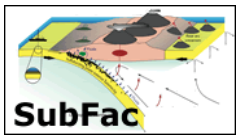
Volatile Chemistry, and Nitrogen Sources and Fluxes, in Subduction Zones: Insights from the Izu-Bonin-Mariana Arc



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T. Fischer[1], D. Hilton[2], E. Hauri[3]

[1]University of New Mexico; [2] Scripps Institution of Oceanography ; [3]Carnegie Institution of Washington

The first systematic study of the geochemistry of volatiles being emitted from the active volcanic front of the Izu-Bonin-Mariana (IBM) arc was undertaken in order to investigate the sources, flux, and mass balance of nitrogen across this 'cool' convergent margin. Volcanic emissions are typical of convergent margin volcanoes, and are dominated by H_2O, CO_2 and S species. Most samples have high N_2/He and low CO_2/N_2., due to addition of sedimentary nitrogen from the subducting slab. This is confirmed by $\delta^{15}N$ values, which are generally positive – up to +5.5‰. Quantitative mixing calculations indicate that, after correction for atmospheric contamination, an average of 75% of nitrogen is sediment-derived. Estimates of the volcanic front flux of sediment-derived nitrogen range from $0.12x10^8$ mol a-1 N_2 to $1.11x10^8$ mol a-1 N_2, representing 2-17% of the total nitrogen input flux, or 5-51% of the sedimentary nitrogen input flux. These results suggest a large fraction of the subducted nitrogen is delivered to the mantle, in contrast to studies of the relatively 'warm' Central American arc, where the majority of nitrogen appears to be recycled to the atmosphere. A major conclusion of the current study is that convergent margin thermal regime is likely the dominant control on the efficiency of nitrogen recycling in subduction zones. A secondary finding from this study, based on correlations between $\delta^{15}N$ values and various trace element and radiogenic isotope ratios, is that slab-derived nitrogen is sourced from subducting sediments but transported into the mantle wedge by an aqueous fluid derived from dehydration of the altered oceanic crust. It is suggested here for the first time that both an aqueous fluid and a sediment melt are involved in the genesis of Izu arc magmas.

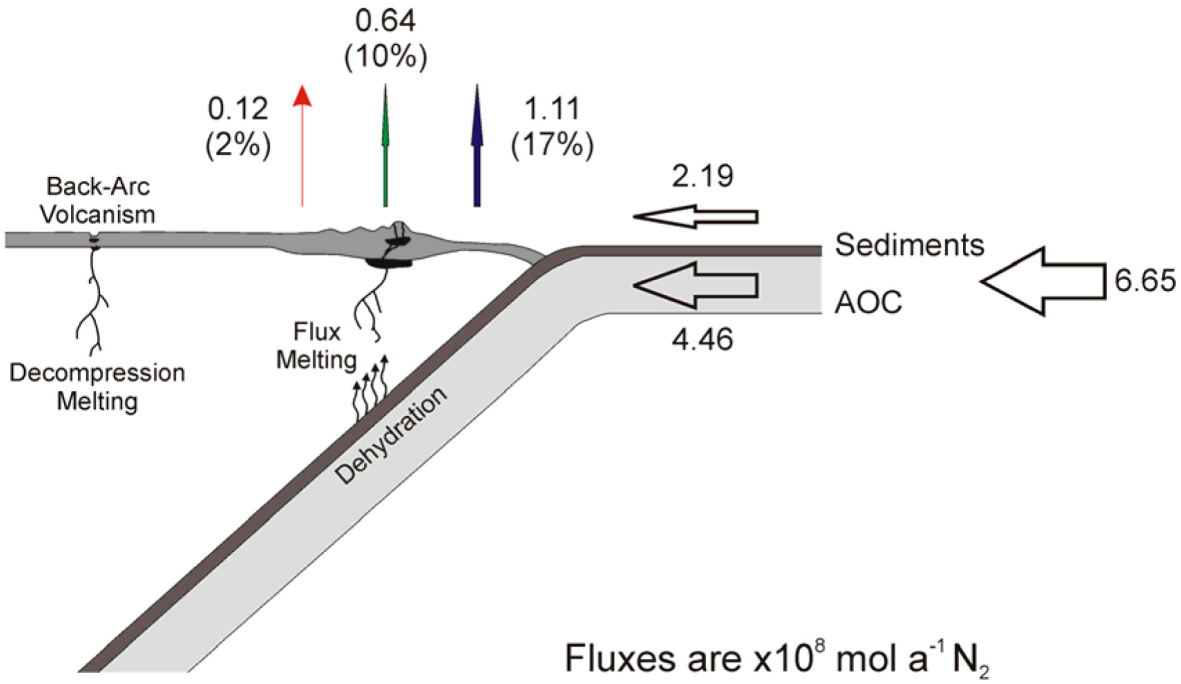

Figure: Inputs and outputs of Nitrogen at the IBM arc. It is notable that the output through volcanism is significantly less than the input at the trench by subducted sediments or altered oceanic crust (AOC). In fact only 2 to 17% of the nitrogen subducted is released through the arc by volcanic activity. This is in contrast to the other MARGINS focus site (Central America) where approximately 70 - 100 % of subducted nitrogen is released through arc volcanism.

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