IODP Expedition 324: Shastky Rise Formation

Week 4 Report (27 September – 3 October 2009)

4 October 09

OPERATIONS

After exchanging the drill bit, Hole U1347A was successfully reentered at 2250 hr on 26 September. The drill string was advanced to the bottom of the hole where the driller found only one meter of soft fill. From 1530 hr on 27 September to 1230 hr on 30 September rotary coring deepened the hole from 242.7 m CSF-A to a final depth of 317.5 m CSF-A with no hole problems. Operations were concluded when the last core was only able to advance one meter in three hours, possibly due to either a worn bit, an extremely hard formation, or a combination of both.

The total penetration into basement in Hole U1347A was 159.5 m cored at an average rate of penetration (ROP) of 1.5 m/hr. While coring basement, the ROP for individual cores ranged from a lethargic 0.7 m/hr to a more energetic 4.1 m/hr. The average recovery for basement coring was 62.3%.

The hole was prepared for logging, the bit was released at the bottom and the bore was displaced with 83.5 barrels of 10.5 ppg mud. The drill string was pulled back in the hole and placed at the logging depth of 131.5 m DSF. The first logging run was made with the triple combo and succeeded in reaching within two meters of the bottom of the hole. A preliminary analysis of the results of the first logging run indicated that the hole was in good condition and suitable for the additional measurement runs planned for this site. The second tool deployed was the FMS-sonic, which was also successfully run (two complete passes). The third logging tool suite included the ultrasonic borehole imager and had to be cancelled because of hardware problems.

After the logging equipment was secured, the drill string and the beacon were retrieved in routine fashion. Once the drilling equipment was secured, the vessel departed for the next site (SRSH-6) at 0400 hr on 2 October. The total time on Site U1347 was 10.4 days.

The vessel was positioning on the new site at 1515 hr on 2 October after a voyage of 115 nm at an average speed of 10.8 knots. The 4-stand RCB bottom hole assembly was quickly deployed with a new C-4 bit and mechanical bit release. With the bit at a depth of 1716 m DRF, the pipe trip in had to be suspended for 12.5 hours to repair the low-speed clutch on the drawworks. By 0830 hr on 3 October, the tripping of the drill string was resumed.

After the driller tagged seafloor at 3275.0 m DRF, Hole U1348A was spudded at 1245 hr on 3 October. The hole was washed ahead with a wash barrel in place to 84.2 m DSF where rotary coring was initiated.

SCIENCE RESULTS

Following the bit change operation, nine additional cores (324-U1347A-21R to -29R) were successfully retrieved from Hole U1347A. These cores are predominantly composed of igneous rocks, a mixture of pillow basalts and massive basaltic flows. A total of ~50 cm of small sedimentary interbeds, ranging from ~5 to 10 cm in thickness, were recovered in Cores U1347A-21R, -22R, -24R and -26R. These interbeds suggest the possibility of hiatuses in the emplacement of igneous units, during which sedimentation of mixed volcaniclastics and nearshore marine material could occur. The small intervals of interbedded sediment consist predominantly of altered radiolarian-bearing, sandy siltstones with a minor calcitic component and exhibit a strong volcanogenic influence. Many of these sediments, however, are highly altered and show signs of compaction, fritting, and baking where they had presumably come into contact with still molten basalt. One piece of altered volcaniclastic limestone was recovered in Core 324-U1347A-22R, indicating a possible increase in the amount of carbonate relative to detrital volcanic material during this interval.

Further investigation of the calcareous nannofossil assemblage suggests that the sediments above the igneous basement (Cores U1347A-2R to -11R) are ascribed to the Berriasian to Valanginian stages. For benthic foraminifera, a single specimen of taxon

indicative of the neritic setting is recognized in Core U1347A-8R. The thorough micropaleontological survey has been extended to the several fine-grained sedimentary layers interbedded in the underlying basement basaltic units, yet both calcareous nannofossil and foraminfer taxa are nearly barren in these intervals.

The volcanic succession of the basement can be described in terms of three broad groups based upon volcanic characteristics and associations. Group (1): an uppermost volcanic succession consisting of four major basalt lava units (~8 - 19 m thick); Group (2): a more complex intervening ~75 m volcanic stack consisting of a mixture of pillow units and larger (typically 1-2 m thick) inflation units, which themselves are interspersed with the up to ~5 m thick sedimentary intercalations (described above) and instances of much thicker homogenous flows 3 to 6 m in thickness; and Group (3): a lower set of two, particularly massive lava flows consisting of a very thick (~23 m) homogenous flow overlying a unit of similar character at the bottom of the hole (the last Core U1347A-29R recovered only 1.6 m from its top). In many instances, the high recovery rate for these volcanic units yielded well-preserved lower- and upper-contact zones (i.e. glass, chilled margins, baked sediment contacts, rubbly and/or pahoehoe-type flow tops), or else the intercalated sediment intervals.

