

IODP Expedition 366: Mariana Convergent Margin

Week 7 Report (22–28 January 2017)

In the first two days of Week 7 we completed the remaining tasks at the screened casing installations at Hole U1496C (Big Blue/Asùt Tesoru Seamount) and Hole U1497D (Blue Moon/Yinazao Seamount). The new cased holes at the three serpentinite mud volcano summits are now ready for future deployment of borehole monitoring instruments. We then moved to the last site of the expedition, Site U1498, on the lower slopes of Blue Moon/Yinazao Seamount where Hole U1498A cored through serpentinite mudflows to underlying microfossil-bearing volcanic ash. For Hole U1498B, we moved 700 m upslope to the northwest, where coring of serpentinite mudflows started on 26 January and is still in progress.

Operations

Hole U1496C (18°06.6074'N, 147°06.1000'E, water depth 1244 mbsl; proposed Site MAF-11A)

At Hole U1496C, following the deployment of the water-sampling temperature probe (WSTP) the previous day, the drill pipe was lowered down the casing and found fill at 99 mbsf, ~7 m above the base of casing, a depth similar to where it was when the casing was installed on 12 January. We sampled the material inside the casing with Cores U1496C-12G and 13G, which recovered 7.7 m serpentinite mud with lithic clasts from this previously cored depth interval. Five barrels of 14 ppg cement were pumped with the aim of sealing the base of casing. The drill pipe was raised above the seafloor and flushed to remove any residual cement, and then raised back to the ship, concluding operations at Site U1496.

Hole U1497D (16°32.2548'N, 147°13.2621'E, water depth 2020 mbsl; proposed Site MAF-9B)

We arrived at Hole U1497D at 2045 h on 22 January after a 95 nmi, 9 h transit. Hole U1497D was reentered at 0325 h on 23 January, and the drill pipe was lowered to 24 mbsf, in the middle of the top joint of screened casing, where the WSTP was deployed to sample borehole fluids and take temperature measurements. In contrast to the WSTP sample at Hole U1496C, here the water sample was mostly drilling fluid (seawater). The drill pipe was lowered further to check the location of the cement plug, now that it had time to harden. The top of cement was tagged at 103 mbsf, about 4 m above the base of the casing, thus the cement plug is well positioned to stop the formation entering into the casing. The ROV landing platform was deployed by free-fall. On the expedition's previous visit to Site U1497, the beacon failed to release, so this time we fished it manually using a grappling hook that had been attached to the subsea camera frame for this purpose. This concluded operations at Site U1497.

Hole U1498A (16°27.0898'N, 147°9.8502'E, water depth 3497 mbsl; proposed Site MAF-10B)

The drill pipe was raised to 1966 mbsl and the ship transited 6 nmi in dynamic positioning (DP) mode to Site U1498 (MAF-10B) in 9 h, arriving at 2300 h. We moved the location of the first hole at Site U1498 southwest ~1300 m (downslope) from the prospectus location to the toe of the slope where the serpentinite mud flows are thinner and where drilling could reach the underlying pelagic sediments more easily in the remaining operation time. The drill string was lowered and tagged the seafloor at 3497 mbsl at 0615 h on 24 January. The steep (~25%) slopes at the foot of the mud volcano caused underestimated seafloor depths when calculated from precision depth recorder (PDR) or the seismic seafloor reflection, and the bathymetric data for the site location proved to be more accurate. Cores U1498A-1R to 19R penetrated 182 m and recovered 21 m (11%). Coring was faster below 45 mbsf, in the nannofossil-bearing volcanic ashes that underlie the serpentinite mudflows. Following low recovery, we ended Hole U1498A at 182 mbsf, and moved ~700 m upslope to the northeast, to a location where the serpentinite mud flows are thicker.

Hole U1498B (16°27.3716'N, 147°10.1166'E, water depth 3285 mbsl; proposed Site MAF-10B)

At 0300 h on 26 January, the seafloor at Hole U1498B was tagged with the drill pipe, and the tag was observed with the subsea camera to confirm the water depth and check seafloor conditions on the lower slope of Celestial Seamount. Cores U1498B-1R to 20R penetrated 186 m and recovered 64 m (34%). In the upper five cores, the rotary core barrel (RCB) coring system preferentially recovered hard rock clasts, but below this depth, recovery of serpentinite muds increased with depth.

