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A submersible study of the Mariana Trough back-arc spreading center at 17^{o}N

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The cruise of JAMSTEC R/V Yokosuka and the submersible Shinkai 6500 took place in the Mariana Trough from 25 June - 6 July 2008. Three submersible dives were devoted to the median valley of the segment center at 17^{o}N (Dives #1088, #1089, and #1090).

The preface of our study was a deep-towed sidescan sonar (˜100 kHz) survey of the central Mariana Trough back-arc spreading centers in 2003. The segment at 17^{o}N is characterized by a dome-shaped topography shoaling at the segment center. The morphology is suggested to be a consequence of enhanced magma supply. Sidescan sonar imagery with high backscattering intensities, indicative of smooth surfaces, was dominant in the median valley of the segment center. Bumpy surfaces were confined to small ridges in the axial portion of the median valley or the segment end (Deschamps et al., 2005; Asada et al., 2007). The bumpy sidescan sonar images suggest pillow mounds and ridges, and the smooth surfaces suggest sheet-like lava flows or lobate flows. The different flow morphologies primarily reflect the rate at which the lava erupted. The presence of sheet flow morphology suggests a high rate of eruption, while pillow flow morphology suggests a low rate of eruption, with lobate flow morphology intermediate (e.g. Gregg and Fink, 1995). Smooth surfaces occupy half of the survey area. Such a broad area of smooth surfaces is unusual among slow spreading centers (the central part of Mariana Trough has full spreading rate ˜30 km/Myr).

Objectives of the submersible survey were: 1) observation of lava flow morphology, faults, and fissures and their spatial variation, 2) collection of rock and sediment samples for chemical and age analysis, and 3) geophysical measurements using a deep-sea magnetometer and a sub-bottom profiler to investigate magnetization of the lava flow and thickness of sedimentary layers that cover the lavas. Because the magnetization intensities relate to age of lava, deep-sea magnetic data may provide geophysical evidence for discussion of old and new lava flows. Quantifiable degrees of sedimentation superposed on the lavas suggest relative age differences of formation.

Our visual geological observation confirmed the following features in the sidescan sonar survey: bumpy surfaces of the sidescan images were pillow mounds or ridges, and smooth surfaces with high backscattering intensities were jumbled-wrinkled, folded sheet, or lobate lava flows. Observations indicated sheet lava flows of high effusion rates. Sheet lava flows in the axial portion of the median valley were considered to be youngest, with sedimentation more or less gradually increasing toward the western margin of the median valley. The observed eastern margin of the median valley was covered with sedimentary layers of ˜0.5-2 m thickness and was regarded as oldest among three dives. As for the tectonic features, the N-S trending tectonic structures (i.e. faults, fissures) could be younger constructions than the NNW-SSE trending structures because they showed relatively little accumulation of sediment, and they cut the other structures in some places.

Basaltic rock samples are folded crust of sheet flows or pillow lava fragments. Samples obtained from #1088, particularly sampled at the axial portion of the median valley, have glass rinds and almost no manganese coating (less than 1 mm) indicating very fresh lavas. Compared to the samples from #1088, samples collected in #1089 and #1090 appear older because of manganese coating and on-site sediment accumulation. All samples collected in #1088, #1090, and samples collected at the northern plain of #1089 are aphyric basalts. On the other hand, samples collected from the pillow lavas on the terraces and the hummocky ridge of the small volcano complex in #1089 are plagioclase-phyric.