

IODP Expedition 339: Mediterranean Outflow

Week 4 Report (5-11 December 2011)

Operations

The 4th week of Expedition 339 began deploying the RCB coring assembly down to the seafloor to start operations at Hole U1386C. The third hole of Site U1386 was offset 20 m south of Hole U1386B and spudded with the RCB at 0345 hr on 5 December. This hole was drilled with a wash barrel down to 405 mbsf, except for RCB coring of two intervals that eluded recovery in the 2 previous XCB 2 holes (Cores U1386C-2R from 165.0 to 174.6 mbsf; U1386C-4R from 205.0 to 214.6 mbsf). Continuous RCB coring started at 405 mbsf at 0545 hr on 6 December and reached the depth objective of 526 mbsf by 0200 hr on 7 December. The rotary cored interval of 140 m recovered 59%. The drilled interval was 386 m. The total cored interval for all holes at this site was 954 m with a recovery of 89% (104 cores).

Following a wiper trip and hole conditioning, Hole U1386C was displaced with 172 barrels of 10.5 ppg mud to prepare the hole for downhole logging. The open end of the pipe was placed at a logging depth of 102.4 mbsf. During the rig-up of the wireline cable, the cable jumped from the lower leftmost sheave wheel in the wireline heave compensator and became jammed between the wheel and the frame. Because of the possibility of damage to the cable, it was cut above the crimped section.

The Triple Combo tool string descended through the seafloor at 2003 hr and was successful in reaching the bottom of the hole (526 mbsf). The tool string was back on deck by 0100 hr on 8 December. Subsequently, the FMS-Sonic tool suite was run into the hole at 0410 hr. The tool suite was blocked from further downhole progress by a bridge at 948 mbrf (375 mbsf) - the lowermost of the tight sections observed in the Triple Combo run. Rig down of the FMS-Sonic was completed by 0930 hr on 8 December.

The marine mammal watch for using sound sources for conducting the vertical seismic profile experiment (VSP) started at 0800 hr on 8 December. The Versatile Seismic Imager (VSI) tool started its descent down Hole U1386C at ~1030 hr and reached a bridge at 940 mbrf (367 mbsf) at 1105 hr. The slightly shallower penetration for this tool run indicated that the hole was closing in with time. The seismic source (two gun cluster; 7 m below sea level on the port side) had been ramped up in a soft start. There were difficulties to get a good clamp with the VSI and consequently noisy waveforms were obtained which were attributed to the rugose borehole and soft formation. Only a fraction of the shots produced clean first arrivals, but there were enough at most stations to stack. The upper part of the hole was especially difficult. The tool was back on deck at 1440 hr and was rigged down by 1530 hr on 8 December. The drill string was recovered and the vessel departed for the next site at 1730 hr on 8 December. The total time on Site U1386 was 8.6 days.

The vessel was offset in DP 2.2 nmi on a bearing of 128° to Site U1387 (proposed Site GC-09A). The transit was accomplished in three hours. During this move, maintenance was performed on the 480-volt switchboard which required shutting down the regulated power from 1800 hr to 1845 hr. The vessel was positioning on Site U1387 at 2030 hr on 8 December. An APC/XCB bottom hole assembly was made up with a used 9 7/8" PDC bit with a LFV and deployed along with the underwater camera. Prior to spudding Hole U1387A, a two-hour survey of the seafloor was made during which many linear furrows on the seabed were observed. These furrows were presumed to be the result of fishing bottom trawls. The vessel had to be offset 10 m from the original position to avoid spudding into what appeared to be manmade debris (spiral of loose wire or cable).

Hole U1387A was spudded with the APC at 0325 hr on 9 December. The sea floor depth calculated from the recovery of the first core established the seafloor depth at 570.5 mbrf (559.1 mbsl). Cores U1387A-1H to 6H advanced to 47.7 mbsf where very sticky and firm clay prevented further progress with the APC. The APC recovery was 48.8 m (102%). Cores U1387A-4H to -6H were oriented. The APCT temperature tool was deployed on Core U1387A-4H (33.9 mbsf). Non-magnetic core barrels were used to obtain all piston cores.

