Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37178

Slab-Derived Volatiles in Mariana Forearc Serpentinite Systems Revealed by Noble Gases and Halogens

MICHAEL W. BROADLEY[1], ALAN M. SELTZER[2], OLIVER WARR[3], GEORGE SEGEE-WRIGHT[4], JAIME D. BARNES[4], MOLLY ANDERSON[5], EMELINE VIDAL[6], KAN LI[5], SARINA MITCHELL[7], LYDIA HAYES-GUASTELLA,[8], JOSHUA CURTICE[5], REBECCA TYNE[9], GREG HOLLAND[10], ELISE GAULIER[1], SUSAN Q LANG[5], JULIE A HUBER[5], JEFFREY S. SEEWALD[5], GEOFF WHEAT[11], BRANDI KIEL REESE[12], KAREN G. LLOYD[13] AND PETER H BARRY[5]

[1]University of Manchester
[2]University College Dublin
[3]University of Ottawa
[4]The University of Texas at Austin
[5]Woods Hole Oceanographic Institution
[6]Marine Biological Laboratory
[7]The University of Tennessee, Knoxville
[8]University of South Alabama
[9]The University of Manchester
[10]Department of Earth and Environmental Sciences, the University of Manchester, UK
[11]Moss Landing Marine Laboratories
[12]Dauphin Island Sea Lab
[13]University of Southern California

Forearc serpentinite mud volcanoes provide rare access to slab-derived fluids released during the earliest stages of subduction. These systems represent a key interface where devolatilization of the downgoing plate drives serpentinization of the forearc mantle, generates H_2-rich fluids, and regulates volatile transfer between Earth's surface and interior.

Here we present coupled noble gas, halogen (Cl–Br–I), and iodine isotope ratio ($^{129}I/^{127}I$) measurements from formation fluids recovered from cased boreholes at four Mariana forearc serpentinite mud volcanoes (Yinazao, Fantangisña, Asùt Tesoru, South Chamorro), spanning progressively increasing slab depths.

Fluids from the sites overlying the shallowest slab depths are dominated by seawater signatures, indicating limited slab volatile flux at these forearc depths. In contrast, deeper sites exhibit elevated $^{4}He/^{20}Ne$ and $^{40}Ar/^{36}Ar$, together with heavy-Xe isotope excesses, indicating mixing between mantle He and slab-derived radiogenic–fissiogenic Ar–Xe. Enrichment in I/Cl combined with low $^{129}I/^{127}I$ ($\sim10^{-13}$) indicates release of ancient iodine from altered oceanic crust, likely linked to carbonate breakdown during slab devolatilization.

Systematic depletion of Ne relative to Ar and Xe with respect to seawater compositions further indicates preferential loss of light noble gases during slab processing.

These results show that forearc serpentinization systems are active geochemical filters that fractionate volatile species prior to sub-arc depths, with important consequences for halogen mobility and noble gas recycling to the mantle.