Science Results

Core Description

Cores recovered from Hole U1498A comprise six units. Unit I is 5.40 m of fine to medium-grained brown muddy silt with microfossils. Unit II is an 11.01 m interval of ultramafic rock, metavolcanic rocks, and breccias containing metavolcanic rocks. Unit III is 6.34 m thick and is subdivided into two subunits: Unit IIIA is 4.15 m thick and consists of alternating, mostly horizontal layers of blue, green, and yellow-orange serpentine sand and silt containing dispersed acicular aragonite and no lithic clasts. The layers average 5 cm thick and range between several millimeters up to 25 cm in thickness. Unit IIIB is 2.19 m thick and consists of intercalated blue and green sandy serpentine muds in distinct layers with a 10 cm layer of serpentinized ultramafic pebble-size clasts near the top of the core, possibly fall-in material. Unit IV is 7.72 m thick and consists of lenticular layered brown and bluish gray silty serpentine mud with sand and volcanic ash and sparse serpentinized ultramafic pebble-sized clasts in the blue zone. Unit V is a 29.35 m interval in which there was only 1.3% recovery of mixed serpentinized ultramafic and

metavolcanic pebble-sized clasts with some clots of silty ash. Unit VI is subdivided into six subunits, based primarily on lithological changes that occur between significant core recovery gaps. Overall, Unit VI extends for at least 80 m, from about 100 mbsf to the bottom of the hole, but core recovery was less than 10% and the lowermost portion was largely fall-in deposits. Unit VIA is <1 m of mixed pebble-sized clasts of pumice, sandstone, siltstone, and serpentinized ultramafic rocks, some with red-brown weathering. Unit VIB, starting at about 113 mbsf, is nannofossil-rich sand and ash. Unit IV probably marks the interface between the seamount formations and the underlying seafloor sediments. Discoaster nannofossils were observed in smear slides and scanning electron microscope (SEM) microscopy in one of the clots of ash-rich sediment in Unit V (U1498A-9R-CC). They were preliminarily identified as dominantly *D. variabilis*, with occasional *D. brouweri* and possibly *D. quinquerramus*, all giving a minimum age of about 2.5 Ma.

At Hole U1498B, cores have been described down to Core 19R (176 mbsf), and units have not yet been assigned. These cores contain mildly to highly serpentinized ultramafic rock alternating with intervals of dense, highly viscous blue-gray serpentinite mud, reflecting the greater thickness of serpentinite mudflows at this hole compared to Hole U1498A. The clasts are predominantly mildly to moderately serpentinized harzburgites and dunites, some with multiple generations of serpentine veins.

Geochemistry

Porewaters were extracted from Cores U1496C-12G and 13G (the muds that had upwelled into the casing), along with 17 porewater samples from Holes U1498A and U1498B. pH values from the two cores from Hole U1496 are over 12, and the WSTP was similarly high, further confirming active fluid flow from depth at Big Blue (Asùt Tesoru) Seamount. At Hole U1498B, pH values plateau at about 11 below 50 m, and salinities reach as low as 26. Thirty-six headspace gas samples were taken for measurement of hydrocarbons, H₂, and other volatiles.

Sixty new ICP analyses were made on rocks and muds from Sites U1493, U1494, U1495, U1496, and U1497. The combined data for serpentinites from the three studied seamounts span similar ranges in MgO, Cr, and Al₂O₃. CaO also shows a wide range in values across the seamount drill sites, from near zero to more than 10% wt. The Na₂O abundances in the serpentinites clearly distinguish the clasts from the muds, and to a degree reflect the compositionally very different porefluid compositions with which they are equilibrated. There is also some evidence in the serpentinite data for mixing toward the compositions of recovered metabasalts.