XCB coring was initiated at 0915 hr on 9 December and deepened Hole U1387A from 47.7 mbsf to a final depth of 352.4 mbsf by 0545 hr on 10 December. The XCB cored 304.7 m (98% recovery). The total cored interval of 352.4 m was cored with 99% recovery.

The bit was pulled clear of the seafloor at 0715 hr on 10 December and the vessel offset 20 m east of Hole U1387A. The underwater camera system was deployed to insure that no manmade debris was present on the seafloor prior to coring. Hole U1387B was spudded with the APC at 1050 hr and established the water depth at 569.6 mbrf (558.2 mbsl). Piston coring advanced to 46.9 mbsf before switching to the XCB. Cores U1387B-3H to -5H were oriented. All cores were obtained with non-magnetic core barrels. The interval of 46.9 m was piston cored with a recovery of 103%.

XCB coring deepened Hole U1387B to a final depth of 338.3 mbsf, when it was stopped after it was noted that "biscuiting" (artificial layering), a type of core disturbance caused by transferring rotary torque to the core, had become too severe on the cores taken deeper than ~305 mbsf (from Core U1387A-34X on). The week ended after deploying the RCB coring assembly down to seafloor and starting drilling operations at Hole U1387C.

Science Results

This week we processed all the remaining cores from Hole U1386B, all cores from Hole U1386C, and all cores from Hole U1387A through the ship's laboratories.

At Site U1386, the sedimentary sequence above ~420 mbsf has been designated as Lithologic Unit I, and is composed of three distinct lithofacies: A) nannofossil mud, B) calcareous or nannofossil silty mud, and C) silty sand or sandy silt, both with biogenic carbonate. Changes in the relative abundances of these lithofacies have been used to define 3 subunits within Lithologic Unit I. Subunits IA and IC contain more silty mud and silty sand/sandy silt than the intervening Subunit IB. Lithologic Unit I overall is interpreted to have been deposited primarily under the influence of contour currents, with the changes between subunits recording variability in current strength and sediment supply to Site U1386. Below ~420 mbsf, the sedimentary sequence has been designated as Lithologic Unit II. While the 3 lithofacies that dominate Unit I are still present in Unit II, 2 additional lithofacies are present in Unit II: A) sharp-based, fining-upward sandy to silty beds, and B) beds with granule- to pebble-size rip-up clasts, in a muddy-to-sandy matrix (including abundant shells and shell fragments). Sediment in Unit II shows evidence of significant deformation (including contorted intraclasts and recumbent folds). The two lithofacies are interpreted to record significant gravity-driven downslope transport, both as turbidity currents and as high-concentration mass flows (debris flows). All sediments at Site U1386 are dominated by colors of gray to dark gray to very dark gray. Macrofossil debris is relatively common, mostly as shell fragments. However, identifiable corals, gastropods, bivalves, and echinoid spines have been found. Bioturbation intensity varies from sparse to slight, and recognizable ichnofauna are rare.

At Site U1387, the sedimentary sequence recovered from Hole U1387A is characterized by the same lithofacies found at Site U1386: A) nannofossil mud, B) silty mud with biogenic carbonate, and C) silty sand with biogenic carbonate. Initial observations indicate that the silty sand lithofacies is relatively rare in the upper ~350 m at Hole U1387A. As at Site U1386, the sediment color at Hole U1387A is predominantly gray to greenish gray to dark gray to very dark gray. Macrofossil debris is relatively common, especially as shell fragments. Bioturbation intensity generally is sparse to slight, but recognizable ichnofauna are rare.

Core catcher samples from Site U1386 and the first hole at Site U1387 were prepared for nannofossil, planktonic and benthic foraminifer, and ostracod analyses. Pollen content was also examined at selected samples from both sites. Additional nannofossil samples were also taken at selected core intervals to refine the biostratigraphy. Based on these analyses, the age of the stratigraphic section recovered at Site U1386 was estimated as ~5.8 Ma. Benthic foraminifer and ostracod assemblages reflect changes in oceanographic conditions, bottom water ventilation and sediment deposition. At Site U1387, biostratigraphic analyses of core catcher samples from Hole U1387A provide an age of 1.6 Ma for the bottom of Hole U1387A (352 mbsf). Analyses of core catcher samples at Site U1387 are still in progress.

