

IODP Expedition 324: Shastky Rise Formation

Week 2 Report (13-19 September 2009)

20 September 09

OPERATIONS

The vessel was positioned on Site U1346 (Prospectus Site SRNH-2) at 0930 hr on 14 September. The 1129 nmi voyage from Yokohama was accomplished at an average speed of 11.8 knots and was without incident. The four-stand rotary core barrel drilling assembly was made up and deployed as the drilling crew performed the routine first site measuring and internal clearance check of each tubular.

After the driller tagged seafloor at 3630.0 m DRF (3.4 m deeper than the corrected PDR depth), Hole U1346A was spudded with a center bit in place at 0140 hr on 15 September. The hole was advanced to a depth of 71.0 m CSF-A at an average rate of penetration (ROP) of 20.8 m/hr. During the course of drilling this interval, hard layers were encountered at 60.0 m, 67.0 m, and 71.0 m and were assumed to be chert. The worn center bit was retrieved by coring line and replaced with a wash barrel. The hole was advanced by drilling ahead from 71.0 m to 100.5 m CSF-A. The 29.5 m advance through chert layers was accomplished at an average ROP of 8.9 m/hr. The wash barrel contained 0.21 m of chert including one nicely cored single-piece sample that was ~15 cm in length.

Rotary coring was initiated at a depth of 100.5 m and deepened the hole to a total depth of 191.8 m by 0915 hr on 18 September. Basaltic basement was contacted at a depth of 140 m. The total penetration into basement was 51.8 m. The average penetration rate for the cored interval was 2.0 m/hr with an average recovery of 29.0%. The average penetration rate for basement coring was 1.3 m/hr with an average recovery of 38.7%. Because of the slow penetration rate combined with the successful recovery of material suitable to address most of the objectives for this site, it was decided to end coring at this depth and prepare the hole for logging operations. An additional factor in the decision to cease coring operations at this site was the approach of Typhoon Choi-Wan.

Following a wiper trip and displacement of the hole with 29 barrels of mud, the Triple Combo tool was deployed on 18 September. The tool was able to log the open hole to within 10 m of the bottom of the bore. The poor condition of the hole did not warrant deployment of the FMS-sonic tool suite. Logging was secured by 0845 hr on 19 September.

The drilling assembly was pulled free of the seafloor and fully recovered. After the beacon was recovered from 20-foot seas, the thrusters were retracted, and the vessel departed for the 370 nmi voyage to Prospectus Site SRSH-3B at 1800 hr on 19 September. Because of the proximity of SRCH-5 and SRSH-6 to Typhoon Choi-Wan's projected track, it was decided to proceed directly to the more southerly and higher priority site.

SCIENCE RESULTS

The basement of Shatsky Rise was previously cored during ODP Leg 198 at Site 1213 located on the Southern High (TAMU Massif). Most of the igneous cores (1213B-28R to 33R) recovered from Hole 1213B are available on board and were used to practice workflow and core description using the DESClogik application, the new interface for entering descriptive information to the database.

Reinvestigation of the igneous rocks from this site is also of direct relevance to achieving the scientific objectives of Expedition 324. In the beginning of the second week, the large group of volcanologists, igneous petrologists, alteration specialists, and structural geologists onboard Expedition 324 finished their examination of the basement cores previously recovered at Site 1213. Three complete massive basaltic flow units were identified based on groundmass grain size variations, the presence of thin chilled margin zones, and changes in point-source magnetic susceptibility and color reflectance. All three units are slightly to completely altered to low-temperature secondary phases that partially or completely replace the primary phases and the glassy mesostasis. Two main

vein generations were observed with a green clay and calcite vein type that is dominant and a dark-green clay with minor pyrite vein type.

Describing these cores allowed the scientists and technical staff to practice hard rock core flow, sampling procedures, core description, database uses and other onboard protocols. The DESClogik software templates were finalized and all macroscopic and microscopic thin section descriptions for Site 1213 cores were completed and entered into the LIMS database. The core describers started on a short report on the basement samples from Site 1213 that will be added to the Expedition 324 Proceedings volume.

