

## **IODP Expedition 339: Mediterranean Outflow**

### **Week 6 Report (19-25 December 2011)**

#### **Operations**

The 55 nmi transit to Site U1388 (GC-04D) was accomplished in ~5 hr at an average speed of 11 knots. At 0745 hr on 18 December the vessel was positioning on the new location. Following a 1.3 hr underwater camera survey of the seafloor utilizing a 30-m grid pattern, Hole U1388A was spudded with the APC at 1500 hr. The calculated seafloor depth from the recovery of the first core was 675.1 mbrf (663.6 mbsl), which was 0.7 m deeper than the corrected PDR depth. The second attempt at a piston core appeared to be an incomplete stroke. The core winch operator spent nearly 3 hr attempting to recover the stuck core barrel. The Kinley cutter had to be deployed to cut the coring line above the sinker bars when it was not possible to jar off the core barrel. The only course of action remaining was to recover the drill string and extricate the core barrel on the surface. The drill string was quickly retrieved by midnight on 18 December. The reason why the core barrel couldn't be recovered was because most of the bottom hole assembly (BHA) was full of sand, which apparently "U-tubed" when the driller advanced into the formation to position the bit for the next piston core.

The BHA was cleared of sand, deployed to 669.9 mbrf and the vessel offset 20 m east of the previous hole. The underwater camera displayed what appeared to be manmade debris on the seafloor, which required another 10 m offset to the east. The strategy for Hole U1388B was to core an XCB hole to refusal and use the information acquired from this pilot hole to assess if and where the APC could be deployed in subsequent holes. The driller tagged seafloor at 674.4 mbrf (662.9 mbsl) at 0645 hr. The camera system was recovered and the top drive picked up. Hole U1388B was spudded with the XCB at 0835 hr on 19 December and advanced to 225.7 mbsf by 0745 hr on 20 December. While coring this interval, there was extensive cutting shoe damage suggesting that the distribution of fluid flow between the cutting shoe and the PDC bit was not optimum for this formation. Rather than continue coring in this fashion and considering that the objectives of this site were deeper in the formation, XCB coring was terminated at 225.7 mbsf. Recovery for Hole U1388B was 47%.

After a short inspection of the seafloor confirmed that the location of Hole U1388C was clear of debris, the driller tagged the seafloor at a depth of 674 mbrf (662.5 mbsl). The underwater camera was recovered and Hole U1388C spudded with the RCB at 1915 hr on 20 December. The hole was washed down to a depth of 205 mbsf where rotary coring was initiated and then advanced from 205 to 229 mbsf. At that depth, the drill sting became firmly stuck in the formation. There was no rotation and limited circulation. It required 1.5 hr to free the pipe utilizing overpulls of as much as 120 kips and adjusting rotary current limits as high as 1050 amps. Once the pipe came free, more mud (both Hi-Vis and 10.5 ppg) was pumped to clear out some of the sand that had collapsed on the BHA. The drill string was pulled free of the seafloor at 1330 hr and was on deck by 1725 hr on 21 December. The hole was considered too unstable to

safely core and the decision was made to move on to the next planned site. The total time on site was 3.2 days, which was 10 days less than the allotted time. The vessel departed for Site U1389 (proposed Site GC-11A) at 1730 hr on 21 December.

The 25 nmi journey to Site U1389 was accomplished in 2.5 hr and the *JOIDES Resolution* was positioning on the new site by 2000 hr on 21 December. The APC/XCB BHA was assembled and deployed to 651.7 mbrf. Subsequent to a 1.3 hr survey of the seafloor, Hole U1389A was spudded with the APC at 0240 hr on 22 December. The water depth calculated from the recovery of the first core established the seafloor at 656.2 mbsf (644.7 mbsl). This was 1.3 m shallower than the corrected PDR depth.

Piston coring advanced Hole U1389A to the refusal depth of 99 mbsf. The average recovery for this interval was 103%. Core orientation started with Core U1389A-4H. There were three APCT deployments at 33 mbsf (-4H), 61 mbsf (-7H), and 90 (-10H) mbsf. Non-magnetic core barrels were utilized on all cores. XCB coring deepened the hole to a final depth of 357 mbsf by 1415 hr on 23 December. The average recovery for the 258 m XCB cored portion of the hole was 91%. The total average recovery for the entire hole was 94%.

