

High-pressure metamorphism and mantle metasomatism in the Mariana convergent margin: Petrology of mafic and ultramafic clasts recovered from IODP Exp. 366

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Serpentinite seamounts distributed in the forearc region of the Mariana convergent margin are formed by mudflows dominantly of hydrated mantle wedge fault gouge that has risen with slab-derived fluids to the ocean floor along deep extensional faults (e.g., Fryer, 2012). Lithic clasts in the mudflows are representatives of the constituents beneath the Mariana convergent margin and give us crucial clues to understanding the mantle wedge processes beneath the Mariana forearc region. From Dec. 8 in 2016 to Feb. 7 in 2017, IODP Exp. 366 coring was conducted at three of these serpentinite mud volcanoes (Big Blue, Celestial, and Blue Moon) in the Mariana forearc region, and a large number of clasts of metabasite and serpentinite were recovered from Big Blue (Asùt Tesoru) Seamount.

Most of the metabasites contain Ti-augite as phenocrysts, indicating that the protolith is alkalic basalt. Ti-augite is replaced with Na-pyroxene (aegirine to jadeite), Na-amphibole (riebeckite), phengite, chlorite, and titanite along cracks. These metamorphic minerals also occur in the matrix of the metabasites in association with lawsonite, pumpellyite, and aragonite. The metabasites lack quartz and albite. The metamorphic conditions of >0.5 GPa and 150-250 °C are consistent with this mineral paragenesis. The ultramafic clasts are highly serpentinized and characteristically contain antigorite and brucite. Relic olivine, orthopyroxene, clinopyroxene, and chromian spinel are preserved in several samples. These anhydrous minerals are partially replaced by amphibole (tremolite to magnesiohornblende), talc, and chlorite.

The above characteristics of the Big Blue metabasites and serpentinized ultramafic rocks are closely similar to those from the South Chamorro and Conical seamounts (Fryer et al., 2006; Maekawa et al., 1993; Murata et al., 2009). Of these three serpentinite mud volcanoes, the latter two are located 78 and 86 km (respectively) away from the Mariana trench axis, whereas Big Blue is about 72 km from the trench. The subducted Pacific plate is situated about 18⁺ km below the sea floor for Big Blue Seamount (Oakley et al., 2008) and slightly deeper for South Chamorro and Conical Seamounts. The metamorphic conditions estimated from the Big Blue metabasites are within range of the positions and temperatures of the slab beneath the three serpentinite mud volcanoes, indicating that the metabasites were brought from subducted oceanic seamounts at all three locations.