IODP Expedition 366: Mariana Convergent Margin

Week 5 Report (8–14 January 2017)

This week was spent coring and installing casing at Site U1496 on the summit of Big Blue (Asùt Tesoru) Seamount and coring the first two holes at Site U1497 on the summit of Celestial (Fantangisña) Seamount. Site U1496 is located at the site of an active spring, and the shipboard interstitial water geochemical measurements confirm fluid flow from depth. The screened casing deployment to 109 mbsf in Hole U1496C provides infrastructure for future monitoring of the fluids, temperature, and microbiology at Big Blue (Asùt Tesoru) Seamount.

Operations

Hole U1496A (18°6.5936'N, 147°6.0999'E, water depth 1244 m; proposed Site MAF-11A)

Coring at Hole U1496A (proposed Site MAF-11A) began at 0045 h on 8 January after a 1 nmi transit from Site U1495. The site is located on the summit of Big Blue (Asùt Tesoru) Seamount. We started with half-length advanced piston corer (HLAPC) coring, and switched to extended core barrel (XCB) coring after Core U1496A-9F did not achieve a full stroke. Penetration rate slowed further and after reaching 44.8 mbsf we ended the hole. Hole U1496A penetrated to 44.8 mbsf and recovered 38.7 m of core (86%).

Hole U1496B (18°6.6210'N, 147°6.1000'E, water depth 1240 m; proposed Site MAF-11A)

Hole U1496B was started at 1915 h on 8 January, 50 m to the north of Hole U1496A. Coring proceeded well until a clast-rich zone starting at about 28 mbsf slowed coring. To try to pass through the zone we took XCB Core U1496B-8X, then drilled ahead to 34.3 mbsf and took Core U1496B-10F, which contained only rock clasts, so we ended the hole at this point. Hole U1496A penetrated to 36.0 mbsf and recovered 38.7 m of core (86%). To reach the target depth of about 110 mbsf for the emplacement of screened casing at this site, we pulled the drill pipe back up to the ship to switch to rotary core barrel (RCB) rotary coring in a new hole.

Hole U1496C (18°6.6074'N, 147°6.1000'E, water depth 1244 m; proposed Site MAF-11A)

Hole U1496C was started at 2320 h on 9 January at a location midway between the first two holes at the site. Coring progressed quickly, penetrated 105 m, and recovered 8.52 m of core (8%). Cores U1496C-1R and 11R contained serpentinite mud with rock clasts, and Cores U1496C-5R and 7R contained ultramafic rock clasts with serpentinite veins, but the other cores were empty. The low levels of core recovery were anticipated for rotary coring in this material, and the coring did its intended job of reaching 105 mbsf, the depth to which casing would be emplaced in the hole. The hole was swept and reamed, the reentry cone was deployed, and the drill pipe was raised back to the ship. The hole was reentered at 2340 h on 10 January with a

14.75 inch bit, and Hole U1496C was widened by drilling and reaming to 120 mbsf to prepare the hole for casing. The drill pipe was raised up to the drill floor and the 105 m long casing was assembled.

The casing for Hole U1496C consisted of two regular 10.75 inch casing joints, three screened casing joints, and three further regular casing joints, connecting to a 16 inch casing hanger at the top. The underreamer and mud motor bottom-hole assembly (BHA) was assembled and lowered through the casing, and the running tool on the BHA was attached to the casing hanger on the casing. The bit extended about 4 m below the base of casing. The casing and bit/underreamer assembly reentered Hole U1496C at 0130 h on 12 January, and reached the target depth of 109 mbsf at 1100 h. Downward progress was fairly rapid, apart from taking a few hours to pass through a hard zone at ~40 mbsf. The casing was latched to the reentry cone and the bit/underreamer assembly was pulled inside the casing. The ~4 m diameter circular ROV platform was deployed and landed slightly off-center, by about 1 ft, but is still functional. Hard fill was found inside the casing at 99 mbsf, indicating that formation material had come up about 6 m inside the casing. The drill pipe was raised up to the ship and the rig floor was secured for transit to Site U1497 (proposed Site MAF-9B).

