

Halogens (Cl, Br, I) in basalt glasses

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Halogens have highly variable concentrations in basalt glass with part of the variation related to mantle abundance. Serpentinites (hydrated mantle lithosphere) are major reservoirs for halogens in subducting slabs and previous work has shown Br/Cl and I/Cl are strongly fractionated during serpentine breakdown. As a result, fractionated and characteristic low Br/Cl and I/Cl ratios could be useful for tracing the presence of subducted halogens (and other volatiles) in basalts from different tectonic settings.

The halogen partition coefficients were investigated using a suite of Enriched Mid-Ocean Ridge Basalt glasses from Macquarie Island (70-1400 ppm Cl; MgO of 5.5-9 wt %; La/Sm of 1.4-7.9; typical MORB ³He/⁴He of ~8 Ra). Log-log covariation diagrams demonstrate Cl, Br, K and U have statistically indistinguishable partition coefficients similar to that of I. Therefore, Br/Cl, I/Cl, K/Cl and U/Cl are not easily fractionated during mantle processing, confirming variations potentially track subducted volatile components. The Macquarie MORB mantle has Br/Cl and I/Cl weight ratios of $(3.7 \pm 0.5) \times 10^{-3}$ and $(130 \pm 100) \times 10^{-6}$, respectively. Together with the Cl/K/U data, these ratios suggest 19 ± 6 ppm Cl, 67 ± 31 ppb Br and 7 ± 5 ppb I (2σ) in the bulk silicate Earth.

Preliminary data for Back-Arc Basin Basalt glasses from Lau and Manus have up to 3000 ppm Cl and variable Br/Cl and I/Cl signatures, including some of the lowest Br/Cl ratios obtained in this study. These data could be partly explained by a Cl contribution from serpentine breakdown fluids, but data are now required to determine the subduction potential of Br and I in organic-rich meta-sediments.

Oceanic Island Basalts from the Society and Pitcairn seamounts (³He/⁴He of 1-10 Ra ± solar Ne indicate mixed recycled and primitive components) are characterised by MORB-like I/Cl and Br/Cl ratios. In contrast, low Br/Cl values are expected in dehydrated serpentinites and high I/Cl values are expected in subducted sediments. Therefore, halogens in basalts with 'EM-type' signatures do not carry an obvious recycled signature, but could be explained by mixing recycled, 'primitive (?)' and MORB mantle components.

Possible Platinum Group Element (PGE) clusters in magmatic systems; Using synthetic sulphide melts

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The aim of the study is to verify whether or not the primary binding mechanism of PGE, in a magmatic environment, is a pure chemical or physical/- mechanical process. The monosulphide (mss) phases of temperature controlled synthetic melts were investigated for the existence of small Pt clusters or nano-structures (10-100 atoms). If such entities are found, they would point towards an initial physical mechanism as the dominant process during early magma differentiation.

Experiments were run with variable concentrations of Pt, As, Cu, S and Fe, chosen to mimic a natural Cu-Ni-S ± PGE system. Samples were cooled down rapidly (from 1050-25°C in a few seconds) and slowly (1050-400 °C over 48 hours).

Pt forms large heterogeneously distributed Pt-As_x and Pt-Fe_x phases (0.2-50 μm i.e. approximately 700-166666 atoms) within the melt phase of both slow and fast cooled samples. Results indicate that Pt needs a suitable anion like As, Fe or Cu to form a stable phase in a magmatic system. Pt-Cu_x phases (200-1000nm i.e. approximately 700-3333 atoms) in the mss phase of faster cooled samples confirm that some kind of clustering process is at work in Cu-Ni-S systems. Faster cooled samples show exsolution textures of Pt out of the mss phases into the melt phase (Cu_x-Fe_x-S_x).

While chemical behaviour may govern the secondary distribution of Pt-phases, clustering is potentially the primary (physical) mechanism. The clusters can easily be taken up into a immiscible sulphide, oxide or silicate phase. Clustering behaviour may explain the high enrichment of PGE in early cumulus phases (olivine and chromite) of the Bushveld complex.