C-N-He-Ar Cycling at the Hikurangi Subduction Margin, New Zealand

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We are evaluating the cycling of C, N, and noble gases at the Hikurangi margin, with ~35 analyses of gases from across the forearc-arc-backarc and further analyses planned for April-May 2020. We present C-N concentrations and isotope compositions of sediments outboard of the trench and wall-rock metasediment in the Taupo Volcanic Zone (TVZ). We compare these data with noble gas and C-N data for gases from fumaroles and thermal springs. Ongoing work includes thermal modeling, thermodynamic calculations of prograde devolatilization, and estimation of TVZ CO_2 output flux.

The incoming sediment section at IODP Site 1520 consists of uppermost terrigenous trench-fill (7 ±3 wt.% carbonate, 0.39 ±0.17 wt.% organic C), pelagic sediment (61 ±21 wt.% carbonate, 0.24 ±0.15 wt.% organic C), and lowermost volcaniclastics (13 ±14 wt.% carbonate). Isotope compositions are relatively uniform, with $\delta^{15}N$ = +4.4 ±0.9‰ (AIR), $\delta^{13}C_{carb}$ = +0.9 ±1.1‰ (VPDB), and $\delta^{13}C_{red}$ = -25.9 ±1.2‰ (VPDB). Wall-rock metasediments have $\delta^{15}N$ = +2.4 to +6.4‰, $\delta^{13}C_{red}$ = -25.0 ±1.9‰. Trench-fill sediments are largely removed by accretion, thus the carbonate-rich section likely contributes more to the gas emissions.

The dominant C-bearing gas phase in the forearc is CH_4 ($\delta^{13}C$ = -35 to -53‰) and that within the TVZ gases is CO_2 ($\delta^{13}C$ = -2 to -10‰). Forearc noble gas ratios have crustal to atmospheric values (± minor mantle contribution; $^3He/^4He$ = 0.2-1.7 R_A and $^{40}Ar/^{36}Ar \geqq 296$), while He-Ar and C-N isotope values of gases from the TVZ are consistent with mantle and recycled sedimentary contributions ($^3He/^4He$ = 4–7 R_A, $\delta^{15}N$ = +1.3 ±0.9‰, and $[N_2/^{36}Ar]/AIR$ = 1–10). Overlap in $\delta^{13}C_{red}$ and $\delta^{15}N$ of incoming sediments and wall rocks complicates differentiation of C sources but, given the accretion of the trench-fill sequence, the apparent sediment-derived C_{org} component (about 30%, after [1]) and N in the gases could reflect contamination by Torlesse/Waipapa wall rocks.

[1] Sano & Marty (1995) Chem. Geol. 119, 265-274.

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