Hole U1497A (16°32.2538'N, 147°13.2641'E, water depth 2020 m; proposed Site MAF-9B)

The 94 nmi transit to Site U1497 (proposed site MAF-9B) took 9 h at 10.4 kt. Site U1497 is located near the summit of Celestial (Fantangisña) Seamount, and is known from previous ROV dives to have more surface boulders and cobbles than the other two seamounts drilled on this expedition. Prior to starting the hole, we surveyed the seafloor with the subsea camera to find preferred coring locations with fewer surface rocks. Hole U1497A was begun at 1915 h on 13 January and reached 34.2 mbsf using a combination of HLAPC and XCB coring. After each HLAPC core we reamed/drilled down to the base of advancement of the previous HLAPC core, during which we recovered additional core material ("ghost" cores, which come from an interval that had been previously penetrated). Hole U1497A cored 34.2 m and recovered 23.4 m of core (70%).

Hole U1497B (16°32.2528'N, 147°13.2606'E, water depth 2019 m; proposed Site MAF-9B)

Hole U1497B was started at 1530 h on 14 January, reaching 25.1 mbsf and recovering 23.8 m of core (95%). It was decided to stop the core at this point, and the bit was raised clear of the seafloor at 0005 h on 15 January.

Science Results

Core Description

At the top of Hole U1496A, 15 cm of brown mud and lithic clasts had a sharp contact with 40 cm of underlying dark bluish gray (almost black) clayey mud with lithic clasts. Most of the rest of the hole consists of light bluish gray serpentinite mud with 5%–10% of highly serpentinized ultramafic clasts in the pebble to cobble range. At 33 mbsf we recovered fluffy, gas-rich light bluish gray serpentinite mud that contained a much higher sand-size matrix component and no lithic clasts larger than granule size. This interval appears to be related to drilling disturbance when the drill bit encountered a clast-rich layer at ~40 mbsf. The top 12 cm of Hole U1496B is dark bluish gray to almost black, 5%–10% lithic-bearing serpentinite mud containing foraminifera. In general, the thinner marine sediment layer at the seafloor suggests less time had passed since the underlying serpentinite mudflow was deposited. Light greenish gray serpentinite muds continue to 28 mbsf, and sediments at the base of this unit showed similar loss of the larger lithic fraction to the equivalent layer at Hole U1496A. Below 28 mbsf a clast-rich zone contains ultramafic and metabasite rock clasts. Most of the cores from Holes U1496A and U1496B are affected by up-arching and flow-in drilling disturbance. Hole U1496C was cored using RCB, recovering larger clasts than those with the APC/XCB system. Clasts included serpentinized harzburgites with zones of "Frankenstein" type serpentine veins as well as a metabasalt.

At Hole U1497A on Celestial (Fantangisña) Seamount, the uppermost 45 cm is brown pelagic mud underlain by lithic clast-bearing serpentinite mud grading from light green to bluish gray. These serpentinite muds are clast-rich (up to 50% primarily ultramafic clasts). A 2 m thick dusky red, oxidized brecciated sequence starting at 18 mbsf contains clasts of carbonate breccia, greenstone, siliceous (chert?) breccia, serpentinized ultramafic rock, and siltstone. Below this zone is an interval of dark bluish gray serpentinite sand and gravel extending for about 8 m, underlain by severely drilling-disturbed mixed serpentinite muds and more reddish-brown breccias and conglomerates. At Hole U1497B, ~40 cm of upper brown muds overlie ~1 m of greenish serpentinite muds, which quickly transition downhole to bluish gray, severely drilling-disturbed serpentinite mud and sand with serpentinized ultramafic lithic clasts. This lithology persists to about 14 mbsf where reddish-brown breccias are observed. Severely up-arched and flow-in disturbed sediments extend to the bottom of the hole.

During the week, the pXRF (portable XRF) instrument was used to analyze, classify, and determine relative elemental abundances for more than 400 samples from Sites U1492 to U1497, which included whole rocks from freshly retrieved cores and powders (both fresh and ignited) prepared for ICP-AES testing. Cross-comparison of results helps to constrain the quality of elemental abundance data from both procedures; the ignited samples prepared for ICP-OES analysis are presumed to be better for pXRF analysis.

Geochemistry

The Geochemistry team extracted and processed 28 pore water samples from Site U1496, and 14 samples from Hole U1497A. A total of 28 gas samples were collected and analyzed for hydrocarbons at Sites U1496 and U1497. ICP-AES analysis of rock samples is waiting until after the fluids analyses are completed; this week we ran 32 additional rock samples mostly from Site U1492 but including three non-serpentinite samples from Site U1496. Pore waters recovered at Sites U1493 to U1496 were analyzed for pH, chlorinity, alkalinity, salinity, anions (Cl, Br, SO_4) and cations (Ba, B, Fe, Li, Mg, Mn, K, Si, Na, and Sr) by a combination of IC and ICP-AES. Samples from Sites U1493 to U1495 were also analyzed for sulfide, phosphate, and ammonium by spectrophotometry.