On 23 and 24 December, we carried out downhole logging operations in Hole U1389A. During preparations for logging, the wiper trip found only 1 m of soft fill at the bottom of the hole, and the hole was filled with 112 barrels of 10.5 ppg mud. The open end of the pipe was placed at a logging depth of 85.7 mbsf. The Triple Combo tool string, comprising natural gamma, density and resistivity tools, descended through the seafloor at 2300 hr on 23 December and was run down to the bottom of the hole at 1011 mbrf (355 mbsf). A short pass of 75 m was followed by a main pass up to the seabed. Sand-rich layers are apparent by their low gamma radiation signature. The hole was mostly in-gauge, but with several m-scale washouts. The tool string was back on deck by 0140 hr.

The FMS-sonic reached the bottom of the hole, and made two passes, recording resistivity images of the borehole, sonic velocities, and natural gamma data over the entire interval. The tool string was back on deck at 0950 hr. The Versatile Seismic Imager (VSI) tool was run to conduct the vertical seismic profile experiment (VSP). Marine mammal watch started at ~1100 hr on 24 December. The airguns (2-gun cluster, 7 m below sea level on the port side) were ramped up in a soft start procedure. The VSI tool started its descent down Hole U1389A at 1145 hr and reached the bottom of the hole. Ten out of eleven stations recorded good sonic waveforms. Stations were spaced at approximately 25 m intervals, and the survey itself lasted from 1300 to 1500 hr. The tool string was back on deck at 1630 hr and logging equipment was rigged down by 1715 hr.

At 1755 hr on 24 December the bit cleared the seafloor and the vessel offset 20 m east of Hole U1389A. Hole U1389B was spudded at 2010 hr, but the full core barrel could not be used to ascertain the seafloor depth. Hole U1389C was spudded with the APC at 2025 hr and established the seafloor depth at 654.5 mbrf (643 mbsl). Piston coring advanced to 95 mbsf. Cores were oriented starting with -3H. There were APCT3 deployments at 19 mbsf (-2H), 47.5 mbsf (-5H), and 76 mbsf (-8H). All cores were obtained with non-magnetic core barrels. Coring continued in

Hole U1389C with the XCB system. The week ended while XCB coring Hole U1389C at ~260 mbsf with the objective of reaching 350 mbsf.

## **Science Results**

This week we completed analyses of all the cores and samples taken at Sites U1387 and U1388, finalized the written scientific reports for Site U1387, and held meetings to present the scientific highlights of Sites U1387 and U1388. At Site U1389, we completed measuring, splitting and describing cores from Holes U1389A and U1389B. We are currently coring and processing cores from Hole U1389C. This week we also held daily meetings to present and discuss post-expedition research plans and sample requests.

The three holes cored at Site U1387 provided enough material to produce a nearly complete composite stratigraphic section down to about 395 meters composite depth (mcd). The spliced natural gamma radiation (NGR) data for the composite section correlate well with the logging NGR, providing a means to assess the completeness of the stratigraphic record and to produce a common core and logging depth scale.

The Sedimentology team completed the lithologic description of all cores from Site U1388 (Holes A, B and C) and is currently describing the cores taken at Site U1389. At Site U1388, the uppermost 7.5 m consist of fine sand with shell fragments both concentrated in layers and scattered throughout the sand. This sand may form the sand waves observed on the video survey collected prior to spudding Hole U1388A. Following the switch to XCB in Hole U1388B, the recovered sediments were primarily silty mud with biogenic carbonate, silty sand with biogenic carbonate and mud with biogenic carbonate. Secondary lithologies were calcareous sand and sand with biogenic carbonate. XCB core recovery improved at about 100 mbsf and more mud beds with biogenic carbonate were recovered deeper with one of the mud intervals being about 15 m thick. Overall the number of sandy and silty beds per core remained constant throughout the entire depth of the hole although these layers occur in relatively higher frequency at about 125 and 230 mbsf. Many of the coarser beds have gradational upper and lower contacts although sharp contacts were also observed. The beds contained bigradational, normal and inverse grading and approximately the same number of beds were assigned to a contour current origin as to a turbidity current origin. A few of the sand layers at this site contained thin stringers of sand with less mud that were much lighter in color, possibly indicating subsequent reworking of sandy sediments. XRD results indicate that the sediments above ~50 mbsf contain a wider range of minerals with greater abundances than at the previous sites. These may be more immature sands or sand beds formed by mixing sediments of several origins.

At Site U1389, Hole U1389A reached 355 mbsf. Preliminary compilations of the stratigraphy at this site are being prepared. Overall, muddy sand and silty sand beds make up about half the stratigraphic section with beds of three meters or more being common. Both contourite bedding and turbidite bedding are recognized, with contourite bedding more commonly observed. Sandy intervals are often separated by nannofossil muds of several meters or more in thickness.

