Nitrogen carrying capacity of slab-derived melts: Implications for deep nitrogen cycling

ANANYA MALLIK[1]

[1]Bayerisches Geoinstitut, Germany (ananya.mallik@uni-bayreuth.de)

Deep cycling of nitrogen (N) through subduction processes involves N-influx via subducting slabs and N-outflux via slab-derived fluids/melts that lead to arc magmatism. Recent studies point to the increased importance of slab melting in subduction zones of varying thermal regimes [e.g. 1]. In this study, I have estimated the N carrying capacity of slab-derived melts in order to understand the influx versus outflux of N via subduction processes. I performed experiments at 1300 °C, 2-4 GPa, buffered at fO_2 of NNO, to determine the solubility of nitrogen in rhyolites (slab-derived melts) with variable dissolved H_2O concentrations. The N is dissolved in the rhyolite as molecular N_2, which likely occupies the ionic porosity in the silicate melt structure. The solubility of N in the slab-derived melts varies from 0.3 wt.% to 1.2 wt.%, with solubility increasing with H_2O concentration. Higher H_2O concentrations correspond to increased OH^- contents in the rhyolite, as obtained from *in-situ* speciation studies on rhyolitic compositions [2], which in turn increase ionic porosity, hence, molecular nitrogen concentrations. Based on the rates of sediment and oceanic crustal input in subduction zones worldwide, the average nitrogen concentrations of sediments and oceanic crust, and the solubility of nitrogen in slab-derived melt compositions, I estimate that as less as up to 2 wt.% of slab–derived melt has enough nitrogen carrying capacity to completely depelete the subducted slab of N. Thus, not only in hot subduction zones such as in Central America [3], N depletion from the slab can also take place in subduction zones of varying thermal regimes. In fact, in the coldest subduction zones such as Tonga where slab melting may be suppresed, about 50% of the incoming nitrogen may be lost via slab-derived aqueous fluids [4]. Therefore, this study finds that the subducted slab is not an efficient carrier of N for deep cycling across subduction zones with a range of thermal regimes. If N has to be sequestered from the slab-derived flux and eventually recycled in the deep interior of the Earth, other carriers such as metasomatic hydrous alkalic minerals in the mantle wedge are required.

[1] Cooper et al, (2012). G3 13, Q03024. [2] Sowerby & Keppler, (1999). Am Min 84, 1843-1849. [3] Fischer et al, (2002). Science 297, 1154-1157. [4] Li & Keppler, (2014). GCA 129, 13-32.