# Press Release for IODP Expedition 339

Integrated Ocean Drilling Program (IODP) Expedition 339, Mediterranean Outflow, was executed from November 2011 to January 2012 on board the Research Vessel *JOIDES Resolution*. The expedition, carrying an international team of 35 scientists from 14 countries, recovered five kilometers of core samples from an area never before drilled along the Gulf of Cadiz and west off Portugal. The scientific party found new evidence of a deep-earth tectonic pulse, retrieved a detailed record of climate changes, and made key discoveries that could influence the future of oil and gas exploration.

The Strait of Gibraltar is one of the most important oceanic gateways, which re-opened less than 6 million years ago after being isolated from the Atlantic for several hundred millennia. Today, deep below the sea surface, a powerful cascade of Mediterranean water spills out through the Strait of Gibraltar into the Atlantic Ocean. Because this water is saltier than the Atlantic, and therefore heavier, it plunges more than 1000 meters downslope, scouring the rocky seafloor, carving deep-sea canyons, and building up mountains of mud on a little known submarine landscape. These sediments, called contourites because the currents that deposit them closely follow the contours of the ocean basin, hold a record of climate change and tectonic activity that spans much of the past 5.3 million years. “The expedition brought us many of the eagerly anticipated answers to our questions, as well as wholly unexpected scientific results”, says Dorrik Stow, Co-Chief Scientist for Expedition 339, from Heriot-Watt University in the UK.

“We set out to understand how the Strait of Gibraltar acted first as a barrier and then a gateway over the past 6 million years,” says Javier Hernandez-Molina, Co-Chief Scientist for Expedition 339 from the Royal Holloway University of London in the UK. “We now have results for understanding the Mediterranean Outflow Water (MOW) through the Gibraltar gateway.” He adds, “But the potential story that unfolds may be even more significant. The oceans and climate are inextricably linked. It seems there is an irrepressible signal of this nexus in contourite sediments.”

The Chief Scientists explain another surprising turn; Expedition 339 found a great deal more sand among the contourite sediments than anyone had expected. The scientists found this sand filling the contourite channels, deposited as thick layers within mountains of mud, and in a single, vast sand sheet that spreads out nearly 100 kilometers from the Gibraltar gateway. All testify to the great strength, high velocity, and long duration of the Mediterranean bottom currents. Moreover, the find could impact future oil and gas exploration. “The thickness, extent, and properties of these sands make them an ideal target in places where they are buried deeply enough to allow for the trapping of hydrocarbons.” The sands are deposited in a completely different manner, in channels and terraces cut by bottom currents; in contrast, typical reservoirs form in sediments deposited by downslope “turbidity” currents. “The sand is especially clean and well sorted and therefore very porous and permeable. Our findings could herald a significant shift in future exploration targets.”

“Another fascinating aspect of these sediments”, says Gary Acton, Stratigraphic Correlator for Expedition 339, “is their ability to record subtle changes in environmental conditions through measurable changes in their magnetic, physical, and chemical properties.” Acton is studying those properties using complex instrumentation, such as a superconducting cryogenic magnetometer and gamma radiation scintillation detectors, and simple variations in the color of the sediment from high-resolution digital images. “My goal is to reconstruct centennial-scale changes in climate and in Earth’s magnetic field for a time period spanning the past 400,000 years. Only thick, rapidly deposited sedimentary units like those we cored provide that ability. They are virtual prehistoric observatories.” Indeed, the climate change recorded at one of the drill sites will be dedicated to providing the most complete marine record of climate change over the past 2 million years of Earth history. This will provide a marine archive for comparison with ice core records from the Greenland and Antarctic ice sheets, and with the numerous land-based records, like those from lake sediments, tree rings, and cave stalactites.

**Science** published some of the first results from Expedition 339 on ***Friday, 13 June 2014***. A research article titled **“Onset of Mediterranean Outflow into the North Atlantic”** demonstrates 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 global thermohaline circulation (THC) and Atlantic Meridional Overturning Circulation (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 Quaternary (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 seafloor morphology.

Hiatuses and shifts in depositional processes are related to regional tectonic events and margin instability. Similar changes in deepwater 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. The temporal overlap of these events suggests that they relate to overall plate reorganization in the North Atlantic.

For more information about IODP Expedition 339, Mediterranean Outflow, visit <http://iodp.tamu.edu/scienceops/expeditions/mediterranean_outflow.html>

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## ABOUT THE PARTICIPANTS

**Dr. Gary Acton** (Sam Houston State University, USA) was the Expedition 339 Stratigraphic Correlator and Paleomagnetist.

Co-chiefs of the Expedition-339 are **Prof. Dorrik Stow**, (ECOSSE, Heriot-Watt Univ., UK) and **Dr. F. Javier Hernández-Molina** (University of Vigo, Spain), and the USIO Expedition Project Manager is **Carlos Alvarez Zarikian** (Texas A&M University, USA).

34 members form the scientific party, which belong to 13 countries and four continents: Europe (14 researchers); USA (11); Japan (6); Australia (1); Korea (1); China (1) and India (1). In Europe researchers come from Spain (4); UK (2); France (3); Portugal (2); Germany (1); the Netherlands (1); and Austria (1). They cover different research specialties including: wireline logging; sedimentology; stratigraphic correlation; sediment physical properties; geochemisty, micropaleontology; and people for outreach and education.

You can also find more detailed info about the members of the Expedition 339 at: <http://iodp.tamu.edu/scienceops/precruise/medoutflow/participants.html>**.**

A map showing where each of the members of the Expedition 339 science party is from and the location of the drilling sites can be found at: <http://joidesresolution.org/node/2053>

## Images

Fig. 1. The Research Vessel *JOIDES Resolution* coring during IODP Expedition 339. Photo by Carlos Alvarez Zarikian.

Fig. 2. The circulation paths of regional water masses in the eastern Atlantic Ocean, along with IODP Expedition 339 drill sites (figure modified from Hernández-Molina et al., Geo-Marine Letters, 31:285–300 2011).

Fig. 3. Dr. Gary Acton (Sam Houston State University) on the *JOIDES Resolution* with the drill derrick in the background.

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