IODP Expedition 366: Mariana Convergent Margin

Site U1494 Summary

Background and Objectives

International Ocean Discovery Program (IODP) Site U1494 (proposed Site MAF-13A) is located about halfway up the southern flank of Asùt Tesoru Seamount (informally called Big Blue Seamount in the Expedition 366 *Scientific Prospectus* and previous publications) at 18°3.0896′N, 147°6.0003′E, in 2200 m of water. The site lies on multichannel seismic (MCS) reflection profile EW0202 42-44.

Asùt Tesoru Seamount is a serpentinite mud volcano that lies about 72 km from the trench axis. At Site U1494, the cores are expected to penetrate the distal edge of a large and apparently coherent 9 km wide serpentinite mudflow feature on the southwest flank of the seamount. The distal edge of the mudflow feature has a maximum angle of about 20°, then flattens onto its upper surface that has concentric ridges and arcuate radiating grooves. The expectation was that it would be possible to date the eruptive sequences on the flank of the seamount by paleontologic dating of sediments between flow units. Samples of any sediment encountered will be taken for postcruise microfossil identification and establishment of age ranges.

Because of difficulties with drilling the deep flank Sites U1491 and U1493, it was decided again to core only one 50 m hole at this locality. The objectives in detail were to: 1) core sediments and serpentinite mudflows on the midslope region of the southern flank; 2) potentially date discrete mud flows paleontologically, should there be sediment layers between them; 3) determine variability of mudflow compositions and thicknesses; 4) investigate potential systematic variability in degree of serpentinization; 5) examine transport characteristics; 6) provide an assessment of pore fluid composition; and 7) collect samples for microbiological analysis.

Operations

The ship arrived at Site U1494 at 2050 h on 5 January after a 4 nmi transit from Site U1493 in dynamic positioning (DP) mode. The first core at Hole U1494A was taken at 2325 h, and coring by half-length advanced piston corer (HLAPC) and by extended core barrel (XCB) became progressively more difficult with depth. After Core U1494-11X took 2 h to drill, we decided to end the hole and move on to Site U1495. Hole U1494A penetrated 39.0 m and recovered 29.6 m (76%). The short transit to Site U1495 started at 2135 h on 6 January.

Principal Results

Hole U1494A consists of serpentinite mud flows, but no ash-bearing sediment was found at the seabed, unlike the other Asùt Tesoru flank sites. At the top of the sequence, 1.7 mbsf of serpentinite mud and clasts have a pale brown color characteristic of oxidation. Below, there is a 0.65 m layer of mostly pale greenish to greenish-grey serpentinite, then bluish-grey serpentinites to 7 mbsf. The interval from 7 to 9 mbsf consists of yellow-brown to red-brown serpentinite silty mud with 3% to 5% clasts of serpentinized ultramafic rock, with interbedded lenses of pelagic, silty sand with foraminifera. The clasts of serpentinized ultramafic rock are commonly oxidized to red-brown or pale yellow-green colors. This yellow-brown interval was likely exposed to seawater and probably marks the top of an earlier mudflow. Some clasts were clearly harzburgites, others have no clear indicator of their protolith. The remainder of the sequence down to the bottom of the hole at 39 m consists of greenish grey to dark blue-grey serpentinites that are occasionally more clast rich.

Pore fluid geochemistry reflects mixtures of seawater and a serpentinite pore fluid that was originally emplaced or trapped when the serpentine muds erupted. The original emplaced pore fluids likely evolved with time (e.g., through continued water-rock reactions and/or microbial activity and diffusion). Similar to Site U1493 lower on the flank, pore fluid pH values are only moderately higher than seawater in Hole U1494A. Concentrations of K, Ca, and Sr are elevated, whereas B shows a depletion pattern that may reflect boron uptake into the serpentines at lower pH. Sulfate is depleted relative to seawater, possibly resulting from microbial sulfate reduction. Na/Cl ratios for these sites are higher than seawater (0.86) and increase with depth, likely reflecting continuing serpentinization (e.g., Mottl et al., 2004; Hulme et al., 2010). These signatures are also similar to those observed for the Yinazao Seamount flank Site U1491, and it may be possible to define pore fluid chemistries that are typical of flank sites on serpentinite seamounts, both near and far from the trench.

The physical property data show that there is a rapid increase in consolidation with depth, far greater than observed in other seafloor sediments (Bekins and Dreiss, 1992). Porosity decreases from 60% to 30% in just 20 m at Site 1494. In the serpenite muds, bulk density is 2.4 g/cm^3, *P*-wave velocity is ~2000 m/s, porosity is ~25%, and thermal conductivity is ~2 W/m·K. Such high values (in comparison to siliciclastic or pelagic sediments, or deposits at Site U1496 at the summit of this mud volcano) imply that consolidation of the material is unlikely to be only related to compaction. Low-temperature diagenetic processes or gravitational destabilization and sliding along the flanks (Oakley et al., 2007) may be important in explaining the differences with the deposits of the mud volcano active summits. Natural gamma radiation values are low throughout, but have higher values, reaching 8 counts/s in the two pale brown intervals (0–1.7 and 7.4–9 mbsf), indicating that there was ash-rich sediment deposition.

Paleomagnetic measurements of section halves and discrete samples from the flank holes were affected by coring disturbance and a pervasive vertical overprint, likely imparted from the drill string, and no clear normal or reversed polarity could be obtained from shipboard measurements.

Sampling efforts for postcruise microbiological analysis focused on representative sequences of both near surface and deeper whole-round cores with evidence of transitions across gradients of microbiologically affecting compounds and gases, e.g., hydrogen, methane, hydrogen sulfide, and sulfate.

References

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