IODP Expedition 366: Mariana Convergent Margin

Week 6 Report (15–21 January 2017)

This week we installed screened casing in Hole U1497D on Celestial (Fantangisña) Seamount, and then returned to Holes U1492D and U1496C, where screened casings had been installed earlier in the expedition. At Hole U1492D, at Blue Moon (Yinazao) Seamount, we broke up the bridge plug that had been blocking the hole, and at Hole U1496C, on Big Blue (Asùt Tesoru) Seamount, we took a water sample and removed ~7 m of fill. It is anticipated that instruments will be deployed in these cased holes in the next few years to monitor fluids, temperature, pressure, and microbial life in serpentinite mud volcanoes. No new coring took place this week.

Operations

Hole U1497C (16°32.2504'N, 147°13.2500'E, water depth 2019 mbsl; proposed Site MAF-9B)

Hole U1497C started at 1145 h on 15 January; the aim was to drill down with a 14.75 inch bit to about 120 mbsf and then deploy screened casing in this predrilled hole for future borehole monitoring at this site. However, we stopped this hole at 12 mbsf because of high torque and slow penetration.

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

For a second attempt to drill a 14.75 inch hole to 120 m, we started Hole U1497D at a location 5 m north of where Hole U1497B had achieved reasonable penetration. Hole U1497D reached 120 mbsf at a slow but steady average rate of 7 m/h. The formation was firm and the hole appeared to be in good condition, apart from a difficult zone in the upper part of the hole, perhaps related to loose sand and gravel observed in Hole U1497A between 23–26 mbsf. The hole was swept with 50 barrels of high viscosity mud to prepare for installing the screened casing. The reentry cone was deployed by free-fall, then the drill pipe was raised back up to the ship.

The rig crew assembled the 106 m long casing string including three joints of 10.75 inch casing, three joints of screened casing, and three further joints of 10.75 inch casing. The regular casing joints underneath the screened section provided space for cement to seal the bottom of the casing to prevent the formation from entering. The mud motor and underreamer assembly was lowered through the casing string and the running tool on the drill pipe was attached to the hanger at the top of the casing. The bit and underreamer extended ~4 m below the base of the casing. The whole assembly was lowered to the seafloor, and Hole U1497D was reentered at 2310 h on 17 January. The casing was successfully installed to 107 mbsf in Hole U1497D by 1230 h on 18 January. During the installation, it took ~5 h to pass below a difficult zone at ~40 m. Then at

~70 mbsf, the casing prematurely released from the running tool, falling ~15 m further down the hole (a similar premature release happened at Hole U1492D, earlier in the expedition), but we were able to continue washing and reaming down to the target depth. The hole was swept with high viscosity mud and the drill pipe and underreamer assembly was raised back up to the ship.

Hole U1497D was reentered with the cementing bottom-hole assembly which was lowered to 105 mbsf, where five barrels of 14 ppg cement was pumped down to seal the bottom of the casing at that depth. The drill pipe was raised above the seafloor and the drill pipe was flushed to remove any residual cement. The bit was at the rig floor at 1540 h on 19 January and the ship prepared for transit. The positioning beacon would not release from the seafloor, but we planned to return to Hole U1497D to check the location of the cement plug later in the expedition so we will make another attempt to retrieve the beacon then.

Hole U1492D (15°42.5694'N, 147°10.5991'E, water depth 3666 mbsl; proposed Site MAF-15A)

The 50 nmi transit to Hole U1492D (Blue Moon Seamount) took 5 h. A custom-built bridge plug hammer was prepared with the aim of unblocking the casing at Hole U1492D. Hole U1492D was reentered at 0740 h on 20 January and the bridge plug was tagged at 40 mbsf. It was hammered over a period of 3 h before it broke and moved downhole. The pipe was lowered and we relocated the fallen bridge plug at 211 mbsf, just below the base of casing, confirming that the casing is unblocked. The ROV landing platform was deployed by free-fall, landing very close to being centered in the reentry cone. The base of casing was cemented with five barrels of 14 ppg cement; cementing is now the expedition's preferred method of sealing the base of casing because of the risk that the mechanical bridge plugs could set prematurely.

