Economic Geology, v. 100, pp. 333–348

The Distribution of Base Metals and Platinum-Group Elements in Magnetitite and Its Host Rocks in the Rio Jacaré Intrusion, Northeastern Brazil

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Abstract

Anomalously high Pt and Pd values have been found in three magnetite bodies in the Rio Jacaré intrusion of northeastern Brazil. The intrusion hosting these magnetite bodies consists predominantly of pyroxenite and gabbro. One magnetite body occurs in the Lower zone and two in the Upper zone of the intrusion. These bodies contain approximately 0.04 percent Ni, 0.1 percent Cu, 0.18 percent S, 1 ppb Ir, 3 ppb Rh, 160 ppb Pt, 120 ppb Pd, and 37 ppb Au. They are much richer in platinum-group elements (PGE) than the surrounding silicate rocks, and there are significant correlations among all of the PGE and between PGE and Ni. However the correlations between PGE and Au, Cu, and S are much weaker than correlations between Au, Cu, and S.

In the magnetite bodies palladium-rich minerals, especially bismuthides and antimonides, are the most abundant platinum-group minerals (PGM). In most cases these occur with interstitial silicates or within silicate inclusions in magnetite and ilmenite grains and are associated with Co-bearing pentlandite and in a few cases with Co-Ni sulfarsenides and arsenides. Sperrylite ($PtAs_2$) is the most abundant Pt mineral and is associated with silicates interstitial to magnetite and ilmenite grains and sometimes with Co-Ni arsenides. At sites where the igneous mafic minerals have been altered to amphiboles, sperrylite may be altered to Pt-Fe alloys. Other alloys present include Pd-Sn-Cu, Pt-Cu, Pt-Ni, and Pt-Au.

It is suggested that Ni and PGE were concentrated in the magnetite bodies by the coprecipitation of a small quantity of sulfide with the magnetite. These PGE-bearing base metal sulfides subsequently exsolved PGM. The association of Pd minerals with base metal sulfides and the small variation in the Pt/Pd ratio (ca. 1.4) suggests that the PGE have not been extensively remobilized in the magnetitite. In contrast, the strong correlation between S, Cu, and Au suggests that, in addition to the redistribution of S, it is likely that Cu and Au were remobilized. It is not possible to say whether the redistribution of sulfur was due to late magmatic fluids dissolving S or the later metamorphic events.

The association of PGE enrichment with magnetite layers in the Rio Jacaré intrusion contrasts with that of the Bushveld, Stillwater, Great Dyke, and Munni Munni Complexes. In these complexes PGE-enriched layers or reefs are found in the lower third of the complexes and the oxide associated with the reefs is chromite. Magnetite-bearing layers, which form from an evolved magma in the upper parts of the intrusions, are generally barren of PGE because, at the time of magnetite crystallization, the PGE had already precipitated either in sulfides or PGM. However in a number of intrusions (e.g., Rincon del Tigre, Skaergaard, Stella, and Rio Jacaré) the upper magnetite-bearing portion of the intrusion shows PGE enrichment. This enrichment is rarely associated with visible sulfides but suggests a possible new target for PGE exploration.

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0361-0128/01/3499/333-16 $6.00