IODP Expedition 366: Mariana Convergent Margin

Site U1498 Summary

Background and Objectives

International Ocean Discovery Program (IODP) Site U1498 (proposed Site MAF-10B) is located at the foot of the southwest flank of Fantangisña Seamount (informally called Celestial Seamount in the Expedition 366 *Scientific Prospectus* and previous publications) at 16°27′N, 147°10′E. The steep slope of the seafloor in this area means that the two holes at this site, 700 m apart, have different water depths of 3497 m (Hole U1498A) and 3285 m (Hole U1498B). The holes lie on multichannel seismic (MCS) reflection profile EW0202 59-60.

Fantangisña Seamount is located about 62 km from the Mariana trench and about 14 km above the subducting Pacific Plate (Oakley et al., 2007, 2008). The edifice lies on the northern edge of a prominent forearc block that trends northwestward. At the base of the western flank of the seamount, numerous large blocks, up to two kilometers in width, are the result of slumps that brought down large portions of the seamount (Oakley et al., 2007). Site U1498 was chosen along the lower slope because of its apparent stability relative to the slumped portion of the western flank.

The objectives at this site were to elucidate a history of serpentinite flows by documenting their physical and chemical characteristics and to penetrate into the underlying pelagic-volcanic sediment. Specific objectives were to: 1) core sediment and serpentinite mudflows on the distal-slope region of the southwestern flank; 2) date discrete mud flows and the base of the seamount paleontologically, should there be sediment layers between them; 3) determine variability of mudflow and rock clast compositions and thicknesses of mud flow units; 4) investigate potential systematic variability in the degree of serpentinization within the flank and changes in physical properties; 5) examine transport and potential deformation characteristics of the mudflows; 6) provide an assessment of pore fluid composition; and 7) collect samples for microbiological analysis.

Operations

Hole U1498A (16°27.0898'N, 147°9.8502'E, water depth 3497 mbsl)

The ship transited 6 nmi in dynamic positioning (DP) mode to Site U1498 (MAF-10B) in 9 h from Fantangisña Seamount summit, arriving at 2300 h. We had moved the location of the first hole at Site U1498 southwest ~1300 m (downslope) from the planned location to the toe of the slope where the serpentinite mud flows are thinner and where drilling could reach the underlying sediments more easily/quickly in the remaining operation time. A rotary core barrel (RCB)

coring assembly was lowered and tagged the seafloor at 3497 mbsl at 0615 h on 24 January. The steep (~25%) slopes at the foot of the mud volcano cause underestimated seafloor depths when calculated from precision depth recorder (PDR) or the seismic seafloor reflection, and the bathymetric data for the site location proved to be more accurate. Cores U1498A-1R to 19R penetrated 182 m and recovered 21 m (11%). Coring was faster below 45 mbsf, in the nannofossil-bearing volcanic ashes that underlie the serpentinite mudflows. Following low recovery, we ended Hole U1498A at 182 mbsf, and we moved ~700 m upslope to the northeast, to a location where the serpentinite mud flows are thicker.

Hole U1498B (16°27.3716'N, 147°10.1166'E, water depth 3285 mbsl)

At 0300 h on 26 January, the seafloor at Hole U1498B was tagged with the drill pipe, and the tag was observed with the subsea camera to confirm the water depth and check seafloor conditions on the lower slope of Celestial Seamount. Seafloor depth from the bathymetry was within 1 m of the tagged seafloor depth at this hole. Cores U1498B-1R to 27R penetrated 260 m and recovered 83 m (32%). In the upper five cores, the RCB coring system preferentially recovered hard rock clasts, and below this depth, recovery of serpentinite muds increased with depth. Drilling was slow until we drilled through to the underlying sediments in the middle of coring Core U1498B-23R at 205 mbsf. We stopped drilling when the hole reached 260 mbsf, and the last core of the expedition came on deck at 1730 h on 29 January. Enough operational time remained for downhole logging, so the drill bit was raised up to 52 mbsf and we logged the hole with the triple combo tool string, comprising magnetic susceptibility, natural gamma radiation, resistivity, and caliper tools. The tool string reached 229 mbsf, 31 m from the base of the hole. Magnetic susceptibility, natural gamma radiation, resistivity, and temperature data were recorded for one downward pass and two upward passes of the tool string. The logging data cover the transition from the sediments to the overlying serpentinite mudflows, and up to the base of the drill pipe. The tools were rigged down by 0530 h on 30 January, and the drill pipe was raised back to the ship by 1250 h. The rig was secured and the transit to Hong Kong began at 1530 h on 30 January.

