

## **IODP Expedition 376: Brothers Arc Flux**

### **Site U1529 Summary**

#### **Background and Objectives**

Site U1529 (proposed Site WC-1A) is located on the western side of the caldera floor of Brothers volcano in a water depth of 1735 m. The primary objective for this site was to complement Site U1527 by drilling into the margin of an upflow zone of a hydrothermal system dominated by modified seawater-derived fluids. This site was planned not only to penetrate deeper into the hydrothermal system but also to obtain a record of the recent eruptive history within the caldera.

#### **Operations**

We conducted operations in two holes at Site U1529. Hole U1529A is located at 34°52.5161'S, 179°3.5139'E, in a water depth of 1735.0 m. In Hole U1527A, we used a rotary core barrel (RCB) to core from the seafloor to 12.0 m with poor recovery of 1.86 m (15.5%). The downhole conditions encountered in Hole U1529A were extremely difficult due to unconsolidated volcanoclastic material, which caused high torque and tight hole conditions that ended drilling of this hole. At Hole U1529B, located at 34°52.5217'S, 179°3.5207'E, in a water depth of 1733.0 m, RCB coring under equally difficult hole conditions penetrated to only 34.4 m with very poor recovery of 0.6 m (1.7%). After observing a tight hole, we attempted to work the drill string back to ~15 m, but lost circulation because the bit and jets were plugged off with volcanoclastic material. This resulted in abandonment of Hole U1529B. An 8.2 m long core was recovered from the core barrel that was in place while working the drill string out of the hole.

#### **Principal Results**

##### *Igneous Petrology and Volcanology*

A common single igneous unit was recovered in Hole U1529A (0–2.52 m) and in Hole U1529B (0–24.82 m). Igneous Unit 1 consists of decimeter-thick, alternating intervals of fresh, black plagioclase-pyroxene phyric dacite lava and unconsolidated, monomict, black lapilli tephra. The contacts between lava and tephra were not recovered. The moderately vesicular (~10 vol%) lava was recovered as individual clasts from 0.5–6 cm in length. The lava has a hypohyaline texture with a groundmass rich in flow-aligned plagioclase microlites, and shows fine fracture networks indicative of incipient breakup. The lapilli tephra consists of fine-ash to medium-lapilli sized, angular to subangular fragments of dacite lava, as well as fragments of plagioclase and pyroxene

crystals. The finest grain size fraction contains 85 vol% of angular vitric ash, resembling the larger lapilli clasts and fragments of dacite lava recovered at Site U1527.

The ghost core from Hole U1529B, which contains material from anywhere between 0 and 34.4 m, likewise consists of unconsolidated fresh, black volcanic lapilli-ash ranging in size from ash (<2 mm) to medium lapilli (8–16 mm). Maximum clast sizes are very large pebbles (32–64 mm). Ash- and lapilli-sized clasts are subangular and angular, with a vesicularity and mineral assemblage (plagioclase-clinopyroxene phenocrysts and glomerocrysts) consistent with the lapilli tephra being a mixture of Igneous Unit 1 volcanic rocks.

### *Alteration*

The volcanic rocks of Igneous Unit 1 appear fresh to slightly altered. Alteration Type I is the only alteration type recognized at this site, and occurs within the lapilli tephra and more coarse-grained fragments of dacitic lava. It is defined by the presence of minor smectite and Fe-oxyhydroxide partially replacing phenocrysts and groundmass and lining some vesicles. A few individual clasts within Igneous Unit 1 are more strongly altered and contain microcrystalline silica, Fe-oxyhydroxide, and a green clay mineral.

### *Geochemistry*

Unaltered to slightly altered clasts and lapilli from Igneous Unit 1 are typical dacites, with SiO<sub>2</sub> ranging from 62.3–65.4 wt%, and total alkalis (Na<sub>2</sub>O + K<sub>2</sub>O) varying from 6.61–7.07 wt%. They are similar in major element composition to fresh dacites from Site U1527 and consistent with the low compositional range previously reported for dacites at Brothers volcano. The uppermost sample (0.06 m) from Hole U1529A and two samples from the ghost core have lower values of total carbon (<200 μg/g) compared to the other five samples from this hole, for which total carbon ranges from 221–344 μg/g. Total sulfur concentrations are below 220 μg/g and are consistent with total sulfur abundances previously reported from Brothers volcano. Total nitrogen and total inorganic carbon are below the limit of detection for all Site U1529 samples.

### *Structural Geology*

At Site U1529, no meaningful structural measurements could be made because no oriented pieces of core were recovered. Some pieces of dacite have a network of microfractures, but there are no faults or alteration veins present. In both Hole U1529A and Hole U1529B, the main structure observed is a shape-preferred orientation defined macroscopically by vesicles and microscopically by vesicles, phenocrysts, and microlites.

### *Physical Properties*

The low recovery, and the fragmented nature of the clasts and volcanoclastic sediments, made the cores mostly unsuitable for continuous physical properties measurements on whole-round cores and section halves. However, natural gamma radiation measurements for Hole U1529A record

values around  $\sim 13$  counts/s (1.9 m), and Section Half Multisensor Logger point data indicate magnetic susceptibilities of up to  $\sim 2250 \times 10^{-5}$  IU (15.14 m).

A total of five discrete samples from Hole U1529A and three samples from Hole U1529B, including cut clasts and volcanoclastics, were analyzed for moisture and density. Bulk density values range from  $1.92 \text{ g/cm}^3$  to  $2.37 \text{ g/cm}^3$ , while grain density values range between  $2.43$  and  $2.50 \text{ g/cm}^3$ . Porosity ranges from 6–38 vol% and is inversely correlated with bulk density. Three measurements of *P*-wave velocity made in the *x* direction on coherent clasts in section halves of Hole U1529A vary from  $\sim 3500$ – $4500$  m/s. No thermal conductivity measurements were made due to the limited recovery and fragmented nature of the material.

#### *Paleomagnetism*

No paleomagnetic measurements were performed on samples from Site U1529 because of the absence of any oriented core pieces.

#### *Microbiology*

No samples were collected from Site U1529 for microbiological analyses due to the nature of the material recovered.