Solubility of Pd and Zn in Hydrocarbons: Application to Ore Genesis

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In some ore deposits, notably Mississippi Valley-type Pb-Zn deposits and black shale hosted Pt-Pd-rich deposits, there is a close spatial association between the metals and hydrocarbons (pyrobitumen). Indeed, Mississippi Valley-type deposits commonly contain hydrocarbon fluid inclusions and locally, oil seeps. Although the association between the metals and the hydrocarbons is generally attributed to the reduction of hydrothermal ore fluids by the hydrocarbons and consequent precipitation of the ore minerals, or the adsorption of the ore metals by organic matter, an alternative that merits consideration is that hydrocarbons (liquids) may be agents of metal transport.

In order to test the possibility that hydrocarbon liquids could transport ore level concentrations of Pd and Zn, experiments were conducted to determine the solubility of solid oxides of these metals in five samples of crude oil. The solubility experiments were performed using fused silica glass tubes into which silica glass holders (open at one end) containing the metal oxides were inserted and to which (the tubes) 5 mL of crude oil was added. The silica glass tubes were sealed and heated at 200°C for 10 days. After the experiments, the metal holders were removed from the fused silica glass tubes, and the tubes were heated to 500°C for 24 hours, and 600°C for another 4 hours to convert the oil to ash. After ashing, the contents of the tubes were leached by filling the tubes with aqua regia and leaving the aqua regia to react with the contents for 24 hours. The aqua regia solutions were then removed, diluted and analysed for Pd or Zn using ICP-MS.

Prior to the experiments, the concentrations of Pd and Zn in the unreacted oils were analysed using the methods described above to establish the background concentrations. These concenrations ranged from 1 ± 0.1ppb to 4.6 ± 0.8ppb for Pd and 387 ± 35ppb to 3.0 ± 1.4ppm for Zn. Concentrations of Pd and Zn after reaction at 200°C ranged from 369 ± 26ppb to 514 ± 83ppb and 11 ± 6ppm to 255 ± 42ppm, respectively. These concentration are comparable to or greater than those measured or predicted for hydrothermal ore fluids, and suggest that liquid hydrocarbons could play an important role as ore fluids in the formation of some of the Pd and Zn ore deposits.