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34

NOBLE METALS IN MID-OCEAN RIDGE VOLCANISM: A SIGNIFICANT FRACTIONATION OF GOLD WITH RESPECT TO PLATINUM GROUP METALS;
J.H. Crocket, Dept. of Geology, McMaster Univ., Hamilton, Ont.

Hydrothermal precipitates, black smoker particulate and massive sulphide dredge samples from the Explorer Ridge on the Juan de Fuca Plate and the TAG hydrothermal area on the Mid-Atlantic Ridge were analysed for selected noble metals including Au, Ir and Pd by radiochemical neutron activation analysis. The preliminary results indicate that gold contents may reach the ppm range (Axial Seamount, Juan de Fuca, 5 to 7 ppm Au) although values in the neighbourhood of 100 to 200 ppb are more typical. The platinum group elements (PGE) represented by Ir and Pd are typically <0.02 ppb and <2 ppb respectively. These abundances represent a significant enrichment of gold relative to the PGE in comparison with average noble metal abundances in mid-ocean ridge basalts (MORB). For example, based on a literature survey the average Au/Ir ratio of mid-ocean ridge tholeiites is approximately 20 (Crocket, 1981; Hamlyn et al., 1985) whereas a ratio of 10,000 represents a lower limit for black smoker-related hydrothermal precipitates.

A partial explanation of this distinctive fractionation can be found in the concepts of sulfur-saturation of basic magma in mid-ocean ridge (MOR) settings, and the origin of MOR hydrothermal fluids. Experimental and petrological data (Wendlandt, 1982; Roedder, 1981; Mitchell and Keays, 1981) suggest that MORBs are sulfur-saturated at the time of magma generation and that an immiscible sulfide component remains in the mantle residue. Hence, MORBs are noble metal-poor, particularly with respect to PGE. MOR hydrothermal fluids are widely regarded as hot, rock-equilibrated, modified seawater solutions which leach substantial quantities of solutes from the rock column (Seyfried, 1987; Edmond et al., 1982). Consequently, black smoker fluids can be expected to reflect the low Ir and Pd contents of the rock column.

The average Au content of MORB is 1.3 ppb (Hamlyn et al., 1985), and so the rock column is not significantly enriched in Au. The generation of fluids which precipitate solids with 200 ppb Au is apparently dependent on highly efficient fluid chemistry to mobilize Au from the rock column, high Au solubility in seawater hydrothermal fluids and efficient precipitation mechanisms to coprecipitate Au on Fe, Zn and Cu sulfides. Significant differences in these parameters appear to be the ultimate cause of the strong Au-PGE fractionation in the MOR setting.

It does not appear from the current data base that MOR hydrothermal fluids are significant contributors to the Ir enrichment seen in Cretaceous/Tertiary boundary sediments.

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