Analytical highlights of the week include the following: (a) Serpentinite muds and ultramafic clasts from Sites U1491 and U1492 are indistinguishable in many key elemental characteristics, but can be resolved based on their Ca, Sr, and Na abundance systematics; (b) Pore fluids from Asùt Tesoru flank Sites U1493 and U1494 show similarities to those from Yinazao flank Site U1491. In contrast, fluids from Asùt Tesoru summit Site U1496 are substantially (twenty- to thirtyfold) enriched in K and B as compared to fluids from the Yinazao summit Site U1492; (c) The highest pH values to date were measured at Holes U1496A and U1496B, reaching an average of 12.43 and a maximum of 12.47; (d) Methane values reached up to 10,000 ppm (1%) at the top of Hole U1496C.

Microbiology

Thirty-eight whole-round samples were taken at Site U1496 and were immediately subdivided and processed according to the type of shorebased microbiological study: (i) Samples were fixed for total cell counts to quantify microbial biomass; (ii) samples were stored at 5°C for multiple cultivation techniques (including FACS high-throughput media screening and detection of adaptation to physical parameters such as pressure tolerance); (iii) Samples were fast frozen at −80°C for molecular analyses, including small-subunit (SSU) ribosomal gene amplicon sequencing (to address community structure in detail), functional gene detection and quantification through quantitative polymerase chain reaction (qPCR), and single-cell genomics (to address individual cell contributions). In addition, metagenomics of the entire microbial community and metatranscriptomics of the most highly expressed genes will be used to establish metabolic potential as well as deeper ecological and evolutionary relationships. Finally, samples were also preserved for the detection of viral counts and diversity.

Physical Properties

In Holes U1496A and U1496B, serpentinite mud gamma ran attenuation (GRA) bulk density values generally range between 1.5 and 1.7 g/cm^3 and are in broad agreement with moisture and density (MAD) data, but the density variations are rather erratic and there is no clear compaction trend. This assessment is in agreement with the rather constant values of shear strength (20–

30 kN/m^2) and thermal conductivity (1–1.5 W/m·K). Serpentinite muds of these holes are characterized by extremely low natural gamma ray (NGR) values (<1 count/s). Magnetic susceptibility of the serpentinite muds is rather constant and ranged between 1000 and 1500 × 10^{-5} SI. However, local significant decreases with values less than 300 × 10^{-5} SI are observed and can be correlated to different lithostratigraphic subunits in the serpentinite muds. In Holes U1497A and U1497B, variations in physical properties reflect transitions between the blue and green serpentinite muds and with the different reddish breccia deposits.

Downhole Measurements

Formation temperature measurements were obtained with the advanced piston corer temperature tool (APCT-3) coring shoe at summit Sites U1496 and U1497. Records from two successful deployments at 26.7 and 40.8 mbsf in Hole U1496B were combined with the mudline temperature to yield a thermal gradient of 11°C/km with a heat flow estimate of 13.8 mW/m^2. In Hole U1497B, a single temperature record at 21.4 mbsf combined with the mudline temperature gave a thermal gradient of 11.5°C/km and a heat flow estimate of 14.9 mW/m^2. These low heat flow values obtained for the summits of Big Blue and Celestial Seamounts are consistent with the low values obtained for Blue Moon summit and the summit of Chamorro on Leg 195.

Paleomagnetism

Paleomagnetic measurements were conducted on archive section halves of the cores of Holes U1496A, U1496B, U1497A, and U1497B at 5 cm intervals after alternating field (AF) demagnetization at steps of 0–20 mT. Natural remanent magnetization (NRM) intensities vary with lithostratigraphic units, for example higher NRM intensity (averaging ~1 A/m) from 27 to 41 mbsf in Hole U1496A. Hole U1496B presented more constant NRM intensities of ~0.7 A/m compared with Hole U1496A. Flow-in drilling disturbance in the cores results in subvertical inclinations even after demagnetization, in addition to the vertical drilling overprint. Bulk magnetic susceptibility of 31 discrete samples from Hole U1496A and 13 from Hole U1496B were measured with the Kappabridge KLY-4. In Hole U1496A, values ranged from ~1 to 12 × 10^{-3} SI with average values of 5 × 10^{-3} SI. In Hole U1496B, values ranged from ~3 to 64 × 10^{-3} SI with average values of ~7.0 × 10^{-3} SI. The magnetic susceptibility and NRM intensities of both cores covary with one another.

