Chemistry of slab-derived fluids in the Mariana forearc

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Geological processes at subduction zone margins control seismicity, plutonism/ volcanism, and ocean-crust-mantle geochemical cycling. The down-going plate experiences dehydration, fluid release and associated metamorphism alters the physical properties of the plate interface.

The Mariana convergent margin is non-accretionary, and serpentinite mud volcanoes in the pervasively faulted forearc permit sampling of fluids and materials from the subducting slab and forearc mantle. IODP Expedition 366 drilled into three serpentinite mud volcanoes: Yinazao (13 km depth-to-slab); Fantangisña (14 km) and Asùt Tesoru (18 km), allowing comparison with the previously drilled South Chamorro (18 km) and Conical (19 km) seamounts.

The shallowest depth-to-slab seamounts are associated with Ca and Sr enriched, but otherwise solute poor, low alkalinity fluids of pH ~11, at equilibrium with gypsum. The Asùt Tesoru seamount fluids are markedly higher in both Na and Cl, as well as in species like B and K which are associated with the breakdown of slab sheet silicate phases, and are dramatically depleted in Ca and Sr. Higher DIC at this site is attributed to slab carbonate decomposition, while the observed elevated pH (up to 12.5) is likely caused by serpentinization reactions during which released iron is oxidised, producing H_2 and OH^-. Asùt Tesoru porefluids are similar to those studied at South Charmorro and Conical Seamounts, but display distinctly higher Na and Cl, and 3-4 times lower B contents. Changes in chemistry between sites reflect changes in metamorphic prograde reactions on the downgoing plate with increasing depth (P-T°). At shallowest depths sediment compaction and opal CT dehydration dominate; intermediate depths are characterised by clay diagenesis and desorbed water release; and at greater depths decarbonation and clay decomposition are dominant.