

Stable isotope (C-N) and noble gas (Ne-Ar) evidence for recycled plume components at the CIR

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We present new CO₂ ($\delta^{13}\text{C}$), N₂ ($\delta^{15}\text{N}$) and Ne-Ar isotope results on basaltic glasses of the Central Indian Ridge (CIR) (~17 – 21°S). Our aim is to assess whether the Réunion plume component evident along the CIR [1] also reveals a recycled contribution in the stable isotope and noble gas systematics. Positive $\delta^{15}\text{N}$ are attributed to post-Archean subduction whereas low $\delta^{15}\text{N}$ are associated with Archean recycling [2].

Nitrogen isotopes ($\delta^{15}\text{N}$) range from +3 to -3‰ (n=10) and overlap with positive $\delta^{15}\text{N}$ anomalies previously observed in Réunion xenoliths [3]. C-isotopes (n=17) range from -4 to -20‰ vs. PDB with the majority of samples falling in the MORB range. Equilibrium degassing models suggest that C-source characteristics may extend to -2.5‰. ²⁰Ne/²²Ne values range from 9.8 to 11.3 and when extrapolated to solar (Ne-B) values, ²¹Ne/²²Ne ratios are ~0.049. ⁴⁰Ar/³⁶Ar ratios range from 298 up to 8413 with the highest ²⁰Ne/²²Ne value occurring in the highest ⁴⁰Ar/³⁶Ar sample. Notably, positive $\delta^{15}\text{N}$ samples display Ne and Ar only slightly higher than air-values, whereas negative $\delta^{15}\text{N}$ samples display distinct primordial Ne. $\delta^{15}\text{N}$ shows no correlation with ⁴He/⁴⁰Ar* [1] indicating $\delta^{15}\text{N}$ values are independent of degassing effects.

Taken together, the N-Ne-Ar results suggest multiple recycled components in CIR basalts, including Archean (low $\delta^{15}\text{N}$) and post-Archean (high $\delta^{15}\text{N}$) components, both of which are potentially integrated into the Réunion plume. Conversely, CO₂ results retain close to canonical MORB-like signatures, suggesting that either the source CO₂ is masked by external processes (e.g. - degassing and/or crustal contamination) or that CO₂ in the (upper and lower) mantle is homogenized to the extent that we cannot differentiate between the various reservoirs.

[1] Furi *et al.* (2011) *JGR* **116**. [2] Marty *et al.* (2003) *EPSL* **206**. [3] Fischer *et al.* (2005) *GRL* **32**.

The influence of F, P and B content on pegmatitic melt viscosity

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The key property governing dynamics in strongly depolymerized partially melted systems is the melt viscosity. To test the individual influences of elements like F, P and B on melt viscosity of pegmatitic water-bearing systems a starting glass was prepared from a mixture of SiO₂, Al₂O₃, Na₂CO₃, and K₂CO₃. This starting composition (67.73wt% SiO₂, 20.20wt% Al₂O₃, 7.80wt% Na₂O and 4.27wt% K₂O) was then doped with different amounts of F (up to 4.8 wt%), P₂O₅ (up to 4 wt%) and B₂O₃ (up to 0.93wt%).

The viscosity of hydrous melts (1 to 6 wt% H₂O) was determined in internally heated gas pressure vessels using the falling sphere method (low viscosity range) in the temperature range 1173 - 1573 K at 200 MPa and 300 MPa. In the low temperature range the viscosity was determined between 580 and 880 K at ambient pressure using the micropenetration technique.

The results demonstrate that the viscosity decreases with the addition of F at all investigated temperatures. This viscosity decrease is more pronounced at low temperature and at low water content. The viscosity of pegmatitic melts containing ~6 wt% H₂O and 4.8 wt% F is 225 Pa·s at 1273 K. This value is about 1 log unit higher than that of complex pegmatitic melts containing F, B, P and Li [1]. Thus, although we confirm that F is clearly a fluxing agent, additional elements and their mutual interaction play a crucial role in the viscosity of natural pegmatite melts.

Our results indicate that phosphorus may not play a major role in viscous flow. In comparison to F the effect of P₂O₅ on melt viscosity is much lower (0.5 log units compared to 1.5 log units at 1373 K, 2.5 wt% H₂O), and in water-rich samples (~6 wt% H₂O) no significant effect of P₂O₅ has been detected. Additional experiments with variation of B₂O₃ content are in progress to determine whether this component will significantly influence melt viscosities in highly fluxed water rich systems.

[1] Bartels A., Vetere F., Holtz F., Behrens H., Linnen RL Viscosity of flux-rich pegmatitic melts. *Contrib Mineral Petrol*, in press