Hole U1496C (18°06.6068'N, 147°06.1001'E, water depth 1244 mbsl; proposed Site MAF-11A)

We arrived at Hole U1496C at 1525 h after the 144 nmi, 13.4 h transit from Hole U1492D. The drill pipe was lowered to the seafloor and reentered Hole U1496C without difficulty, despite having to pass through the 32 inch diameter central aperture in the ROV landing platform. We used a 9.825 inch polycrystalline diamond compact (PDC) bit because it was narrow enough to fit inside the casing. The drill pipe was lowered to 42 mbsf, within the upper joint of screened casing, where the water-sampling temperature-pressure tool (WSTP) was deployed to sample borehole fluids and temperature measurements. Initial geochemical measurements of the ~1 L fluid sample indicate that it was mostly formation water, mixed with some drilling water (seawater).

Science Results

No new core was recovered this week, but analyses and interpretations of material collected in Holes U1497A and U1497B (the summit of Fantangisña Seamount) continued, and all groups worked on site reports.

Core Description

While the large majority of the clasts at Site U1497 are serpentinized ultramafic rocks, petrographic analysis of the thin sections also identified several with volcanic textures, ranging from dolerites to basalt and basalt vitrophyre. Some vitrophyres occur in breccias that may have been pyroclastic originally. Many of the clasts contain pink, slightly pleochroic clinopyroxene, and one contains euhedral olivine (now serpentine) in the groundmass as well as phenocrysts. The pink clinopyroxene is consistent with the mineral titanaugite, and is suggestive of mildly alkaline basalt compositions; this is supported by the occurrence of groundmass olivine. Others contain colorless clinopyroxene and may be tholeiitic basalts. Thin sections show that many of the clasts in the reddish matrix-supported polymict breccia unit are sedimentary lithologies, including cherty limestone and siltstone, almost all of which have been deformed by faulting. Shear fabrics are ubiquitous, and some clasts are ultracataclasites. The less-deformed clasts contain microfossils such as radiolaria. These materials are thought to represent samples of a subducted seamount.

Petrographic analysis also revealed the occurrence of peridotite clasts from Site U1497 that have only minor serpentine alteration, and still contain all of their primary phases. One clast in particular is almost a lherzolite (olivine + orthopyroxene + clinopyroxene), which makes it unique among the samples identified to date.

Geochemistry

The geochemistry team completed analyses on porewaters from Site U1497. This included pH, chlorinity, alkalinity, salinity, anions (Cl, Br, SO_4, PO_4, NH_3 Sulfide), TIC/DOC, and cations (Ba, B, Fe, Li, Mg, Mn, K, Si, Na, and Sr, using a combination of ion chromatography [IC], spectrophotometry, and inductively coupled plasma–atomic emission spectroscopy [ICP-AES]). An additional 25 rock samples were analyzed for major and selected trace elements by ICP-AES. At Site U1497, pH reaches 11. In many respects the porewater geochemical profiles at Site U1497 look similar to the profiles on the flanks of both Yinazao and Asùt Tesoru seamounts, rather than their summits. No active seeps were observed on the summit of Fantangisña Seamount, so it is likely that the serpentinite muds recovered here are older than at the summits of the other two seamounts.

Physical Properties

Serpentinite muds recovered in Holes U1497A and U1497B show similar physical properties to those measured along the flank of Asùt Tesoru seamount (Sites U1493, U1494, and U1495),

with GRA density of about 2.0–2.3 g/cm^3, porosity of 20%–40%, extremely low natural gamma radiation (NGR) values (<1 cps), and magnetic susceptibility (MS) of about 600 to 1000 × 10^{-5} SI with higher peaks up to 2000 × 10^{-5} SI. The dusky red breccia and conglomerate units are distinct from the serpentinite mud in their physical properties, for example with NGR values up to 25 cps, suggesting higher clay contents.

Downhole Measurements

At Hole U1496C the WSTP was deployed inside the casing to obtain a water sample and measure the temperature profile between the seafloor and the water sampling depth at 43.5 mbsf. Both efforts were successful. The goal in measuring the temperatures is to use the borehole values to extrapolate the in situ formation temperature. Bullard (1947) and Jaeger (1956) estimated that equilibration time requires 10–20 times the total time spent drilling. A total of 3.78 d were spent coring and casing in Hole U1496A and the time between when the pumps were shut-down after the casing installation (13 January) and acquisition of the temperature profile (21 January) is 8.5 d. Analyses to extrapolate the formation temperature are in progress.

