Archaean mantle halogen composition from komatiites

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The heavy halogens (Cl, Br and I) are volatile elements which play a key role in terrestrial planetary processes and can be used as a tracer of volatile concentration and evolution on Earth. However, relatively little is known about the behaviour of heavy halogens in the mantle over time.

Archaean komatiites have been selected as representative of the ancient terrestrial mantle. Komatiite samples were chosen that vary in age and greenstone belt location: Canada, (n=1, 2.7 Ga), South Africa (n=3, 3.3 Ga), SE Baltic Shield (n=1, 2.4 Ga) and Zimbabwe (n=4, 2.7 Ga). All samples have experienced low grade metamorphism and a varying degree of serpentinisation. Materials of differing texture (olivine cumulative, pyroxene spinifex and olivine spinifex) were sourced, reflective of different layers within a komatiite flow.

Bulk and olivine separates were neutron irradiated to convert the halogens into noble gas isotopes, Ar, Kr and Xe. The noble gases were released from samples by step heating and fusion for analysis by noble gas mass spectrometry at the University of Manchester.

The measured bulk halogen concentrations are: Cl, ~87 to 485 ppm; Br, ~480 to 9978 ppb and I, ~6 to 394 ppb. Concentrations of halogens in olivines in the same samples are consistently lower by ~50-90%. Halogen ratios are between 1.98×10^{-5} and 2.92×10^{-4} for I/Cl, and 2.15×10^{-3} and 9.13×10^{-3} for Br/Cl, with no significant difference between bulk samples and olivine separates. Minor variation is seen between sample location and/or sample age. The lower-most I/Cl and Br/Cl values are similar to the modern MORB source [1]. This may imply that the Archaean and modern terrestrial mantle have similar halogen compositions.

A greater range of halogen ratios are obtained during step heating, extending up to 2.17×10^{-3} for I/Cl and 2.59×10^{-2} for Br/Cl. The cause of these high halogen values is uncertain, but could be related to post-emplacement alteration.

In-situ halogen analysis of the komatiite alteration phases and olivine hosted melt inclusions will help to constrain halogen composition and behaviour in the Archaean mantle.

[1] Kendrick et al. (2013), *EPSL*. **365**, 86-96.