The Biostratigraphy and Paleontology team prepared all the core catcher samples taken at Sites U1388 and U1389 for calcareous microfossils analyses. Pollen content was also examined in two samples from Hole U1388B and is being examined from Hole U1389A. Preliminary results based on various nannofossil events indicate that the age at the bottom of the Hole U1388B (226 mbsf), the deepest hole at Site U1388, may be between 0.6 and 0.9 Ma. At Site U1389, the age at the bottom of Hole U1389A (355 mbsf) is estimated at >0.9 Ma.

The Physical Properties team carried out all routine measurements on cores taken at Site U1388 including magnetic susceptibility, natural gamma radiation, bulk density, colorimetry, thermal conductivity, sediment strength, moisture and density, natural remanent magnetization and associated rock magnetic experiments. At Site U1389, all cores from Holes U1389A (39 cores), U1389B (1 core) and up to Core 18X in Hole U1389C have been measured in the Whole-Round Multisensor Logger and up to Core U1389C-25X in the Special Task Multisensor Logger. Physical property measurements at Sites U1388 and U1389 show pronounced variability partly related to grain size variations and minor detrital compositional changes.

The remanent magnetization of archive-half sections of the APC/XCB and RCB cores from all holes at Site U1388 was measured in the paleomagnetism laboratory before and after 20 mT alternating field demagnetization. Paleomagnetic measurements of split core sections from Hole U1389A are currently in progress. Detailed measurements of the demagnetization behavior of discrete samples were carried out to confirm magnetic results from the pass-through measurements and to determine the demagnetization behavior of the recovered sediments. Inclination data from all three holes at Site U1388 indicate that only the Brunhes (C1n) normal polarity chron is recorded. This interpretation is supported by discrete sample measurements, which exhibit well-defined natural remanent magnetizations with associated maximum angular deviations of <10 degrees.

The Geochemistry team performed standard gas analysis on 20 headspace samples from Site U1388. Methane, ethane, and propane were the only hydrocarbons detected. Bulk sediment analysis of CaCO<sub>3</sub>, total and organic carbon, and total nitrogen were also completed for Site U1388. Headspace and bulk sediment analysis are ongoing for Site U1389. Elemental analyses were made on 14 whole-round samples taken at Site U1388 to a total depth of 211 mbsf, including one sample from Hole U1388A and 13 from Hole U1388B.

Interstitial water measurements of alkalinity, chloride, ammonia, sulfate, and major and minor seawater elements for Site U1388 were completed. Chloride and sodium increase downhole from seawater values at the top to 800 and 690 mM at 211 mbsf, respectively, indicating interaction with a potential brine in the subsurface. Water isotopic measurements were also completed for Site U1388.

At Site U1389, high-resolution (1 per section) interstitial waters were squeezed from hydraulic piston cores in Hole U1389A to a depth of 97.2 mbsf. Below this level, whole-rounds were taken (1 per core) down to a depth of 200 m and every third core thereafter to the bottom of Hole U1389A (350 mbsf). Geochemical analyses are ongoing at Site U1389.

## **Education and Outreach**

This week education and outreach events have continued through diverse activities. Blogs posted on the *JOIDES Resolution* site (<http://joidesresolution.org/blog>) include life at sea, day to day operations, and scientific research ongoing aboard the JR written in several languages (i.e., English, Portuguese, French, Spanish and Dutch) by our international bloggers.

Four live ship-to-shore interactive video conference programs were conducted with 10th graders from IES Inca Garcilaso Mountain (Spain), 5th graders from Brickey-McCloud Elementary School (Tennessee, USA), 6th graders from Misumi Elementary School (Japan) and researchers from the Instituto Geologico y Minero of Spain. Two more videoconferences are scheduled for next week.

In addition, the expedition's Education Officer continued to post daily updates on the JR Facebook page and Twitter account. Updates included links to the blog or other pages on the JR website and photos. Our Education Officer and our Camp Boss have given an interview to SIC (a Nationwide Portuguese TV Station) about the science and life on board the *JOIDES Resolution* to air on Christmas Eve.

## **Technical Support and HSE Activities**

The USIO technical staff was engaged in core processing at Sites U1388 and U1389. Other activities included marine mammal watch during the vertical seismic profile (VSP) experiment conducted in Hole U1389A, assistance to the scientific party, and laboratory and instrument support, as well as minor software upgrades to various applications.

The tug boat '*Obama*' visited the ship at 1340 hrs on 23 December to deliver charts, fresh goods and other supplies. It also took on one departing scientist back to Cádiz, Spain.