Exhumation of high-pressure rocks by corner flow and serpentinite mud volcanism – implications from serpentinite mud seamounts along the Mariana convergent margin (IODP Expedition 366)

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International Ocean Discovery Program (IODP) Expedition 366 recovered cores from three serpentinite mud volcanoes that also contain clasts that originate from the subduction-channel along the Philippine Sea Plate – Pacific Plate boundary. The drilled and sampled mud volcanoes (Yinazao, Fantangisña, and Asüt Tesoru) are located at distances of 55 to 72 km from the Mariana Trench.

In general the recovered cores comprise serpentinite mud with lithic clasts from the underlying forearc lithosphere and from the subducting Pacific plate. This allows the reconstruction of mass transport processes and geochemical cycling within the forearc, the spatial variability of slab-related fluids within the forearc, and water-rock-reactions in subduction and supra-subduction zone settings, the metamorphic and tectonic history of the subduction channel, and the timing and rates of these processes.

Mafic rock clasts, embedded within a serpentinite mud matrix, from the flanks and summits of both Asüt Tesoru and Fantangisña Seamounts were analyzed for reconstruction of their metamorphic and deformational overprint in order to reveal the tectono-metamorphic conditions at the metamorphic peak within the subduction channel and the subsequent low-grade overprint during exhumation.

Several seamounts comprise clasts of lower plate metabasites with different metamorphic overprint (from low-grade greenschist facies to lower blueschist facies). The metabasites are also associated with clasts of fossiliferous carbonates and cherts with different degrees of metamorphic and deformational overprint, that also originated from the Pacific lower Plate. This implies that these rocks were exhumed from different depths within the subduction channel before being regurgitated within a serpentinite mud matrix. The blueschist facies metamorphic rocks, being affected by metamorphic pressures in the range of 11 to 13.8 kbar at minimum, were very likely exhumed from greater depth within the subduction channel before being captured by uprisings, localized serpentinite mud flows, indicating evidence that corner flow is actually taking place along the Mariana convergent margin, and, to our knowledge, this is the first direct evidence of exhumation of high-pressure rocks by corner flow in an active subduction zone. Final
exhumation, however, is related to the embedding of the rocks within a serpentinite mud matrix and the buoyant ascent of serpentinite mudflows along forearc fracture zones extending from the plate boundary to the upper plate sea floor.

Biostratigraphic analyses of calcareous nannofossils and planktonic foraminifera from serpentinite mud flows, and intercalated pelagic sediments immediately above the metabasites analysed in this study give an age record of ~6.10 Ma (late Miocene, Messinian) to 4.20 Ma (early Pliocene, Zanclean), indicating that the final exhumation of the metabasites occurred during late Miocene times, slightly before 6.10 Ma.