gulf of Cadiz is located between the Strait of Gibraltar (Spain) and the Cape St Vincent (Portugal). The Gulf is placed at the Eurasian and African plate boundary and subjected to complex tectonic processes (Srivastava et al., 1990; Sartori et al., 1994; Maldonado and Nelson, 1999). This tectonic activity is partly responsible for the formation of the diapiric ridges diverting the Mediterranean Outflow Water (MOW) pathway since the Quaternary (Nelson et al., 1993; Llave et al., 2007).

Present day water circulation along the Gulf of Cadiz margin is controlled by the exchanges between the Atlantic Inflow surface current circulating as deep as 300 m (Mélières, 1974), and the MOW bottom current flowing between 300 and 1500 m water depth (Madelain, 1970; Ambar et al., 1999) (Fig. 1). The MOW flows westward just west of the strait of Gibraltar with a velocity reaching 2.5 m s^{-1} (Boyum, 1967; Madelain, 1970; Ambar and Howe, 1979). West of 6°20′W, the MOW is deflected northward and splits into two cores (Madelain, 1970; Zenk, 1975; Ambar and Howe, 1979; Gardner and Kidd, 1983; Ochoa and Bray, 1991; Johnson and Stevens, 2000; Borenäs et al., 2002; García, 2002; Hernández-Molina et al., 2003): (1) the Mediterranean Upper Water (MUW, Fig. 1), a geostrophic

* Corresponding author. Tel.: +33 5 40 00 34 35; fax: +33 5 56 84 08 48.
E-mail address: v.hanquiez@epoc.u-bordeaux1.fr (V. Hanquiez).

0025-3227/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.margeo.2007.08.002

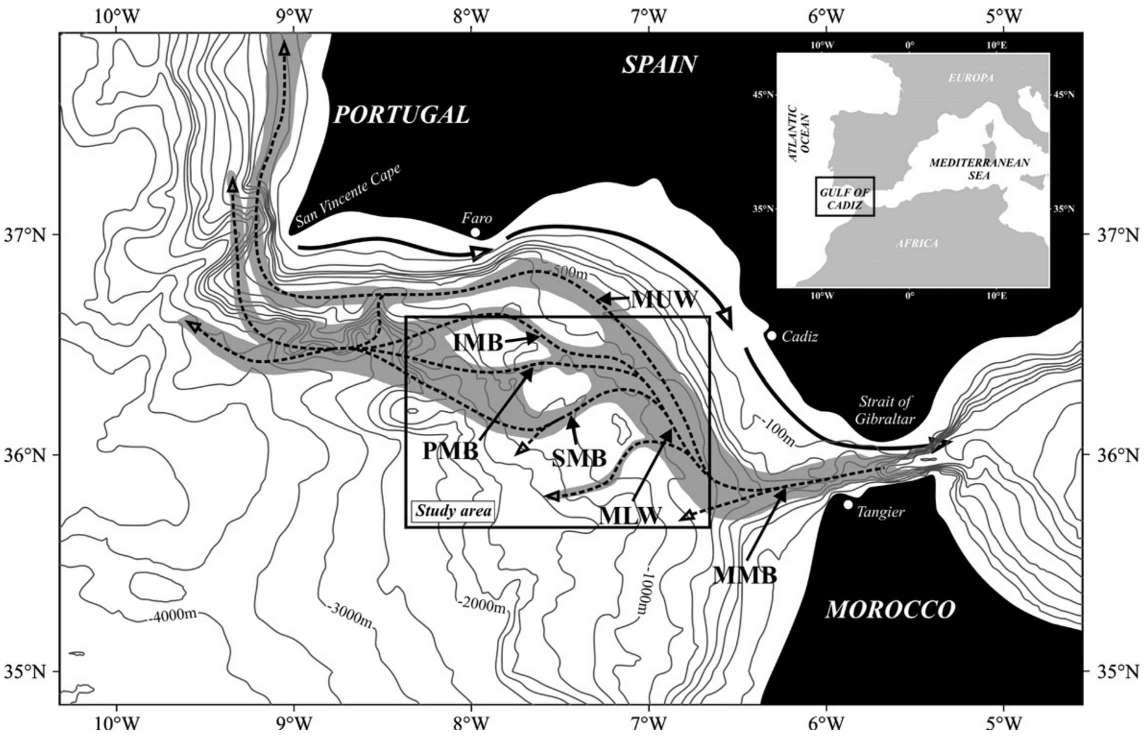

Fig. 1. Map of the Gulf of Cadiz showing the general MOW pathway (grey area); black dotted arrows indicate MOW direction; black arrows indicate Atlantic Inflow direction; IMB: Intermediate MOW Branch; MLW: Mediterranean Lower Water; MUW: Mediterranean Upper Water; MMB: Main MOW Branch; PMB: Principal MOW Branch; SMB: Southern MOW Branch. Modified from Madelain (1970) and Hernández-Molina et al. (2003).

current following a northerly path between 300 and 600 m water depth (Ambar and Howe, 1979; Ambar et al., 1999; Baringer and Price, 1999), and (2) the Mediterranean Lower Water (MLW, Fig. 1), an ageostrophic current flowing westwardly from the Strait of Gibraltar, at water depths ranging from 600 to 1500 m (Madelain, 1970; Zenk and Armi, 1990; Baringer, 1993; Bower et al., 1997). At about 7°W, the MLW splits into three branches (Intermediate/IMB, Principal/PMB and Southern/SMB; Madelain, 1970; Kenyon and Belderson, 1973; Mélières, 1974; Nelson et al., 1993; García, 2002), due to a complex bathymetry (Fig. 2) previously described by Mulder et al. (2003) and Hernández-Molina et al. (2003, 2006). According to the distribution of Hernández-Molina et al. (2003), three morpho-sedimentary sectors are distinguished in this area:

(1) The proximal scour and sand-ribbons sector with the Main MOW Channel (MMC, Fig. 2) which drains the MUW and the MLW.
(2) The channels and ridges sector with (i) the Cadiz Contourite Channel (CC, Fig. 2) which drains the SMB, the Huelva Channel (HC, Fig. 2) which drains the IMB, and the Guadalquivir Channel (GC, Fig. 2) which drains the PMB; (ii) the topographic highs composed of the Cadiz (CR, Fig. 2), Doñana (DR, Fig. 2), Guadalquivir (GR, Fig. 2) diapiric ridges, and the Guadalquivir Bank (GB, Fig. 2); (iii) the smooth areas composed of the Bartolome Dias (BDD, Fig. 2), Faro-Cadiz (FCD, Fig. 2), Guadalquivir (GD, Fig. 2) and Huelva (HD, Fig. 2) drifts;
(3) The overflow-sedimentary lobe sector recently interpreted as a Giant Contouritic Levee (Mulder et al., 2003) (CL, Fig. 2) partly dissected by the Gil Eanes Channel (GEC, Fig. 2) and by secondary channels (SC, Fig. 2) and whose western part coincide with the ponded basin area (PB, Fig. 2).

The MOW disconnects from the seafloor at around 1200 m and 1500 m water depth in the eastern and western parts of the Gulf, respectively, and becomes a water mass intercalated between the deep and intermediate Atlantic waters (Baringer and Price, 1999; Hernández-Molina et al., 2003). The MOW velocity decreases gradually down to 0.5 m s^{-1} on the middle slope (Kenyon and Belderson, 1973), and 0.2 m s^{-1} off Cape St Vincent (Meincke et al., 1975; Johnson et al., 2002). The progressive MOW velocity decrease leads to particle sorting and induces varied development of