

In an Underwater River of Sand and Mud off the Iberian Coast, Six Million Years of Earth History

Scientists have just returned from an expedition onboard the research vessel *JOIDES Resolution*, during which they recovered five kilometers of core samples from an area never before drilled. The team 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.

January 18, 2012; Lisbon, Portugal – The world’s oceans are far from static. Many large currents flow at various depths beneath the surface, and together, these currents form a global conveyor belt that transfers heat energy and helps buffer Earth’s climate from the extremes. Critical gateways in the ocean affect circulation of these major currents. The Strait of Gibraltar is one such gateway, which re-opened less than 6 million years ago after being isolated from the Atlantic for several hundred millennia.

Today, deep below the surface, there is a powerful cascade of Mediterranean water spilling out through the Strait into the Atlantic Ocean. Because this water is saltier than the Atlantic – and therefore heavier – it plunges more than 1000 metres down slope, scouring the rocky seafloor, carving deep-sea canyons and building up mountains of mud on a little known submarine landscape. These sediments hold a record of climate change and tectonic activity that spans much of the past 5.3 million years.

An international team of 35 scientists from 14 countries has just returned from an eight-week scientific expedition onboard the *JOIDES Resolution* to collect core samples of these sediments, called *contourites* because the currents that deposit them closely follow the contours of the ocean basin. Although the southwest coast of Iberia and the nearby Gulf of Cádiz have long been recognized as prime sites to study this record, Integrated Ocean Drilling Program (IODP) Expedition 339: Mediterranean Outflow is the first to retrieve sediment core samples from deep below the seafloor here.

“We now have a much greater insight into the distinctive character of contourites, and have validated beyond doubt the existing paradigm for this type of sedimentation,” says Dorrik Stow, Co-Chief Scientist for Expedition 339, from Heriot-Watt University in the UK. “The expedition brought us many of the eagerly anticipated answers to our questions, as well as wholly unexpected scientific results.”

The team found evidence for a “tectonic pulse” at the junction between the African and European tectonic plates, which is responsible for causing a repeated rising and falling of key structures in and around the gateway. It also led to strong earthquakes and tsunamis that dumped large flows of debris and sand into the deep sea. At four of the seven drill sites, there was also a major chunk of the geologic record missing from the sediment cores – evidence of a strong current that scoured the seafloor.

“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 University of Vigo in Spain. “We now have that understanding, and a record of a deep, powerful Mediterranean Outflow through the Gibraltar gateway.”

The first drill site, located on the west Portuguese margin, was chosen to provide the most complete marine sediment record of climate change through the past 1.5 million years of Earth history. These cores cover at least

four major ice ages, and provide a new marine archive to compare against ice core records from Greenland and Antarctica, among other land-based records.

But the team was surprised to find exactly the same climate signal in the mountains of contourite mud they drilled in the Gulf of Cádiz. Moreover, because these muds were deposited much faster than the sediments at the Portuguese margin site, the record from these cores could prove to yield even richer, more detailed climate information.

“Cracking the climate code will be more difficult for contourites because they receive a mixed assortment of sediment from varying sources,” Hernandez-Molina explains. “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.”

In another surprising turn, the team 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,” Stow explains. 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.”

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About IODP

The Integrated Ocean Drilling Program (IODP) is an international research program dedicated to advancing scientific understanding of the Earth through drilling, coring, and monitoring the seafloor. The *JOIDES Resolution* is a scientific research vessel managed by the U.S. Implementing Organization of IODP (USIO). Together, Texas A&M University, Lamont-Doherty Earth Observatory of Columbia University, and the Consortium for Ocean Leadership comprise the USIO. IODP is supported by two lead agencies: the U.S. National Science Foundation (NSF) and Japan's Ministry of Education, Culture, Sports, Science, and Technology. Additional program support comes from the European Consortium for Ocean Research Drilling (ECORD), the Australia-New Zealand IODP Consortium (ANZIC), India's Ministry of Earth Sciences, the People's Republic of China (Ministry of Science and Technology), and the Korea Institute of Geoscience and Mineral Resources. For more information, visit www.iodp.org.

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

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Media Contacts:

Matthew Wright
Consortium for Ocean Leadership
Washington, D.C. USA
mwright@oceanleadership.org
+1-202-448-1254

Albert Gerdes
MARUM – Center for Marine
Environmental Research
Bremen, Germany
agerdes@marum.de
+49-421-218-65540

Miyuki Otomo
IODP Management International, Inc.
(IODP-MI)
Tokyo, Japan
motomo@iodp.org
+81-3-6701-3188