IODP Expedition 330: Louisville Seamount Trail

Week 3 Report (December 27, 2010 to January 2, 2011)

OPERATIONS

This week begun with the scheduled drill bit change at Hole U1372A after the bit had accumulated 64.4 hours of rotation. Once a new bit and a rebuilt mechanical bit release were made up, the Bottom Hole Assembly (BHA) was deployed with an extra stand of drill collars. The Free Fall Funnel (FFF) was reentered at 0100 hr on 27 December and by 0430 hr rotary coring was resumed at a depth of 145.0 mbsf.

Coring advanced to 175.4 mbsf where ~3 hours was expended working tight hole conditions by pulling back from 174 to 163 mbsf with a maximum overpull of 40,000 pounds (40 Kips) and circulating frequent mud flushes. Once the drill string was free, rotary coring then advanced from 175.4 to 232.9 mbsf, where the drill string again had to be worked free over a duration of 5.5 hours. Coring then resumed and advanced slowly and smoothly from 228.9 to 232.9 mbsf. At this juncture, the hole was flushed with a 20-barrel mud sweep in preparation for a wiper trip.

The drill string was pulled back from 232.9 to 204.5 mbsf where it became irretrievably stuck. Unlike the previous stuck pipe episodes where both circulation and rotation were maintained, the top drive stalled out at 800 amperes, making extrication even more problematical even though circulation was still possible. From 2130 hr on 29 December until 0800 hr on 30 December all attempts to free the drill string and salvage the hole failed. The only remaining course of action was to sever the first 5½” joint of drill pipe directly above the tapered drill collar in the BHA at a depth of 83 mbsf. This was successfully accomplished at 1950 hr on 30 December. Left in the hole were one 9-7/8" core bit, one mechanical bit release, two modified head subs, 11 controlled length drill collars, one modified top sub, one tapered drill collar, and the lower end of one joint of 5-1/2" drill pipe. Above the severed BHA there could have been a short open hole section of around 40 m available for downhole logging. After considering the probable condition of the hole following the use of explosives and the potential risk to the logging tools, downhole logging was not attempted in Hole U1337A.

In summary, coring in Hole U1372A penetrated 232.9 m with an average recovery of 60.0%. The total penetration into basement was 187.7 m with an average recovery of 55.8% and an average rate of penetration of 2.2 m/hr. There was one bit change during the 227 hours (9.5 days) on site.

After the pipe was recovered and the beacon retrieved, the vessel departed for approved alternate site LOUI-6A at 0300 hr on 31 December. The site is located on a similar age seamount (working name "28.6ºS guyot") just 146 nautical miles to the SE. By 1730 hr on 31 December, the vessel was positioning on the new site. The voyage was accomplished at an average speed of 10.1 knots.

A new rotary core barrel BHA with a C-4 bit and mechanical bit release was made up and deployed. The corrected PDR depth for this site is 1455 mbrf. The VIT camera was deployed with the drill string and by 0200 hr on 1 January 2011 a seafloor strewn with large boulders and outcrops of hard rock was visible. From 0230 hr to 0445 hr a VIT survey was made around the periphery of the site until a clear area was found that appeared to be able to support a FFF deployment. After the driller tagged the seafloor at 1458.0 mbrf, the top drive was picked up and Hole U1373A spudded at 0700 hr on 1 January. By midnight on 2 January, the RCB coring assembly had penetrated 32.7 m with an average recovery of 52.9%.

SCIENCE RESULTS

Although operations started at the Site U1373 at the end of this week, all of the analyses and observation summarized below were carried out on core material and samples retrieved from Site U1372.

Core and thin section observations in Unit II of Hole U1372A (previously defined as a single interval predominantly composed of basalt breccia and conglomerate between the overlying pelagic sediments and the igneous basement) allowed definition of five lithological subunits based on clast angularity and composition of inter-cobble and boulder spaces: (1) Subunit IIA, a multicolor basalt breccias; (2) Subunit IIB, a foraminiferal limestone with basalt clasts, manganese incrustations and abundant

Inoceramus fragments; (3) Subunit IIC, a multicolor basalt breccia; (4) Subunit IID, a multicolor basalt conglomerate; and (5), Subunit IIE, a bluish gray basalt conglomerate that was deposited on top of the volcanic basement. Occurrences of *Inoceramus* fragments defined a Cretaceous age for Subunits IIB to IIE. Bioclasts of shallow water origin (annelid and calcareous alga) and well-rounded basalt clasts occur throughout Unit II. These observations and the absence of rudist-coral limestone in retrieved sediments indicate that the drilled seamount sequence represents a rocky shore environment in the Cretaceous. Increasing clast roundness and increasing amounts of shallow water bioclasts, in combination with decreasing amounts of planktonic fossils (foraminifera and calcisphere) with depth downhole, support the interpretation that Unit II includes a deepening upward sequence developed during the subsidence of the drilled seamount.