Site U1346, the first drill site of Expedition 324, is located on the Northern High (Shirshov Massif) of Shatsky Rise and was chosen to yield information about the late stage of this large igneous plateau.

The first six cores from this site contained sedimentary material. The first three cores (including one wash core) recovered small isolated pieces of dark-colored chert. Cores U1346A-4R to -6R recovered approximately 3.5 m of lithified sediments, including limestones and mudstones. Core U1346A-4R is an intriguing mixture of basaltic rock associated with calcareous sediments. The basalt appears to have intruded into soft, clay-bearing calcareous sediments, intermingling with the sediment at the margins and deforming the original depositional bedding. Stratigraphically below, there is a well-preserved laminated, graded sandstone to mudstone interval interpreted as turbiditic in origin. Beneath this, clayey limestone pieces in Core U1346A-5R and -6R contain abundant, angular volcanoclastic grains and bivalve shell fragments, suggesting a relatively shallow depositional marine environment in close proximity to a volcanic sediment source.

Calcareous nannofossils occur through all the recovered carbonate sediment intervals. Ages estimated from calcareous nannofossils remain inconclusive, ranging from the Berriasian to Campanian, yet two samples from the uppermost part of Core U1346A-4R and Section U1346A-5R-CC can be narrowly constrained to Zone NC4a (131.2–129.6

Ma) of the Hauterivian. Foraminifera successfully retrieved from two levels in Section U1346A-4R-CC are composed entirely of benthic forms and the planktonic group is completely absent, possibly due to the pre-Aptian age (i.e., prior to major diversification of planktonic foraminifera) and/or because of an ecological bias induced by overwhelmingly large population of radiolaria. Benthic foraminifera are diverse and predominate the upper bathyal assemblage.

Certainly one of the highlights at this site is the recovery of the 2.9 m long spectacular succession of highly vesicular lava intermixed with calcareous sediment in Core U1346A-4R, which has been interpreted as possible peperite but further detailed studies are needed for confirmation. Below this “peperite” and the short sediment succession described above, we recovered a seemingly continuous sequence of numerous small 0.3 to 4 m basalt pillows (U1346A-6R to -16R). In total more than 40 individual inflation units could be identified on the presence of pillow contact zones, chilled glassy margins, vesicle abundance, banding and filling, cm-long pipe vesicles, non-vesicular pillow cores, and so on. These basalts are all aphyric containing a large proportion of very fine-grained plagioclase laths set in a variolitic matrix. The pillow basalts are generally vesicular in nature and have zones that are moderately vesicular (30%-50% vesicles).

Alteration of the igneous rocks is highly variable and in some places pervasive, ranging from relatively fresh dark gray basalts in the pillow units at the bottom of the hole, to completely altered and oxidized brown vesicular basalts. Green and brown clays are the main secondary phases of the highly altered basalts and replace the primary phases as well as the glassy mesostasis. Minor pyrite and calcite have also been observed associated with the groundmass clays, as well as in veins. We are awaiting onboard geochemistry and XRD data to evaluate the extent of the alteration. The first thin sections were produced and are now being studied, photomicrographed and described.

Structural examinations confirmed the interpretation that the lower igneous units recovered at this site are formed by pillow basalts. Many pieces show typical pillow structures, having heterogeneously and/or radially distributed cracks and veins. Many

vesicles, dominantly filled with calcite, are layered parallel to the rim of pillows. Some of the vesicles, on the other hand, form elongated pipe structures pointing towards the rim. Both types of vesicles are generally concentrated along the rim of the individual pillow units resulting in lower vesicularity in the center. Only longer pipe vesicles (>1 cm), however, are also found in the central portion of the pillows.

