The nitrogen budget of subducted crust

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Background

Nitrogen is a volatile, atmophile element whose terrestrial cycle has not been adequately constrained. Nitrogen speciation in fluids is complex, controlled by oxygen fugacity, pH, temperature and pressure (Mikhail et al., 2017); moreover, microanalysis of N can be challenging.

One indicator that N is subducted back into the mantle is that N concentrations in diamonds from an eclogitic paragenesis are generally higher than those in peridotitic diamonds. However, it has to date been unclear whether N can be hosted in significant concentrations by other minerals in eclogites. The mostly likely method for N to be present in silicates is as the ammonium (NH_4^+) ion. The charge and size of this ion indicate that it is likely to have similar chemistry to Rb, and therefore should be most abundant in K-rich minerals. In diamonds from Argyle, Western Australia, the concentrations of K_2O in omphacite can be as high as 1.4 %, which, in addition to the high modal abundance of omphacite, makes this mineral likely to be the most significant host of NH_4^+ in the subducted slab. We aim to present ion probe measurements of N from Argyle diamond inclusions to evaluate the range of possible N fluxes to the mantle.

Omphacite inclusions were analysed by EPMA for major element composition and using the SHRIMP-RG ion probe for N contents. The SHRIMP-RG measurements used the $^{14}N^+/^{28}Si^{2+}$ ratio, referenced to synthetic buddingtonite ($NH_4AlSi_3O_8$). A small subset of inclusions were observed *in situ* and the N content of the diamond adjacent to the inclusion was measured by SHRIMP to determine $D_N^{omphacite/diamond}$.

Table 1. Compositions of omphacite inclusions from Argyle diamonds, as determined by EPMA.

	A70	A110	A112	A116	A145	ARG103
SiO_2	56.01	56.20	54.22	56.76	55.84	55.09
TiO_2	0.61	0.51	0.73	0.46	0.69	0.51
Al_2O_3	13.04	13.76	8.20	17.22	12.98	10.01
Cr_2O_3	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
FeO	4.88	3.30	7.74	4.23	6.23	5.62
MnO	0.04	0.03	0.09	0.04	0.06	0.08
MgO	7.00	7.69	9.62	4.61	6.63	8.72
CaO	10.93	11.25	14.75	8.26	10.11	13.08
Na_2O	6.97	6.74	4.11	8.68	7.41	4.81
K_2O	0.72	1.23	0.69	0.33	0.73	1.12
P_2O_5	<0.05	<0.05	<0.05	<0.05	0.07	n.a.
NiO	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Total	100.22	100.70	100.14	100.58	100.76	99.06

N concentrations will be presented in due course.

Reference

Mikhail S, Barry PH and Sverjensky DA (2017) The relationship between mantle pH and the deep nitrogen cycle. Geochim. Cosmochim. Acta 209: 149-160