IODP Expedition 339: Mediterranean Outflow

Site U1388 Summary

Background and objectives

Site U1388 (proposed site GC-04D) is located on the southern Iberian Margin (36°16.142' N and 6°47.647' W) about 50 km SW of the Spanish city of Cadiz, in a water depth of 663 m. Its location lies within the extensive Cadiz Sand Sheet, which is in the proximal part of the larger Cadiz Contourite Depositional System (CDS). It is the site closest to the Gibraltar Gateway drilled during Expedition 339.

The Cadiz Sand Sheet represents an important example of very poorly studied sandy contourite deposits on a middle-slope terrace. The seismic profiles show a well-layered internal acoustic structure with laterally extensive, aggradational to seismic depositional units, some thin intervals of lateral progradation and inferred within-section discontinuities. This sand sheet has accumulated on a mid-slope terrace over the past 4-5 million years, under the direct influence of Mediterranean Outflow Water (MOW).

Our primary objective at this site was to recover a full Pliocene, Pleistocene and Holocene sedimentary succession formed under the influence of the MOW close to its exit from the Gibraltar Gateway, and also to penetrate the Miocene/Pliocene boundary. It was intended as our deepest-penetration site (to 1550 mbsf).

Site U1388 was occupied on 18 December 2011. Three holes were drilled and cored using the advanced piston corer (APC), the extended core barrel (XCB), and the rotary core barrel (RCB) system, but a depth of only 226 m was achieved in the third hole, U1388C. The site was terminated prematurely as a result of hole instability; downhole logging was considered unwise. Overall recovery for Site U1388 was 3.6 m (107%) with the APC, 107 m (47%) with the XCB, and 10.4 m (43%) with the RCB. The total cored interval for Site U1388 was 253 m and total recovery was 121 m (48%), which was significantly lower than at the other expedition sites.

Main results

The sedimentary succession at Site U1388 extends for 226 m from the mid-Pleistocene to Holocene. It comprises a single lithologic unit (Unit I), notable for its distinctly sandy nature and consequent low core recovery, particularly in the upper 100 m where only 14% of material was recovered. The principal lithologies include sand, silty sand, silty mud, all calcareous in nature with 10-25% carbonate content, which is part bioclastic and part detrital in origin. On the assumption that much of the missing material is unconsolidated sand, then the upper 100 m is sandier than the underlying 50 m of section. The lowemost ~126 m of the unit comprises an alternation of 20-30 m-thick units of sand-rich and mud-rich material. A range of bi-gradational, normally-graded and reverse-graded sequences occur, which are interpreted as mainly contouritic in nature, although further work is required to improve our understanding of the depositional process.

Calcareous microfossils (nannofossils, planktonic and benthic foraminifera, ostracods and rare pteropods) are much less abundant than at other sites, but generally show good to very good preservation. The section is inferred to reach an age of <0.56-0.7 Ma, with a sedimentation rate of 60 cm/ky. The planktonic foraminifer assemblages indicate temperate to sub-tropical conditions. Benthic foraminifers show typical upper bathyal assemblages, some mixing with shelf-derived taxa, and variation in ventilation and/or MOW intensity.

Paleomagnetic measurements from all three holes indicate that only the Brunhes (C1n) normal polarity chron is recorded in these sediments, which confirms the biostratigraphic dating. Neither the intensity of natural magnetic remanence nor magnetic susceptibility values are especially high. Physical property data show a correspondence between higher magnetic susceptibility and sandier layers within the more mud-prone sections. Otherwise the paleomagnetic data is relatively poor.

The pore water profile at Site U1388 shows a relatively deep sulfate reduction zone in which sulfate reduces to zero at ~50 mbsf, followed by transition to methanogenesis. This corresponds to a level of increased authigenic dolomite observed in the cores. There is an anomalous increase in both Na and Cl down-section, indicating mixing with deeper saline waters. Total organic carbon values of 0.2-0.8% are relatively lower than at other sites.

Highlights

Although drilling was difficult, recovery generally poor, and the site was terminated early due to hole instability, the sediments recovered form a very important part of the MOW story. High rates of sedimentation and a generally sand-rich section testify to an intensified MOW flow coupled with abundant sediment supply. These sandy contourites represent the best record we have to date of this facies type, which appears significantly different from the down-flow counterparts at other sites drilled. The presence also of thick mud-rich intervals records variable MOW intensity since ~0.6 Ma, during construction of a sand-prone sheeted contourite drift.