Overall, the 158.5 m volcanic section consists of plagioclase-pyroxene phyric basalts, whereby the plagioclase and clinopyroxene cotectically occur as clusters, glomerocrysts and intergrowns. Olivine phenocrysts occur in the basalt, but always as a trace and typically completely replaced by clays and calcite. The frequent recovery of (fresh) glassy rinds from the pillow-unit stack, as well as delicate pillow-pillow contact and pahoehoe-type structures indicates that alteration was efficiently buffered in these rocks.

Based on the visual description and on petrographic observation of thin sections, overall alteration of the basaltic lavas ranges from slight to, at worst, moderate (from 5% to 50%), with the majority of the rocks showing ~15% alteration. Generally both the primary mineralogy (with the exception of extensive olivine replacement) and the finer

spherulitic textures in the interstices between phenocrysts and microcrysts are well preserved. Plagioclase and clinopyroxene are relatively fresh throughout the hole, either in the groundmass or as phenocrysts. In contrast, both olivine and groundmass glass are highly altered to brown clays and calcite (in various proportions). Fresh glass was observed in some slightly altered basaltic samples, from Section 324-U1347A-15R-2 (187 m CSF-A) downhole. Fresh glass and plagioclase and pyroxene phenocrysts are also commonly well preserved at pillow margins, whereas olivine phenocrysts are always completely altered. Vesicles are filled with very fine-grained clays and calcite and traces of pyrite.

Structural descriptions of recovered basement cores continued from last week. Most of the igneous rocks show the characteristic features for massive lava flows. In general, the chilled margins between the flow unites and interbedded sediment intervals are sub-horizontal. Compared to the upper part of the basement, the number of joints increase and the dip angles steepen in the lower part of Hole U1347A. Veins are widespread along the cores, with an average of 3 veins/m over the ~160 m of basement lavas, and are predominantly filled with calcite with or without fine-grained green clays.

The physical properties of the lower igneous basement cored after the drill bit change are similar to those preceding it. Magnetic susceptibility remained high (generally over 2500 x 10^5 SI and ranging up to 3800 x 10^5 SI in massive flows) and total counts from the natural gamma ray logger remained low (2-4 cps). Massive flows in igneous sections gave higher gamma ray attenuation (GRA) densities compared to smaller pillow lava units. Filtering of whole round (GRA density and MS) data for Hole U1347A was completed by the end of this week.

Fifty-nine thermal conductivity measurements of igneous material yielded values from 1.402 W/mK to 1.801 W/mK, which is slightly higher than found at previous Site U1346. The thermal conductivity of the ~23 m thick massive flow unit beginning at ~290 m CSF-A is consistently higher than the rest of the hole, averaging 1.733 ± 0.092 W/mK (n=7).

A single sample of sedimentary material from Section 324-U1347A-17R-1 yielded a lower thermal conductivity of 1.007 W/mK.

Fifty-seven discrete samples were taken for measurement of moisture and density characteristics and compressional wave velocity in three directions. Forty-four have been processed and the remaining thirteen will complete their circuit within the next day. Bulk densities range from 2.49 to 2.88 g/cm^3, which is higher than seen at Hole U1346A. The massive igneous flows are distinguishable by their elevated P-wave velocities (up to 6.982 km/s in the downhole direction), which correlate well with high density and low porosity (3-5%).

Also this week, a total of 63 cubic samples were paleomagnetically measured using alternating field and thermal demagnetization. About one third underwent alternating field (AF) demagnetization while the other two-third was used for thermal demagnetization. AF demagnetizations showed evidence of a large overprint, which was erased around 20 mT, after which it was usually possible to isolate a stable characteristic remanent magnetization. However, most samples are characterized by an extremely low coercivity (median destructive fields as low as 2 mT). Many samples show erratic behavior in thermal demagnetization steps, mainly because of thermochemical alteration that takes place at >300ºC. According to the measurements carried out so far (about 2/3), samples taken at the top of the hole have a negative shallow inclination, while the rest of the samples have a positive inclination.

The geochemistry group completed ICP-AES analysis of 21 lava samples from Site U1347 during this week. Data reduction and interpretation commenced. Processing of another batch of 19 lava samples for ICP-AES analysis is underway. Additionally, thirty-seven sedimentary samples from Site U1347 were analyzed for carbonate and for total carbon.

The week was concluded by logging operations in Hole U1347 with two successful tool deployments. The triple combo toolstring was run to within two meters of total depth and

collected good density, natural gamma, porosity and resistivity data from the formation including across the sediment-basement interface. The second deployment was the FMS-sonic toolstring, which completed two passes to within two meters of total depth. Shipboard processing show good FMS images in the basement section. The third planned deployment at the site (UBI) had to be abandoned after the toolstring failed to activate fully.

TECHNICAL SUPPORT AND HSE ACTIVITES

The labs are busy processing samples. A new overhead safety shower was installed at the hazardous stores lockers. Site U1348 was occupied after a short transit at the end of this week.