Nitrogen and potassium transiting the redox and subduction barrier

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Nitrogen and potassium are coupled during their respective deep cycles, as implied by the nearly constant N/^{40}Ar ratio of mid-oceanic ridge basalts and Earth's surface reservoirs. This coupling is surprising given that at Earth's surface nitrogen predominantly speciates as N_2, an inert gas, while potassium remains dissolved in minerals. The subduction efficiency of an inert gas compared to a chemically-bound element is expected to be lower, and these relative efficiencies should decouple nitrogen from potassium over geologic time. Under reducing and low pH conditions, however, aqueous nitrogen is stable as the ammonium ion (NH_4^+). Importantly, NH_4^+ can substitute into K-bearing minerals with extensive solid solution. Thus, the deep cycle coupling of nitrogen and potassium suggests stability of NH_4^+ during slab subduction.

To quantify the stability field of NH_4^+ and N-K exchange coefficients applicable in hydrous systems, we have conducted high pressure-temperature experiments (up to 800 °C and 2 kbar). Each experiment equilibrates an N-H-O fluid with rhyolitic melt, biotite, plagioclase, and K-feldspar at controlled oxygen fugacity within Fe-Pt capsules. Major element composition of minerals and glasses are determined by electron microprobe. Work is underway to collect XANES and vibrational spectroscopy data. These data will ultimately quantify the controls on the exchange equilibrium between nitrogen and potassium within slab environments and indentify conditions required for coupling during (de)hydration and melting.