All routine laboratory measurements have been carried out on all cores from Site U1386 and Hole U1387A, including core logging (magnetic susceptibility, natural gamma radiation, bulk

density, colorimetry); measurements of thermal conductivity, sediment strength, moisture and density; and natural remanent magnetization and associated rock magnetic experiments. Physical property measurements show pronounced variability related to changes in clay and detrital content of the sediments. Results from discrete samples taken from the relatively undisturbed drilling biscuits in cores from Site U1386 enabled us to identify the Brunhes/Matuyama boundary at ~275 mbsf, and both the top and base boundaries of the Jaramillo Subchron, at ~345 and ~375 mbsf, despite significant loss of magnetic intensity and the compromised quality of the magnetic signal in the split XCB and RCB core sections.

Standard gas analysis from headspace samples from Holes U1386A through C, and U1387A were carried out at a resolution of one per core. The detected hydrocarbons were methane, ethane and ethene. At Site U1386, we also completed bulk sediment analysis of CaCO₃, total carbon, total organic carbon and total nitrogen. Inorganic carbon was measured and CaCO₃ content calculated down to 526 mbsf using samples from Holes U1386A, B and C. Measured total carbon and nitrogen, and calculated total organic carbon and C/N ratios were obtained in Hole U1386A down to a depth of 289 mbsf. We estimated organic carbon by subtracting the inorganic carbon in wt% from the total measured carbon in wt%. The technique for acidification and direct measurement of organic carbon via CHNS was tried and rejected. We observed unexpected leakage from the silver capsules used in the acidification process leading to sample loss and under-reporting of organic carbon and nitrogen content in the samples in the process. High-resolution interstitial water sampling (rhizon) for shipboard water isotopic analysis and shore-based chloride measurements was done in the top 150 meters at Hole U1386A. Standard shipboard interstitial water samples were taken from whole rounds at the bottom of each core in the top 150 meters and from every third core thereafter until Core U1386B-41X (~377 mbsf). Interstitial water measurements of alkalinity, chloride, ammonia, sulfate, and major and minor seawater elements for Site U1386 were all completed. High-resolution water isotopic analysis for Site U1386 is still in progress, but is complete up to Core U1386A-8H.

At Site U1387, whole rounds for interstitial water analyses were taken at a resolution of one per core in the top 150 m and every third core thereafter to the bottom of Hole U1387A. Rhizon samples were also taken from the center of the same section as the whole round in the top six cores to continue to compare results between the sampling methods. Rhizon sampling ended at APC refusal in Hole U1376A due to 1) the difficulty in extracting water from this sediment lithology and 2) the expected sediment water disturbance by the XCB. Alkalinity and chloride measurements from Hole U1387A are complete. Sulfate and major element analysis are in progress and should be completed by the end of the day.

Education and Outreach

Expedition participants continue to share their experience aboard the *JOIDES resolution* on the *JR*'s website (<http://joidesresolution.org/blog>) and other blogging sites (for example,

<http://www.uu.nl/faculty/geosciences/NL/Actueel/dossiers/expeditiemediterraneanoutflow/Pages/default.aspx>; and <http://mfiodpexp339.canalblog.com/>).

One live ship-to-shore interactive video conference program was conducted with 10th graders from International School Valbonne Sophia Antipolis (France). Four other videoconferences are scheduled for next week. The expedition's Education Officer continued to post daily updates on the *JR* Facebook page and Twitter account. Updates include links to the blog or other pages on the *JR* website (e.g. glossary) and photos. In addition this week our Education Officer has devoted significant time to his own students regarding the development of classroom activities using bathymetric data.

Technical Support and HSE Activities

Activities of the USIO marine technical staff included laboratory and instrument support, processing, curation and storage of cores from Sites U1386 and U1387, and marine mammal watch during the vertical seismic profile (VSP) experiment conducted at Site U1386. An Abandon Ship Drill was held for all hands on 9 December.