Paleomagnetism

Remanent magnetization measurements were conducted on archive section halves and 22 discrete samples of the cores from Holes U1497A and U1497B at 5.0 cm intervals after 5–20 mT alternating field (AF) demagnetization steps. Relatively high NRM intensity averaging ~1.3 × 10^{-1} A/m occurs in lithostratigraphic Unit IIB (bluish-gray matrix-supported, monomitic serpentinite breccia with clasts), while the lowest values of about 1.0 × 10^{-2} A/m are registered in Unit III (reddish matrix-supported polymict breccia). Unit III also has the lowest magnetic susceptibility values. Similarly to the previous sites, paleomagnetic inclinations are generally close to vertical, reflecting overprint and drilling deformation, except the inclinations between 0° and 24° registered in the pelagic brown sediments from Unit I of both holes.

Education and Outreach

The Education/Outreach Officers hosted 15 live broadcasts with schools this past week, with classes from the U.S., France, Germany, and Morocco. A science spotlight video featuring the shipboard geochemists was posted during the week, and a video on microbiology is in the editing phase. We made daily social media posts as well as blogs to the http://joidesresolution.org website, and continue to gather photos and video footage for future posts.

Technical Support and HSE Activities

Technical staff engaged supporting science at Site U1497, working on various laboratory systems, maintenance projects, and prepping for end-of-expedition logistics.

Laboratory Activities

- Special Task Multisensor Logger (STMSL):
    - *P*-wave logger (PWL): Ran data quality tests and developing calibration methods.
    - Rewired system and cleaned up hardware installation.
- Superconducting rock magnetometer (SRM): Refinished and reinstalled temporary shelf; completed final hardware installation details such as cable labeling.
- JR6 spinner magnetometer: Vendor is providing a quote to modify the output a file to a format suitable for uploading to LIMS.
- Chemistry Laboratory: Vendor recommended that we "reintegrate" the auto-sampler to the GC. The scientist party was not enthusiastic about this so the issue will be passed to the oncoming crew.
- Thin Section Laboratory: The "vintage" replacement polisher blew two capacitors that filter the line power voltage. The capacitors were removed and we plugged the polisher into a regulated power supply.
- Downhole Laboratory: The WSTP was successfully deployed for the first time since Expedition 309 in 2005.
- Pallet Stores: Reorganized and sorted material rack. Disposed of excess scrap material.
- Fantail: Installed the new motor controller on the port winch and rebuilt the fleet-arm sensor. The level-wind system for the magnetometer cable will be tested on the transit into Hong Kong.

Application Support Activities

- LIVE: Created a new template and format for comparing results from the WRMSL and STMSL. Discovered that the source for the Instrument list was wrong and changed to use the Result table instead of the Test table.
- LIVE PanelBuilder: Fixed numerous problems reported by test team.
- LIVE code: Rebuilt and deployed on ULURU.
- LDAQ: Worked on controller and prepared a demonstration for the next Zoom meeting.
- DESClogik: Fixed issue where records were pulled down to separate tabs with the same name.
- NGR: Fixed issue with the report's timestamp.
- MUT: Deployed version 15.2.0.5.
    - Fix for date/time parsing on NGR;
    - PXRF uploader;
    - Ghost cores modified so that their top and bottom curated depths agree with length of the material recovered from that core and they are recorded at the base of the interval that was cored, rather than beneath it. This will allow LIMSpeak (LIVE) to plot the ghost cores without overlap.
- LIME: Version 4.1 deployed and tested.

IT Support Activities

- No major changes took place during the week beginning 15 January 2017.
- Completed testing the video encoder for the ship's cameras. The Poop Deck camera feed has been returned to its configuration used at the start of the expedition.
- The MS Exchange project is ongoing.
- The subsea vibration isolated television (VIT) video pixelation problem that we experienced last week has been mitigated. Mike Meiring reports that during the previous two VIT deployments only minor events of pixelation occurred on the VIT video. The pixelation affects only a very small portion of the screen and for only about 2 s every 5 min. According to Mike, the video is functional.

HSE Activities

- Held the weekly fire and boat drill as scheduled.