

Boron isotope compositions of South Atlantic MORB and mantle sources

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The B isotope composition of subducted materials such as altered oceanic crust ($\delta^{11}\text{B} +3.7\%$) or marine sediments ($\delta^{11}\text{B} -4\%$ to $+16\%$) is typically significantly higher than the mantle ($\delta^{11}\text{B} -10\pm 2\%$) making B isotopes potentially useful as a tracer of mantle recycling. New *in situ* B isotope compositions [1], plus volatile, halogen and light-element concentrations [2], are being obtained on South Atlantic MORBs that show effects in trace elements [3], water content [4] and radiogenic isotopes [5] of recycled plume or crustal components.

B isotope compositions of these MORB samples indicate local depleted MORB mantle (DMM) $\delta^{11}\text{B}$ of $-11.7\pm 1.0\%$ to $-10.1\pm 0.9\%$, while one sample affected by assimilation of high H_2O , altered crust [4], has $\delta^{11}\text{B}$ of $-3.8\pm 0.9\%$. Samples affected by EM mantle components (Discovery and Shona Group II [4]) trend towards heavier $\delta^{11}\text{B}$ (up to $\sim 7\%\pm 1.0\%$) with increasing plume influence. Correlated increasing $\delta^{11}\text{B}$, Ba/Nb and decreasing $\text{H}_2\text{O}/\text{Ce}$ in these samples indicate that although subducted lithosphere might be efficiently dehydrated [4], a heavy $\delta^{11}\text{B}$ composition survives to raise $\delta^{11}\text{B}$ in these EM-affected MORB mantle sources to $\sim 7\%$ or higher. The $\delta^{11}\text{B}$ of 2 samples affected by Shona Group I type components [4] (FOZO type mantle) is $-7.8\pm 0.9\%$ and $-7.5\pm 1.0\%$, similar to EM-affected samples. This could reflect a fundamental difference between the MORB source and lower mantle in B composition.

References

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Volatile (C, N, Ar) heterogeneity in MORB popping-rock vesicles: Mantle volatiles mixed with air

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In order to better characterise the so-called “air-like noble gases” measured among mid-ocean ridge basalt vesicles, we analysed C, N, Ar-contents, C- and N-isotopes of gas released during step crushing of two chunks of MORB popping rock dredged at 14°N on the Mid Atlantic ridge.

The results obtained through 13 crushing steps show large variations in $\delta^{15}\text{N}$ from 0.0 to -5.1% , the variations being correlated positively with N_2/Ar (from 83.3 to 41.6) and negatively with C/N-ratios (from 20 to 444) respectively. The variations are best explained by a binary mixing between an atmospheric [$\delta^{15}\text{N} (\approx 0\%)$, N_2/Ar (83.5) and C/N (~ 0)] with one step being nearly atmospheric and a mantle component [$\delta^{15}\text{N} \sim -5.1\%$, $\text{N}_2/\text{Ar} \sim 45$ and C/N ~ 430]. The mantle end-member is particularly well constrained by the intersection of the mantle-atmosphere mixing line with the late-stage degassing trend (increasing $\delta^{15}\text{N}$, decreasing N_2/Ar) defined by three crushing steps. We stress that these specific values cannot reflect contamination by air-saturated water as the samples show associated increasing C/N.

We thus extend the observation of “air-like noble-gases” (i.e. as opposed to air-saturated sea-water, see Ballentine and Barford, 2000) to major volatiles (C, N). The origin of atmospheric-vesicles is unlikely to be related to “the subduction of air-like noble gases” (see Sarda, 2004). Indeed, a subducted component would rather show positive $\delta^{15}\text{N}$ and N_2/Ar higher than air reflecting that in subduction zones, high amounts of nitrogen (with positive $\delta^{15}\text{N}$) are present in metasediments. Moreover, following the model of Sarda (2004), air-like noble gas vesicles would form first. This is incompatible with the inferred amount of atmospheric nitrogen (0.20-0.22 $\mu\text{mol/g}$) and uncontaminated mantle-derived CO_2 ($\sim 69 \mu\text{mol/g}$). From the data and the respective solubilities of N and C, we would indeed infer that the first vesicles to form would have been the CO_2 -rich vesicles.

References

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