Onset of Mediterranean Outflow into the North Atlantic

Francisco J. Hernández-Molina[1], Dorrik A.V. Stow[2], Carlos A. Alvarez-Zarikian[3], Gary Acton[4], André Bahr[5], Barbara Balestra[6], Emmanuelle Ducassou[7], Roger Flood[8], José-Abel Flores[9], Satoshi Furota[10], Patrick Grunert[11], David Hodell[12], Francisco Jimenez-Espejo[13], Jin Kyoung Kim[14], Lawrence Krissek[15], Junichiro Kuroda[16], Baohua Li[17], Estefania Llave[18], Johanna Lofi[19], Lucas Lourens[20], Madeline Miller[21], Futoshi Nanayama[22], Naohisa Nishida[22], Carl Richter[23], Cristina Roque[24], Hélder Pereira[25], Maria Fernanda Sanchez Goñi[26], Francisco J. Sierro[9], Arun Deo Singh[27], Craig Sloss[28], Yasuhiro Takashimizu[29], Alexandrina Tzanova[30], Antje Voelker[24], Trevor Williams[31] and Chuang Xuan[32]

1. Dept. Earth Sciences, Royal Holloway Univ. London, Egham, Surrey TW20 0EX, UK
2. IPE, Heriot-Watt Univ., Edinburgh, Scotland, UK
3. International Ocean Discovery Program (IODP), Dept. of Oceanography-Texas A&M Univ., USA
4. Dept. of Geography and Geology, Sam Houston State Univ., USA
5. Institute of Geosciences, Univ. of Frankfurt, Germany
6. Institute of Marine Sciences, Univ. of California, Santa Cruz, USA
7. EPOC, Univ. de Bordeaux, France
8. School of Marine and Atmospheric Sciences, Stony Brook Univ. USA
9. Dpto. de Geología, Univ. de Salamanca, Spain
10. Dept. of Natural History Sciences, Hokkaido Univ., Japan
11. Institute for Earth Sciences, Univ. of Graz, Austria
12. Godwin Laboratory for Palaeoclimate Research, Univ. of Cambridge, Cambridge, UK
13. Dept. of Biogeosciences-JAMSTEC, Japan
14. Korea Ocean Research and Development Institute, Korea
15. School of Earth Sciences, Ohio State Univ., USA
16. Institute for Frontier Research on Earth Evolution (IFREE), JAMSTEC, Japan
17. Dept. of Micropalaeontology, Nanjing Institute of Geology and Palaeontology, P.R. China
18. Instituto Geológico y Minero de España (IGME), Spain
19. Géosciences Montpellier, Univ. Montpellier II, France/ Dept. of Geology, Univ. of Leicester, UK
20. Institute of Earth Sciences, Utrecht Univ., The Netherlands
21. Dept. of Mechanical Engineering, California Institute of Technology, USA
22. Institute of Geology and Geoinformation, Geological Survey of Japan (AIST), Japan
23. Dept. of Geology and Energy Institute, Univ. of Louisiana, USA
24. Divisão de Geologia e Georecursos Marinhos, IPMA, Lisboa, Portugal
25. Grupo de Biologia e Geologia, Escola Secundária de Loulé, Portugal
26. Ecole Pratique des Hautes Etudes (EPHE), EPOC, Univ. de Bordeaux, France
27. Dept. of Geology, Banaras Hindu Univ., India
28. Dept. of Biogeosciences, Queensland Univ. of Technology, Australia
29. Dept. of Geology, Fac. of Education, Niigata Univ., Japan
30. Dept. of Geological Sciences, Brown Univ., USA
31. Lamont-Doherty Earth Observatory, Columbia Univ., USA
32. NOCS, Univ. of Southampton European Way Southampton, SO14 3ZH, UK

Abstract: *Sediments cored along the southwestern Iberian margin during Integrated Ocean Drilling Program Expedition 339 provide constraints on Mediterranean Outflow Water (MOW) circulation patterns from the Pliocene epoch to present day. After the Strait of Gibraltar opened (5.33 Ma), a weak and limited volume MOW entered the Atlantic. Depositional hiatuses indicate erosion by bottom-currents related to higher volumes of MOW circulating into the North Atlantic beginning in the late Pliocene. The hiatuses coincide with regional tectonic events and changes in global thermohaline circulation (THC). This suggests that MOW influenced Atlantic Meridional Overturning Circulation (AMOC), THC, and climatic shifts through the supply by contributing a component of warm, saline water to northern latitudes, while in turn being influenced by plate tectonics.*

Key words: *Contourites, Gulf of Cadiz, IODP Expedition 339, Mediterranean Outflow Water, global thermohaline circulation, Atlantic Meridional Overturning Circulation.*

INTRODUCTION

Changes in the Mediterranean Outflow Water (MOW) co-occurred with some shifts in global ocean circulation and climate, but the exact timing of MOW evolution vis-à-vis major climate events remains unclear. This paper interprets the sequence of events very recently identified by Hernández-Molina et al (2014) that established a significant MOW contribution to North Atlantic thermohaline dynamics, and how these dynamics relate to Neogene and Quaternary climatic and tectonic events. This study combines geophysical and drill-core data acquired along the southwestern Iberian margin during Integrated Ocean Drilling Program (IODP) Expedition 339 aboard the RV *JOIDES Resolution*.

