Economic Pt and Pd in amagmatic settings?

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Experimental data on the solubility of Pt and Pd under various hydrothermal conditions suggest that transport and deposition of high levels of these elements could occur in several geological environments without the need for mafic magmatic fluids or heat.

In intracratonic rift environments, oxidized brines generated by surface evaporation and/or halite dissolution circulate to depth through a preponderance of oxidized lithologies and precipitate Pt and Pd in association with U and Au (unconformity-type U deposits) or Cu (sediment-hosted Cu deposits). Pt and Pd are likely to transported as chloride complexes in such oxidised brines. The best known product of this process is the Coronation Hill deposit in Australia.

In deformed passive margin sequences rich in carbonaceous and pyritic metasedimentary rocks, hydrothermal fluids are most likely to be reduced and have elevated sulfur content. Under these conditions Pt and Pd would be transported as bisulfide complexes. Potentially economic levels of Pt and Pd have been reported in numerous orogenic gold deposits of the former Soviet Union (notably the Sukhoi Log deposit) and in sediment-hosted Ni and Mo deposits of southern China and north-western Canada.

Oxidized low-salinity waters in surface environments buffered by atmospheric oxygen could also lead to mobility of Pt and Pd as hydroxyl complexes. Anomalous but sub-economic levels of Pt and Pd have been reported in low-temperature hydrothermally altered rocks of the Semail ophiolite and in laterite developed on ophiolitic rocks.

These examples suggest that high grades of Pt and Pd occur in a wide range of deposit types, although there is clearly a problem in some cases with quality of analysis. A crucial question is whether there is the potential for both high grades and large tonnages of Pt and/or Pd-bearing ore in these settings. This question can be answered in part by routine analysis for Pt and Pd by exploration geologists and by further research into transport and depositional processes.

The hydrothermal Ni-Cu-PGE sulfide ore of the Fortaleza de Minas deposit, Brazil

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The hydrothermal Ni-Cu-PGE massive ore of the Fortaleza de Minas deposit

The Fortaleza de Minas Ni-Cu-PGE sulfide deposit is hosted by Archean komatiite rocks (Brenner et al., 1990) in the southwestern margin of São Francisco craton. The deposit contains 6 million tons at the average grade of 2.2%Ni, 0.4%Cu, 0.05%Co and 1.2ppm PGE+Au (Brenner et al., 1990) and comprises metamorphosed-magmatic and hydrothermal ore bodies . The former is cut by N-S and NE-trending late faults that host the hydrothermal ore. The hydrothermal ore is characterised by thin, discontinous and irregular lenses and veins of massive sulfides hosted by serpentinite and talc schist (Almeida, 2003). It is composed mainly of pyrrhotite, pentlandite, chalcopyrite, magnetite and carbonates, with minor cobaltite-gersdorffite, sphalerite, ilmenite, serpentine and chlorite, and rare maucherite, tellurides (Pd-bearing melonite, tsumoite, tellurobismuthite and hessite) and PGM (omeiite, irarsite, testibiopalladite, Ni-bearing merenskyite and RuTeAs unknow phase). Late pyrite, chalcopyrire and carbonate fill fractures and violarite replaces sulfides. The PGM occur either included or associated with sulfides, silicates and oxides or filling fractures in pyrrhotite and chalcopyrite, indicating they started to precipitate with these minerals and continuous to precipitate after the sulfides were formed.

Geochemical Results And Interpretations

The hydrothermal ore grades are 290-2180ppb Pd, 69-1180ppb Pt, 113-282ppb Rh, 194-602ppb Ru, 156-447ppb Ir, 132-335ppb Os and 31-61ppb Au, being consistently higher than the metarmorphosed, magmatic ore. In addition, the hydrothermal ore is strongly depleted in Cr when compared with the metamorphosed magmatic ore. The geological mineralogical and geochemical data suggest that the PGE were remobilized by carbonic-rich fluids and precipitated as tellurides and arsenides in the late faults.

References

[1]Almeida, C.M, (2003), M.Sc. thesis, Universidade Estadual Paulista, Brazil. 110p. (unpublished)
[2]Brenner et al., (1990), Econ. Geol., 85, 904-920.