Halogens in the Bon Accord Ni-Sulphide deposit

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The ~3.5 Ga Bon Accord ore deposit occurred in the Barberton Greenstone Belt of the Kaapvaal Craton, South Africa. It was completely mined out in the early 1900's, but is known to have comprised a unique assemblage of Ni-rich minerals that originally led to its interpretation as an extraterrestrial body [1]. It was subsequently interpreted as a fragment of the Earth's core, emplaced into the upper mantle in a deeply-sourced plume [2]. More recently, Bon Accord has been ascribed to the interaction of komatiite magma and sediment in an ocean floor setting, resulting in either a Ni-sulphide deposit or a variety of black smoker [3]. Recently published Cr isotope data have also been important in ruling out an extraterrestrial origin for Bon Accord [4]. Here, we use petrology and halogen geochemistry to shed further light on the origin and evolution of this intriguing deposit.

For the halogen measurements, silicate (5.1 mg) and oxide (12.2 mg) components were separated for individual analysis. Halogen abundances were determined by neutron irradiation noble gas mass spectrometry (NI-NGMS), utilising the neutron conversion of Cl, Br, and I into the readily measurable noble gas proxy isotopes $^{38}Ar_{Cl}$, $^{80}Kr_{Br}$ and $^{128}Xe_{I}$.

Bon Accord halogen concentrations range from 30-180 ppm Cl, 70-280 ppb Br and 12-45 ppb I. The oxide fraction contains 5 times less Cl and 3.5 times less Br and I than the silicate fraction (largely Ni-serpentine). The Br/Cl and I/Cl ratios (1.5-2.0 x 10^{-3} and 2.5-3.6 x 10^{-4}, respectively) are typical of serpentinites from different tectonic settings [5] and together with petrological observations, support formation in a sea-floor setting such as would be expected from the hydration of sub-aqueously erupted komatiite lavas.

[1] DeWaal (1978) Mineralisation in Metamorphic Terranes pp 87-98. [2] Tredoux et al. (1989) JGR, 94 (B1): 795-813. [3] O'Driscoll et al. (2014) Min. Mag, 78:145-63. [4] Tredoux et al (2014) Chem. Geol, 390:182-190. [5] Kendrick et al (2013). EPSL, 365: 86-96.