Education and Outreach

The Education/Outreach Officers hosted eight live interactive events with schools this past week, with classes from the USA, France, and Germany, ranging from 6th to 12th grade. The Education/Outreach Officers received several emails from teachers with positive feedback about the broadcasts. One video diary and one science spotlight video were posted during the week.

We made daily social media posts as well as blogs to the http://joidesresolution.org website. We continue to gather photos and video footage for future posts.

Technical Support and HSE Activities

Technical staff were engaged in supporting science at Sites U1496 and U1497, and worked on various laboratory instrument systems, maintenance projects, and end-of-expedition logistics preparation.

Laboratory Activities

- Special Task Multisensor Logger (STMSL):
    - Gamma ray attenuation (GRA) signal distortion: The signal distortion is caused by a capacitive ground issue that affects HV gain on the detector. The HV is oscillating between two values causing the Cs peak to be counted in different channels. Grounding the GRA support frame to ship's hull resolves the issue. Why this occurs only on the STMSL and not the WRMSL is still a mystery.
    - *P*-wave logger (PWL): After some modification to the air cylinders to limit travel, the system is up and running. Some additional fine-tuning of the design will be necessary for long-term operations.
    - Software: We completed the PWAVE module for the PWL hardware and changed to the DAQ engine to make multiple control measurements on the new nylon-water standard.
    - Change Notice will be sent out shorty for both hardware and software.
- Paleomagnetic instruments:
    - Superconducting rock magnetometer (SRM): Minor changes to the SRM software were made, including to the display units, per requests from the Singapore portcall.
    - JR6 spinner magnetometer: We are working with the vendor to restructure the output files to improve the upload to LIMS.
    - Kappabridge: A blown fuse was found and replaced, and the instrument is up and running.
    - Cryomech Compressor: We received programming resources from the vendor so that a monitoring program can be developed.
    - Maintenance was conducted on the ship's chill water system, which caused the temperature to rise slightly. There was no impact to the SRM.
    - Icefield tool: The pressure housing end piece that was damaged earlier in the expedition will be returned for repair and it has been requested that the tool on shore be returned to the ship.

- Chemistry: Staff are working with the vendor to fix software issues that prevent the auto-sampler from working on the tracer-GC.
- Natural gamma radiation (NGR): The semicircular end piece of the titanium boat was repaired.

Application Support Activities

- LIMS crash: Analysis showed there was no issue with the database or network. The root cause was an unknown process using 100% of IO, Memory, and CPU. We were unable to ID the process because it was not possible to get a good logon to the server. The MCS restarted the server and now all systems are running fine. Java Platform Monitor is running in the Developer Office but no issues were observed in running for 23 h so far.
- LIVE: Distributed on Uluru.
- Drill Report: When reusing an old bit that had been removed from the report, the old hours are not stored. Old hours have to be manually loaded.
- DESClogik: Code was changed to more efficiently locate records that are stored at the HOLE level. Samples will be checked against the actual depth of the record and not the entire hole.
- LDAQ: Worked on the event-based architecture planned for LDAQ.
- LimsW 2.0: Deployed on ship. This will allow DQView to be able to update panels and templates.
- Adjusting to new requirements for PanelBuilder. Changing to new name LIVE. Adding new fields. Testing is restarted.
- LIME: Changed to notify users if a sample to be canceled has active tests on it. That way user can reassign them before the cancel happens.
- pXRF (portable XRF) Uploader: Updated to allow test comments.

IT Support Activities

- No major changes took place during the week beginning 8 January 2017.
- We're continuing the Exchange project and testing a replacement video encoder for the ship's camera feeds.
- A number of reports were received of vibration isolated television (VIT) video freezing on the Mac Mini video display units (VDUs). We have taken steps to troubleshoot the video program running on the VDUs. The Operations Office and others in the drilling operation who use hardware decoders are unaffected. This issue mainly affects the science party who use the television monitors to view the VIT videos. Where possible we have set up the QuickTime viewer on individual workstations to view the VIT videos, including the PC in the Science office.

HSE Activities

- Held the weekly fire and boat drill as scheduled.