Principal Results

Hole U1498A penetrated 53 m of serpentinite mud and 129 m of underlying volcanic ash with microfossils. Hole U1498B, upslope, penetrated 205 m of serpentinite mud before reaching the underlying volcanic ash deposits. In the upper portion of each hole, only ultramafic rock clasts were recovered, because RCB drilling preferentially recovered the harder materials. The bluish-gray serpentinite muds at Site U1498 contain ultramafic rocks and other rock types with clasts up to boulder size. Some of the rock clasts preserve cataclastic faults, and extensional structures (high-angle normal faults, extensional veins) might either be related to shearing or to faulting during exhumation. The volcanic ash underlying the mud volcano materials contains microfossils, including discoaster nannofossils, that can be dated in shore-based analysis.

Similar to samples from the summit of Fantangisña Seamount (Site U1497), pore water methane and ethane concentrations were below detection levels in samples from Hole U1498A. However, they were detected in several samples from Hole U1498B. The sample with the highest methane concentration had a methane/ethane ratio of 50. Similarly, concentrations of dissolved hydrogen were below the detection limit in samples from Hole 1498A, but some hydrogen was observed in Hole U1498B.

The two holes at Site U1498 also reflect different conditions in terms of their pore water chemical profiles. Chemical profiles from Hole U1498A, the furthest from the summit, are similar to those from the flanks of Yinazao Seamount (Site U1491). Here pore waters have a seawater-dominated signature upon which diagenetic reactions with serpentinite muds, clasts, and sands modified sediments imparting changes to some ion profiles. In contrast, Hole U1498B is similar to Hole 779A on the flank of Conical Seamount drilled during ODP Leg 125 (Mottl, 1992), where the pore water pH is consistently >10.5 at depths greater than 50 mbsf. The porewater "fingerprint" of the deep-sourced fluid (e.g., Site U1497) is also evident in profiles of major and minor ions in Hole U1498B data.

Samples were collected for shore-based microbiological samples. To assess possible artifacts from drilling operations, tracers were pumped into the drill string prior to and during core recovery. Tracer analyses indicate that most of the whole-round samples for microbiology are suitable for continued shore-based analyses.

Physical properties of the serpentinite mud at this site are similar to those of the southern flank of the Asùt Tesoru seamount (Sites U1493, U1494, U1495). They differ from those observed at active summit sites (Sites U1492 and U1496) in that Site U1498 has higher average values of bulk density (2.0–2.3 g/cm^3), higher *P*-wave velocities (1700–1900 m/s), higher thermal conductivities (1.5–2.0 W/m·K), and lower porosities (30%–40%). The underlying ash deposits have bulk density values of 1.5–1.7 g/cm^3, and higher porosity values of 50%–60%.

The downhole log data provided significant formation information across intervals of the borehole where core recovery was not complete (overall core recovery for this hole is 32%), and correlated well to the shipboard physical properties in the recovered intervals. Natural gamma radiation (NGR) logs showed that there is about 9 m of unrecovered pelagic sediments at the seafloor. Two possible internal mudflow boundaries with pelagic sediments may be present at 118 and 137 mbsf, based on two small peaks in the NGR log. The base of the serpentinite mud is seen clearly by NGR, magnetic susceptibility, and resistivity. The resistivity data also are useful for highlighting large clasts in the serpentinite matrix.

The shipboard remanent magnetization of all archive section halves of cores and 34 representative discrete samples from Holes U1498A and U1498B was measured using the shipboard superconducting rock magnetometer (SRM). Generally, the variability of magnetization in rock lithologies indicates that relatively high values of both magnetization and bulk magnetic susceptibility of discrete samples are related to ultramafic rocks, particularly the

dunite present in lithological units described as the bluish gray serpentinite pebbly mud with lithic clasts and peridotite clasts with magnetite-rich veins. A pervasive drilling overprint is also evident.

References

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