Preparations to analyze both sedimentary and igneous samples were completed in the chemistry lab this week. A test run of the CHNS analyzer was conducted, and preparation of samples for CaCO₃ and total organic carbon analysis was complete and analysis of a set of samples began. Modification and development of Excel spreadsheets for the reduction of shipboard ICP-AES major and trace element data was completed, and a group of standards was analyzed. The results were used to verify that the machine was working properly and to refine the spreadsheets. Processing of samples of igneous rocks and vein-filling material from the Site U1346 cores is underway.

In contrast to chemical analyses, requiring long preparation time and time-consuming instrument set-up, physical property measurements could start immediately. The thermal conductivity setup was tested with the basaltic samples from ODP Leg 198 available on board and the Macor disc standard. All recovered material (sediment and igneous sections) from Cores U1346-1R to -16R have been run through the whole round multisensor logger for measurement of gamma ray attenuation (GRA) density and magnetic susceptibility at 2 cm intervals; and through the Natural Gamma Ray logger (NGR) in two positions with a count time of 1800-5400 seconds, depending on available time between core recovery. Density measurements of basaltic material is generally 2.2–2.3 g/cm³, which is slightly lower than the range of 2.4–2.7 g/cm³ measured on Leg 198 Shatsky Rise basalts. This could be due to the pervasive alteration observed in the Hole U1346A cores. Sixteen discrete physical property samples were taken from cores 4R-11R, and determination of moisture and density, and compressional wave velocity in three directions are underway.

The discrete physical property samples are being shared with the paleomagnetists who spent the first part of this week testing the software (both for long core sections and discrete samples) for the 2G-Cryomagnetometer. It was found that the long-core software is reliably stable while the discrete-sample software needs further improvement. Several sections from Leg 198 cores (Sections 1213B-28R-1 and 3, Sections 31R-1 through 4, Sections 32R-3 and 4, and Section 33R-2) were re-measured. Magnetic remanence of the cores with 0, 30, and 40 mT AF demagnetization steps were measured. Remanence inclinations and declinations from Leg 198 cores were found to be 0 and 90 degrees, respectively, and the remanence magnetization intensities are much higher than the previously documented values from Leg 198 after 30 mT demagnetization. Remanence magnetization intensity values increase over time (within 12 hrs or 3 days) up to 1 A/m even after demagnetized to 40 mT. Since this puzzling behavior seems to be restricted to the Leg 198 samples, it was planned to investigate this issue in more detail with shore-based measurements. Next, several sections recovered from Hole U1346A were demagnetized and measured (Sections U1346A-6R-1 and -6R-2, -7R-1 and -7R-2, -9R-3, -10R-1 and -10R-2). These basalt archive halves were stepwise AF-demagnetized up to about 40 mT. When demagnetized to higher fields, all the basalt cores regained some magnetization and their natural remanent magnetization (NRM) inclination tended towards 90 degrees. This behavior is somewhat similar to that observed in the Hole 1213B cores. Until it can be determined if this is due to the samples or the magnetometer, it was decided to stop the AF demagnetization by the 2G magnetometer. Preliminary determinations of characteristic remanent magnetization (ChRM) are being processed on discrete samples by using DTech AF demagnetizer and Molspin spinner magnetometer.

This eventful week was concluded by logging operations in Hole U1346A. Despite high sea state one logging run was successfully completed and provided gamma ray, density, and resistivity measurements from this hole including the sediment basement interface. The results show a variable size hole, several distinctive resistivity units, and uranium anomalies near the sediment basement contact that could indicate zones of focused hydrothermal fluid flow. The FMS-sonic tool string was not run due to poor borehole

conditions. The wireline heave compensator was tested in heave conditions ranging from 4 to 5 m with occasional excursions up to 6 m.

TECHNICAL SUPPORT AND HSE ACTIVITIES

After arrival of the first core on deck on September 16 the shipboard labs were busy processing cores and samples. The ALOs met with the marine technicians on their shifts and explained how to handle and curate hard rock cores. Dr. Sager gave a presentation about the expedition objectives at Shatsky Rise for the ship's crew and technical staff. A fire and boat drill was held on September 18 for the entire ship's complement. The safety showers and eyewash stations were tested.