DEPOSITS FROM LATE MIOCENE TO PRESENT: SEISMIC RECORDS AND DRILL CORE INTERPRETATION

Major regional discontinuities appear as high-amplitude seismic reflections within late Miocene to present-day sediments around the Gulf of Cadiz (Fig. 1). These discontinuities provide a record of MOW circulation relative to coeval tectonic and environmental events. In seismic records, Pliocene deposits appear as sheeted drifts, overlying a weakly reflecting Miocene unit that progrades downslope (Fig. 1). The late Pliocene to early Quaternary section records significant synsedimentary deformation associated with two discontinuities that define erosional surfaces (Fig. 1). Quaternary deposits are distinguished by high amplitude seismic reflections and show clear upslope progradation.

The predominant sedimentary facies in the late Miocene to present-day sedimentary record include pelagites, hemipelagites, contourites, turbidites, debrites and slump deposits. Contourites constitute up to 95% of Quaternary deposits, and about 50% of the recovered Pliocene succession. This facies includes sand-rich, silt-rich and mud-rich contourites, deposited at moderate (20-30 cm/ky) to very high (> 100 cm/ky) sediment accumulation rates. Dolomitic mudstone and dolostones are rare, but also occur in drill core material. The chronostratigraphy and absolute ages of key horizons, namely several depositional hiatuses and stratigraphic boundaries derive from shipboard bio- and magnetostratigraphic analyses of core samples collected at IODP Expedition 339 sites. Two depositional hiatuses (Fig. 1), evident at 3.2 - 3.0 Ma and 2.4 - 2.1 Ma, indicate that MOW did not significantly circulate into the North Atlantic until the late Pliocene and early Pleistocene. A latter event, occurring at 0.9 - 0.7 Ma, suggests the existence of an additional Pleistocene phase of MOW intensification.

CONCLUSIONS

The results presented here show that initial MOW circulation, into the Atlantic following the opening of the Strait of Gibraltar, was relatively weak. Significant interaction between MOW and the North Atlantic did not begin until the late Pliocene. The establishment of MOW added relatively salty water at intermediate depths and contributed to enhanced THC and AMOC. The addition of the warm, salty MOW component reduced pole-to-equator temperature gradients during the mid-Pliocene warm period (3.2 -3.0 Ma), during the early Pleistocene (2.4 - 2.0 Ma), and at 0.9 - 0.7 Ma. These climatic events coincide with widespread depositional hiatuses, pronounced changes in the sedimentary stacking pattern and establishment of the present-day sea-floor morphology (Fig. 1). Hiatuses and shifts in depositional processes are related to regional tectonic events and margin instability. Similar changes in deep water sedimentation and tectonics have been described in association with other margins and basins around the same time in both the Northern and Southern hemispheres, demonstrating that the relationship between climatic shifts and plate tectonic events operates over a wide range of timescales.

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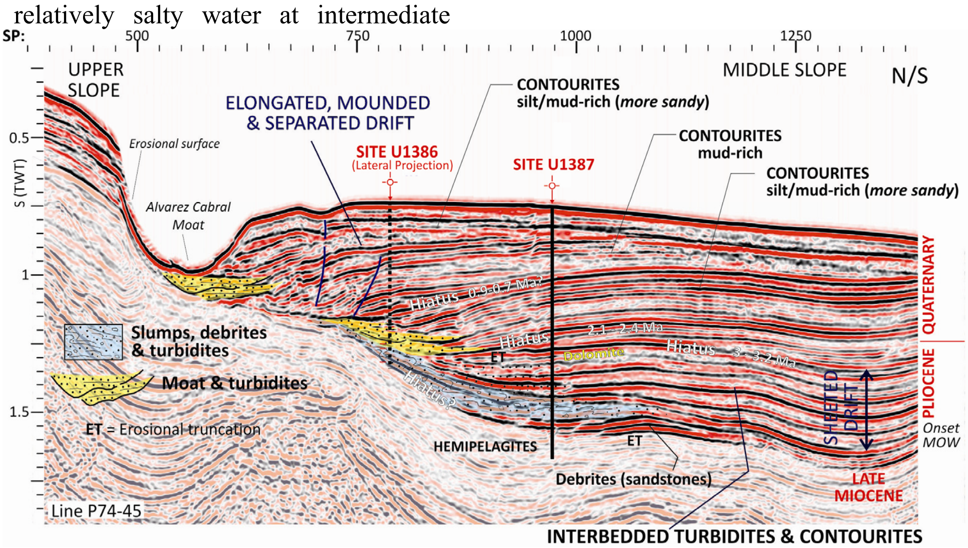

FIGURE 1. Seismic profile showing the major sedimentary stacking pattern, from the Pliocene sheeted drift to the Quaternary elongate and mounded drift, based on the correlation between Sites U1386 and U1387 and the multichannel seismic reflection line P74-45. The hiatuses and main type of contourite drifts are indicated (data courtesy of REPSOL).