The paleontology laboratory group investigated the carbonate matrix between the volcanic clasts of Unit II by preparing smear slides from Intervals U1372A-4R-1W, 38-40 cm and -5R-1W, 30-32 cm. In addition, two thin sections were prepared with 10 µm thickness from Intervals U1372A-5R-1W, 31-34 cm and -2W, 1-3 cm. Unfortunately, both smear slides and the 10 µm thin sections proved to be totally barren of nannofossils. Additional thin sections with normal thickness (~30 µm) from Cores U1372A-4R, -5R, and -6R were produced and analyzed for planktonic foraminifer content. The preliminary results suggest that the consolidated breccia in Section U1372A-4R-1 is correlated to the Danian and Section U1372-5R-1 can be assigned to the late Campanian to early Maastrichtian. No age diagnostic species are found so far from samples below Section U1372-5R-1.

Also during this week, the investigation of the uncemented, pelagic carbonate sediments of uppermost Unit I (Cores U1372A-2R and -3R) continued. The top of each section was sampled resulting in 8 samples in total. Unfortunately both cores were homogenized owing to the RCB drilling disturbance and the soupy nature of the sediment. Preliminary ages for the six samples taken from this Core U1372A-2R are from biostratigraphic zones CN13 to CN15 corresponding to Pleistocene - Recent. Examinations of 2 samples from Core U1372A-3R are preliminarily assigned to CN11a based on the common abundance of *Reticulafenesta psuedoumbilica* and *Sphenolithus neoabies*. There is an inferred discomformity above and below CN11a in the column

due to the presence of species in the mixed assemblage that do not share a concurrent interval with all members of the assemblage. This is taken to be an artifact of the drilling disturbance.

Below Unit II, drilling recovered igneous rocks. Lava flows dominate the hole down to 128.9 mbsf with hyaloclastite making its first appearance at 92.4 mbsf. The 36.5-meter interval between these two depths represents a period of transition from subaerial to submarine volcanism downhole. Hyaloclastite dominates the volcanic succession from 128.9 to 228.4 mbsf and includes several (up to 2.2 m) short intervals of massive basalt representing pillows or submarine flow lobes. The hyaloclastite deposits can be divided into seven individual eruptive packages on the basis of the phenocryst content of the basaltic clasts. Three of these packages were terminated by short (0.13, 0.16 and 3.3 m) intervals of vitric-lithic volcanic sandstone, implying periods of quiescence or more distant eruption sites. Drilling terminated in a beautifully fresh and thick (4.3 m penetrated), massive, olivine-augite-plagioclase-phyric basalt lava flow.

The division of the igneous part (Units III-XVII) of Hole U1372A into an upper subaerial and lower submarine stage is confirmed by examinations of the Alteration Petrology group. A “reddish” alteration is distinguished indicating oxidizing conditions for the upper portions of the hole and a more “greenish” alteration from reducing conditions in the deeper portions in the hole.

Three main secondary minerals were identified. Clay minerals are among the most abundant alteration minerals. They were principally identified using optical microscopy and X-ray diffraction (XRD). But because of large amounts of associated calcite dominating the XRD patterns, it was difficult to identify the more specific clay minerals without more detailed on-shore XRD studies. Clays are often found as a coating in vesicles or are commonly intergrown with carbonate and zeolite. Carbonate is the second-most abundant secondary mineral and was found in vesicles, veins, and as cement in breccias. XRD measurements on carbonate samples revealed that they are mostly calcite or Mg-calcite, but some siderite is also present in the core. The third mineral is zeolite, which is predominant in vugs and veins. Another major alteration phase appears because of are the alteration of olivine to iddingsite, which is present throughout the entire core.

The Structural Geology group completed the identification and description of veins, joints, geopetals, and aligned vesicles within core and thin sections. It was observed that fractures and veins are relatively common in lava flows, but are rare to absent in hyaloclastites. This distribution is likely due to differences in rock rheology, with lavas being comparatively impermeable and strong, but brittle, thus concentrating strain (i.e., fractures) and fluids (i.e., veins) along zones of weakness. In contrast, the porous hyaloclastites are able to deform via compaction, with the high porosity enabling easy fluid flow, negating any significant flow through veins. If veins are present within hyaloclastite units they are strongly concentrated along unit boundaries. Several of the recovered lava flows (particularly in the upper subaerial portion of the lava pile) have moderate to strong macro- and microscopic flow alignment.

