

Serpentinite mud volcanoes as natural laboratory for mineral carbonation reactions

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The rate of oceanic CO₂ uptake has increased during the recent decades as consequence of the rising concentration of atmospheric CO₂, causing ocean warming, acidification, and oxygen loss. Searching for efficient and safe methods of carbon capture and storage is one of today's greatest challenges. Mineral carbonation is a very promising option of carbon sequestration, capable of decreasing atmospheric CO₂ and mitigate climate change.

During IODP 366 expedition, three serpentinite mud volcanoes (MVs) – Yinazao, Asùt Tesoru and Fantangisña – located at the Mariana forearc were sampled. Here, mineral carbonation occurs naturally as authigenic carbonates (AC) precipitated in the serpentinite muds from the MVs.

This work aims to characterize the C, O and Ca isotopic composition of the AC to understand the geochemical conditions that promote their precipitation and its carbon source.

The AC are found within serpentinite-dominated samples, predominantly within the core's top meters. At Yinazao we found two groups of AC. One was composed of aragonite needles and spherulites and the other by rhombohedral calcite. Aragonite, located on the MV's summit, has $\delta^{13}\text{C}$ of $\sim 0\text{‰} \pm 0.9$ (n=16), $\delta^{44/40}\text{Ca}$ of $\sim 0\text{‰} \pm 0.5$ (n=15), and $\delta^{18}\text{O}$ $\sim 5\text{‰} \pm 0.3$ (n=16), while calcite, located on the MV's flank, shows higher values of $\delta^{13}\text{C}$ and $\delta^{44/40}\text{Ca}$ ($\sim 2.9\text{‰} \pm 0.08$ and $1.4\text{‰} \pm 0.06$, respectively), and lighter $\delta^{18}\text{O}$ ($\sim 1.7\text{‰} \pm 0.43$). At Asùt Tesoru and Fantangisña we also found aragonite needles and spherulites, located on the MVs' flank and summit, respectively, with similar $\delta^{13}\text{C}$, $\delta^{44/40}\text{Ca}$ and $\delta^{18}\text{O}$ isotopic signatures compared to aragonite needles and spherulites from Yinazao. The $\delta^{44/40}\text{Ca}$ was recalculated from $\delta^{44/42}\text{Ca}$ following Heuser *et al.*[1].

Preliminary results support the previously proposed precipitation models for Yinazao[2] and suggest seawater as the major carbon source of AC precipitation at these three serpentinite MVs. Their precipitation would result from the reaction between seawater and the highly alkaline fluids, sourced by serpentinization reactions at depth that ascend through the MVs. This knowledge may contribute to the development of natural carbon sequestration enhancement mechanisms to mitigate climate change.