Evidence of subducted Archean nitrogen in the Siberian Craton

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Crustally-derived xenoliths (Gt, Cpx and Ol) from Siberia are originally derived from subducted oceanic crust which has since amalgamated to form the Siberian craton. For example, the occurrence of non-mantle-like oxygen isotope signatures in Siberian xenoliths suggests that these lithologies are artifacts of partially-melted subducted ocean crust [1, 2]. The ages of Siberian xenoliths are constrained to be within 2.7 - 3.1 Ga using Re-Os and Sm-Nd isotope dating techniques [3].

In order to assess if nitrogen is also recycled in ancient subducted-oceanic crust we determined N-isotopes ($\delta^{15}N$) and N_2/Ar values for a suite of peridotitic and eclogitic xenoliths (n=10) from two petrologically-distinct kimberlite pipes (i.e., Udachnaya and Obnazhennaya). Due to the antiquity of these particular xenoliths, they represent prime targets to understand the temporal evolution of N-isotopes in Earth's mantle, which has previously been suggested to show a secular variation throughout Earth history [4].

N-isotopes ($\delta^{15}N$) of Siberian xenoliths range from -5.9 to 3.9 ‰ (vs. air) consistent with both upper (MORB = -5 ± 2 ‰) and lower (plume = +6 ± 2 ‰) mantle contributions. Notably, all Obnazhennaya samples display N-isotope values in the MORB range or slightly above, whilst Udachnaya samples span the entire range of values reported here. $\delta^{15}N$ in Udachnaya xenoliths is inversely correlated with Br/Cl [4], with the lowest $\delta^{15}N$ values exhibiting the highest Br/Cl. The high Br/Cl within Udachnaya has previously been interpreted as evidence for an altered oceanic crust contribution [4]. Here, we suggest that the low $\delta^{15}N$ values in Udachnaya are also the result of Archean subduction of oceanic crust containing kerogens with isotopically low $\delta^{15}N$ signatures [5]. The range of $\delta^{15}N$ measured within Udachnaya can therefore be explained by mixing between an Archean subducted oceanic crustal component and plume component, whereas Obnazhennaya samples require an admixture of MORB and plume sourced N, which is consistent with He isotope values measured in the same samples [6], which show upper mantle overprinting of a pervasive plume component.

[1] MacGregor and Manton, 1986. [2] Taylor and Anand, 2004. [3] Pearson et al., 1995. [4] Broadley et al., 2018. [5] Beamont and Robert, 1999. [6] Barry et al., 2015.