Physical Properties

Because of relatively low core recovery at Hole U1498A, preliminary observations focused on serpentinite muds in Hole U1498B. These serpentinite mud deposits have similar values than those measured along the flank of the previously analyzed Big Blue (Asùt Tesoru) mud volcano

(Sites U1493, U1494, and U1495). Bulk density generally ranges from 2.0 and 2.3 g/cm³, natural gamma ray (NGR) values are extremely low (<1 counts/s), and magnetic susceptibility (MS) is highly variable, varying from 200 to 1000 × 10⁻⁵ SI with higher peaks over 2000 × 10⁻⁵ SI. In comparison to the previous sites, drilled with half-length advanced piston corer (HLAPC)/ extended core barrel (XCB) drilling, the serpentinite mud core sections retrieved with RCB coring produced a more consistent *P*-wave velocity dataset, with values ranging mostly between 1700 to 2000 m/s.

Downhole Measurements

Borehole fluid temperature measurements taken with the WSTP at Holes U1496C and U1497D are being analyzed in terms of formation temperature, temperature equilibration of the borehole fluid, and (at Hole U1496C) formation fluid flow.

Paleomagnetism

The remanent magnetization from sections and discrete samples of Holes U1498A and U1498B was measured with the superconducting rock magnetometer at 5.0 cm intervals after 5–20 mT and after 5, 10, 15 and 20 mT alternating field (AF) demagnetization steps, respectively. Overprints are pervasive. There is some lithologic dependence in the paleomagnetic results. The darker layers from Cores U1498A-4R and 5R have a higher magnetic intensity than the lighter layers, which have less than 0.5% of magnetite and a relatively large amount of aragonite compared with the darkest layers, which reach to more than 5% of magnetite. The calibrated bulk magnetic susceptibility of three rock samples of Hole U1498A and 23 rock samples from Hole U1498B was measured with the AGICO KLY 4S Kappabridge. We observe variation in bulk magnetic susceptibility values from different types of clasts, varying by over one order of magnitude.

Education and Outreach

Over the past week, the Education/Outreach Officers hosted 12 live broadcasts with schools from the U.S., France, and Germany, with students ranging from 5th grade to university undergraduates. Three blogs were published on the <http://joidesresolution.org> website this week, as well as daily social media posts with photos of the latest core samples and ship activities. Two videos were produced, one about the Microbiology team, and one video diary about the latest shipboard celebrations and updates. The Education/Outreach Officers have started writing reports and drafting postcruise article ideas related to their IODP science education and outreach experience.

Technical Support and HSE Activities

Over the last week, technical staff supported science activities at Site U1498, worked on various laboratory systems and maintenance projects, and started end-of-expedition logistics.

Laboratory Activities

- Store: The store was cleaned and reorganized.
- Fantail: Removed and packed towed seismic equipment for return to College Station.
- NGR: Ends on both of the core boats broke. We turned one boat around to complete the expedition.

Application Support Activities

- LDAQ project: Working toward a replacement for the Coulometer software.
- TestLog: Modified service so that it includes test.instrument when evaluating whether it should update preexisting tests' x_display flag. Tests produced by different instruments (such as magnetic susceptibility from the Special Task Multisensor Logger [STMSL] and Whole-Round Multisensor Logger [WRMSL]) should not be considered together in this respect.
- SampleMaster: Worked on two defects discovered by the drillers.
- DESClogik: Deployed 16.1.0.10, and later .11, to fix two defects reported by scientists.
- ImageCapture: Deployed 5.0.0.2. Identified that it does not consistently send the "display" parameter to the TestLog service.

IT Support Activities

- There were no major changes during the week beginning 22 January 2017.
- Two pilot users were migrated successfully to Microsoft Exchange email.
- We are working with the VSAT service carrier RigNet to switch to a satellite viewable from the VSAT antennas while in port in Hong Kong. Our current satellite has a high likelihood of being blocked by terrestrial structures around the ship's dock. There is a moderate risk of extended Internet outage in the coming week while we switch over to the new satellite. The work on the ship will involve physical replacement of hardware inside both antenna domes. The potential outage has been communicated to the science party and technical staff.
- The MCS office is beginning End of Leg (EOL) procedures.

HSE Activities

- Held the weekly fire and boat drill as scheduled.