Re-Os and Sm-Nd isotopic constraints on basaltic komatiitic volcanism and magmatic sulphide formation in the Cape Smith Foldbelt, Quebec

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Sills (Bravo and Delta deposits) and flows (2-3 and Katiniq deposits) derived from magmas of roughly basaltic komatiitic composition and nearby sedimentary rocks have been analyzed for their Re-Os and Sm-Nd isotopic systematics. The purpose is to better understand the role of sediment assimilation in the formation of komatiite-hosted Ni-sulphide deposits, to compare the behavior of siderophile vs lithophile isotope systems during this process and to obtain an initial Os isotopic composition on high-MgO melts derived from deep-seated mantle upwelling associated with a mid-Proterozoic rift.

In outcrop, these are ultramafic rocks consisting of pyroxenite, peridotite and dunite. They display orthocumulate and adcumulate olivines and sulphide textures that vary from massive to net-textured to disseminated. The sulphides present are pyrrhotite, pentlandite and chalcopyrite with accessory pyrite (Barnes *et al.*, 1992; Barnes and Picard, 1993).

Re-Os isotopic analyses were performed on 1-2 g whole-rock powders by digestion in HF-HCl-ethanol in teflon bombs (Walker, 1988) and by high-temperature attack with HCl-HNO_3 in sealed Carius tubes to assure spike-sample equilibration (Shirey and Walker, 1994). Sm-Nd isotopic analyses were performed on separate 0.10 g aliquots of powder by conventional techniques. In ultramafic rocks, Re concentrations display a range from 0.184 ppb to 3.97 ppb while Os ranges from 0.108 ppb to 12.04 ppb. $^{187}Re/^{188}Os$ and $^{187}Os/^{188}Os$ in ultramafic rocks is much less variable (1.63 to 9.97 and 0.168 to 0.441, respectively). Samples from the Bravo, Katiniq and Delta deposits form a Re-Os isochron regression with an age of 1888 ± 10 Ma but the high MSWD of 121 suggests a larger age

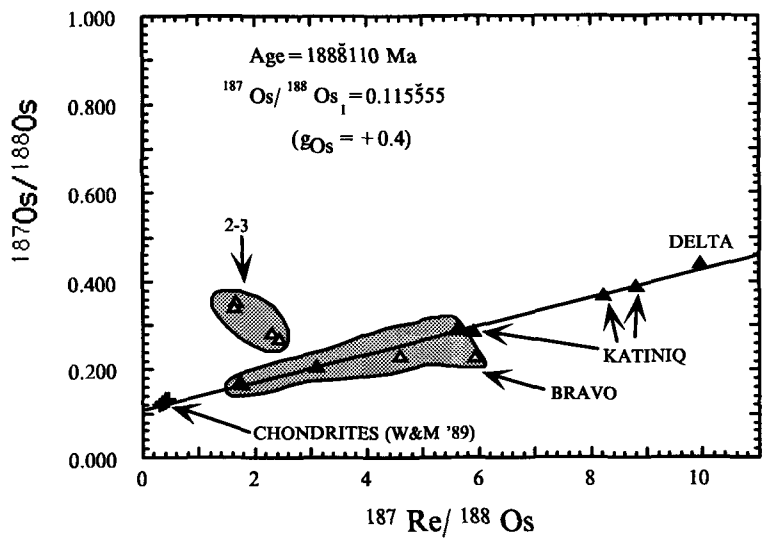

FIG. 1.

uncertainty (circa 110 Ma) is more geologically reasonable (Figure; note open symbols omitted from isochron regression). This age is in good agreement with U-Pb zircon age determinations of Parrish (1989) and stratigraphic correlations that place the ultramafic magmatism between 1918 and 1958 Ma (Barnes *et al.*, 1992). The initial $^{187}Os/^{188}Os$ of this isochron ($\gamma Os = +0.4$) is similar to a mantle source that has evolved with chondritic Re/Os systematics (Figure; chondrite data from Morgan and Walker, 1989). In contrast, samples from the 2-3 deposit have high initial $^{187}Os/^{188}Os$ of 0.209 to 0.302 ($\gamma Os = +66$ to $+164$) and a very low $^{187}Re/^{188}Os$ (1.63 to 2.43). The sedimentary rocks (shales and quartzite) are variable in their Re/Os and Os isotopic compositions; all have very radiogenic initial Os isotopic compositions at 1888 Ma and fall on a poorly-defined 2750 Ma array.

Significant amounts of shale assimilation into the Bravo, Katiniq and Delta lavas is precluded by the chondritic Os isochron initial ratio for these ultramafic rocks, the radiogenic Os isotopic composition of the shales ($^{187}Os/^{188}Os = 0.99$ to 6.82 at 1888 Ma) and their relatively high Re and Os contents (16.5 ppb and 0.66 ppb, respectively). More assimilation is permissible for the quartzite because of its lower Os content (0.019 ppb) but it is sulphur-poor and less likely to drive the magmas to sulphur saturation. Sm-Nd isotopic analyses support a lack of assimilation because samples from the Bravo locality have εNd at 1888 Ma of $+4$ to $+5$. The radiogenic Os isotopic signature of the 2-3 deposit is likely the result of small amounts shale assimilation. This process is supported by the Re-Os systematics and Sm-Nd isotopic data for which the samples from the 2-3 deposit fall on a mixing line of 2750 Ma slope between shale and the mantle source of the Bravo magmas. Assimilation of shale would substantially raise the $^{187}Re/^{188}Os$ of the magma so it is likely the low $^{187}Re/^{188}Os$ of the 2-3 deposit reflects post-assimilation fractionation of Re over Os into immiscible sulphide which was removed from the system leaving the silicate portions with lower Re/Os. Coupled Sm-Nd and Re-Os systematics demonstrates the closure of the Re-Os isotopic system in the Cape Smith area and underscores the utility of combining lithophile and chalcophile radioisotope systems for understanding the formation of magmatic sulphides.

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