IODP Expedition 340: Lesser Antilles Volcanism and Landslides

Site U1401 Summary

Background and Objectives

Integrated Ocean drilling Program Site U1401 (CARI-12A, 14°39.10'N, 61°25.08'W, 2590 mbsl) is located westward of Martinique. Site U1401 was dedicated to characterizing a debris avalanche deposit and its depositional processes. Montagne Pelée volcano has experienced at least three major flank collapse events, which systematically destroyed the western flank of the volcano. Previous studies revealed the presence of a debris avalanche deposit with hummocky morphology associated with the 9,000 year old, flank-collapse of the Montagne Pelée volcano. Pre-site survey data indicated that Site U1401 might penetrate through the volcanic and biogenic sediments with intercalated large chaotic debris avalanche deposits. We expected to core through mass wasting deposit 3 and mass wasting deposit 2 from Montagne Pelée volcano with the aim to distinguish between the two deposits and identify erosive levels or frictional interactions between them. We also planned to core the sediments on top of the debris avalanche deposit to better constrain the its age. The data obtained from the cored section was intended to provide valuable insights into the chronology, number, and mobility of debris avalanches as well as the processes of possible syn-transport flow transformation.

Scientific Results

Site U1401 (CARI-12A) consisted of four holes. CARI-12A was originally an alternate site to CARI-07C, but was felt to be a better fit with expedition objectives in the remaining expedition time. The original plan called for two holes to be cored to a depth of ~500 mbsf, but due to limited time remaining in the expedition, we decided to attempt a single hole to ~350 mbsf. However, the first hole had to be terminated at 82 mbsf because of unstable hole conditions. Given the very difficult coring conditions and short amount of time remaining in the expedition, we decided to alter our plan again and APC core a transect of shallow-penetrating holes spaced at 300 m intervals along the Aguadomar seismic line crossing Site U1401 (oriented 242°).

Three more holes were cored at this site. Three APC cores were recovered from Holes U1401B and U1401C and a single APC core was taken at Hole U1401D before expedition operations time expired. At Site U1401 eleven APC cores penetrated 47 m and recovered 46 m (99%). In addition, seven XCB cores penetrated 67 m and recovered 1 m (2%). The overall recovery for Site U1401 was 42% and the time spent on the site was 53 hours.

The sediments cored at Site U1401 were subdivided into three lithostratigraphic units consisting of a combination of hemipelagic mud with interbedded tephra, and/or volcaniclastic turbidites. Unit A (0 to 8.1 mbsf in Hole U1401A; 0 to 7.0 mbsf in Hole U1401B; 0 to 5.6 mbsf in Hole U1401C; 0 to 3.7 mbsf in Hole U1401D) is composed of a thick, ungraded to weakly-graded volcanic sand layers containing locally some light colored lava and pumice granules. This sequence is underlain by hemipelagic mud with numerous interbedded, poorly sorted, and sometimes laminated volcanic sand layers. Most of these layers can be interpreted as tephra layers. The thicker layers exhibit planar lamination and poor sorting, however, suggesting their emplacement by density flows rather than fallout. In a few places, the sandy tephra layers are separated by fine brown mud, which is most likely volcanic in origin. Unit B (8.1 to 14.4 mbsf in Hole U1401A; 7 to 12.9 mbsf in hole U1401B; 5.6 to 10.4 mbsf in Hole U1401C; 3.7 to 9.1 mbsf in Hole U1401D) is composed of a series of coarse to very coarse volcaniclastic turbidites. These are up to 2 meters thick and are generally normally graded with a basal part rich in gravels and a top part composed of fine to medium sand. At least three or four distinct turbidites are observed. They contain pumice and scoria in variable proportions, with vesiculated, massive and oxidized lavas and crystals. The basal part is rich in granules and clasts of grey to reddish grey dense lavas; some of them reach 7 cm in size. The clasts comprise mainly two-pyroxene andesites or dacites. Interbedded hemipelagic mud has only been observed in Hole U1401A and U1401D of this unit. Unit C (14.4 to 72.0 mbsf in Hole U1401A) is characterized by abundant mafic, vesicular andesite clasts up to 7 cm in length, as well as subsidiary amounts of clasts of two-pyroxene andesite.

Calcareous nannofossils and planktic and benthic foraminifera in core catcher samples at Site U1401 are generally low in abundance or more often barren, likely due to the very coarse nature of the majority of the cored material. Only very few of the core catcher samples were adequate for biostratigraphical analysis. However, nannofossil and planktic foraminifera content were sufficient to resolve an age of Late Pleistocene for this site. The observed nannofossil assemblage characteristic for the Late Pleistocene comprises *Emiliania huxleyi* and *Gephyrocapsa* sp., dating the material to less than 0.08 Ma (zone CN15, *Emiliania huxleyi* acme zone). The most abundant species of planktic foraminifera observed at this site are *Globigerinoides ruber* (pink and white) and *Globigerinoides sacculifer.* One datum species, *Globigerinella calida* (base of occurrence 0.22 Ma) was found in Sample U1401D-1H-CC, placing this sediment also within the Late Pleistocene.

Interpretation of the behavior of the geomagnetic field during the deposition of the cored sediments to derive a magnetostratigraphy is solely based on generally discontinuous hemipelagic sediment recovered in the uppermost sediments (<10 mbsf). Expected inclination for the site is 27.6° during normal polarity and -27.6° during reversed polarity assuming a Geocentric Axial Dipole (GAD). The inclination data all show positive values and a normal GAD-like inclination. Declination shows some scatter but coupled with the

positive inclination data suggests all sediments were deposited under normal polarity conditions. Using the GPTS of Cande and Kent (1995) these sediments were deposited in the Brunhes Chron and are younger than 780 kyrs. This agrees with the ages obtained from the biostratigraphic studies.

The physical property data obtained from the cored material generally show differences based on the lithology retrieved. At all holes, peaks in magnetic susceptibility (MS) correspond to volcaniclastic beds (2000 to 5000 x 10^{-5}), whereas low MS values (<2000 x 10^{-5}) correspond to hemipelagic muds. In the uppermost 6 mbsf at Hole U1401A, bulk density progressively increases from 1.4 to 2.0 g/cm^3 with depth despite several mud layers interlaced with volcaniclastic sand. This trend is not observed in the other three holes at this site. Similar to the behavior of the natural gamma radiation (NGR) observed at the other sites, NGR is strongly correlated with the mud content, with more mud resulting in higher NGR values. A mud layer at ~10.3 mbsf in Hole U1401B has the highest value of with 21 cps. The two major lithologies are also clearly identified in the P-wave velocity data, showing low values in the hemipelagic mud (1500-1650 m/s) and higher values in the volcaniclastic material (1650-1800 m/s; maximum 1860 m/s). Measurements of P-wave velocity obtained from discrete samples also exhibit this pattern; the hemipelagic mud has velocities ranging from 1530 to 1660 m/s, whereas the volcaniclastic sand has velocities ranging from 1720 to 1920 m/s. The density and porosity values obtained from the hemipelagic sediment are typical for shallow, buried marine sediments. Porosities are between 50% and 60%, and grain densities are ~2.75 g/cm^3. Shear strength measurements in the hemipelagic intervals show an increase from 3-5 kPa in the upper few meters to values of 20 kPa at 15 mbsf.

References

Cande, S.C., and Kent, D.V. (1995) Revised calibration of the geomagnetic polarity timescale for the late Cretaceous and Cenozoic. Journal of Geophysical Research, 100: 6093-6095.