In addition to the predominately optical observation of the igneous rocks of Units III-XVII by the three petrological laboratory groups, archive halves from Core U1372A-14R through to the bottom of Hole U1372A have been also measured by the Paleomagnetism group during this week. The section halves were AF demagnetized in the cryogenic magnetometer system up to a peak field of 70 mT over 8 steps, and the remanent magnetization measured at 2 cm intervals. These data have been processed and directions picked for oriented pieces greater than 9 cm. In addition, average directions for each continuous archive half-piece have also been calculated. AF demagnetization has been carried out on further 41 discrete 8 cm^3 cubes up to a peak field of 160 mT using the D-Tech AF demagnetizer, and 32 discrete cubes have been thermally demagnetized in batches of eight up to a temperature of 675°C. To monitor thermal alteration during thermal demagnetization, magnetic susceptibility measurements were made using the Bartington point susceptibility meter after each heating step. The last batch of five discrete cubes is currently being thermally demagnetized. AF and thermally demagnetized samples from the same lava pieces exhibit very similar characteristic directions. These in turn show good agreement with the directions derived from archive half-cores at the same interval.

The Physical Properties group continued running tests this week on whole core and discrete samples from Units III-XVII. Whole round and split half measurements have been completed for Cores U1372A-21R to -38R, along with natural gamma ray testing with total count times between one hour and one and a half hours, depending on the

overall core flow speed. A total of 14 non-destructive thermal conductivity tests were performed on selected intervals from Cores U1372A-11R to -38R. Discrete samples were chosen in collaboration with the Paleomagnetism group, and the large majority of them have been already subjected to the entire set of paleomagnetic, P-wave, and moisture and density measurements. The automated data filtering program for processing whole round multi-sensor and section half multi-senor data was completed this week and has been successfully implemented for Expedition 330 data. The group also performed additional programming during this week that was needed to display data results for use in presentations and site reports.

Also this week, the Geochemistry group completed ICP-AES analyses of 22 igneous rock samples from this site. The initial run of these samples through the ICP-AES machine revealed minor instrument problems, which were subsequently addressed by the chemistry technician. Data reduction and interpretation are underway after a successful second run. In addition, eight samples of foraminiferal ooze from Cores U1372A-2R and -3R were analyzed for total carbon, total nitrogen, carbonate as $CaCO_3$, and total organic carbon.

Five whole round samples were collected for microbiological analysis; four from Site U1372 and one already from the Site U1373. The standard suite of sampling, which includes preservation for cell counts, DNA analysis, and ^{34}S and ^{13}C stable isotope analyses, was conducted on each sample. For one sample from Hole U1372A and for the first sample collected from Hole U1373A (from Section U1373A-2R-1), culturing experiments were innoculated. During the downtime between microbiology sampling, a rigorous blank (negative control) for cell counts was developed, and some samples needed to be recounted after the new cell count method was devised.

EDUCATION AND OUTREACH

The educator or “Teacher at Sea” continued posting daily blogs on the JR website and facebook page. The JR website had 763 visits between December 26 and January 1. Of those, 287 were new visitors. The JR Facebook page had over 12,000 page views per day during the week and has increased its followers from 2,235 fans on December 26 to 2,245 fans on January 1. Several video conference tests were performed during this

week in preparation for the videoconferences beginning next week. The videographer has written a draft script for a 330 Expedition Mission video, started creating animations, collecting premade graphics, and laying in scratch narration. She interviewed the Schlumberger Logging Engineer as he prepared to blast off the lower part of the drill string. She also shot and edited a “New Years” video, which will be released shortly. In addition, she recorded a new song "Calm Before the Core," with a click track and sent it to her band in San Francisco, hoping they have time to kick it up.

TECHNICAL SUPPORT AND HSE ACTIVITES

Technical staff engaged in providing full support for coring operations at Sites U1372 and U1373. No HSE incidents to report. Other activities included the following:

1. Deployed magnetometer during transit from Site U1372 to U1373.
2. Initiated work on relocating whole core track amplifiers to reduce NGR electrical interference.
3. Continued effort on minor software upgrades to various applications.
4. Continued software development for the core liner engraver.