Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.7518

Stable isotope, noble gas, and forward modelling insights into the fate of volatiles subducted along the Hikurangi Margin, New Zealand

GABE S EPSTEIN[1], GRAY E. BEBOUT[1], BRUCE CHRISTENSON[2], HIROCHIKA SUMINO[3], IKUKO WADA[4], CYNTHIA A WERNER[5] AND DAVID R HILTON[6]

[1]Lehigh University
[2]GNS-Lower Hutt
[3]The University of Tokyo
[4]University of Minnesota
[5]Research Geologist (contractor)
[6]Scripps Oceanographic Institute, University of California, San Diego

Presenting Author: gse216@lehigh.edu

We present a multidisciplinary assessment of volatile production associated with subduction of the Hikurangi Plateau beneath the North Island of New Zealand. We quantitatively assess the input and output of CO_2 and N_2 based on the chemical and stable isotope composition of seafloor sediments and basaltic breccias (from IODP 375), previously accreted metasedimentary rocks (Torlesse and Waipapa Terranes), and volcanic/hydrothermal gases sampled from North Island fumaroles and springs (together with noble gas data for the latter). These results are compared with a 3-D thermo-petrologic models for four lithologic structures: a typical section of oceanic crust and serpentinized mantle peridotite as well as three idealized plateau structures containing variably altered, thickened oceanic crust. Devolatilization reactions and volatile loss are calculated using the thermodynamic software Perple_X assuming instantaneous fluid loss (i.e. approximating channelized fluid flow).

The model results indicate that 30–85% of initially subducted C and 5–12% of N is lost from the slab during metamorphism at forearc to subarc depths, with both volatiles being dominantly sourced from altered oceanic crust with some contribution from subducted sediment at the forearc-arc transition (75–90km depth). Gabbro and serpentinized peridotite do not supply appreciable CO_2 or N_2.

The $\delta^{13}C_{VPDB}$ and $CO_2/^3He$ values for the arc gases range from -8.3 to -1.4‰ and 2×10^9 to 2.7×10^{11}, indicating contributions from slab carbonate, organic C (subducted and/or assimilated), and mantle C of 67%, 30%, and 3%, respectively. The concentration of organic C in the subducted sediment is insufficient to account for the $\delta^{13}C$ signature of gases, requiring addition by tectonic erosion and/or crustal assimilation. The $\delta^{15}N_{air}$ and $N_2/^{36}Ar$ values of arc gases are -1.0 to +2.3‰ and 1.54×10^4 to 1.9×10^5, indicating slab and mantle contributions of 70% and 30%. These calculations yield whole-margin fluxes of 5.4–7.0 Tg/yr for CO_2 and 0.0023–0.0061 Tg/yr for N_2, corresponding to ~2.2% and 1–30% of the global CO_2 and N_2 flux from subaerial volcanoes worldwide (with global N_2 flux being poorly constrained). This unique assessment of volatile cycling could prove useful in refining regional and global estimates of volatile recycling efficiency.