

The O'Toole Nickel Sulfide (+ PGE) Deposit, Minas Gerais, Brazil: Ore Geochemistry

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The O'Toole deposit, the only significant nickel sulfide (+ PGE) deposit known in the Brazilian greenstone belts, is located in the Morro do Ferro Greenstone Belt, Minas Gerais, Brazil. The greenstone sequence consists of four differentiated komatiitic volcanic cycles (separated by banded iron-formation), which can be modeled as products of fractional crystallization of olivine, clinopyroxene and plagioclase from a komatiitic parental magma with 28.9 wt% MgO. The O'Toole deposit is hosted by the third volcanic cycle and comprises four textural types of ores: brecciated, interstitial, disseminated, and stringer.

The O'Toole deposit, grading 2.2% Ni and 1.2 ppm PGE, is similar to many other komatiite-hosted nickel sulfide deposits, which have been interpreted as magmatic. Features of the O'Toole deposits that are consistent with a liquid immiscibility origin are: (a) interstitial texture of the sulfides in unbrecciated ores; (b) the estimated bulk composition of the ore (pyrrhotite:pentlandite:chalcopyrite:: 65:30:5), which falls within the monosulfide solid solution (mss) field at 600°C in the Fe-Ni-S system (mss); (c) Ni:Cu ratios in the range of 3-10; (d) low Pd/Ir ratios, mostly 2 - 6; and (e) chondrite-normalized PGE profiles similar to those of typical komatite-hosted deposits. A plot of Cu/Pd ratio versus Pd suggests that the silicate melt to sulfide liquid ratio (R value) was in the range of 100 to 1000.

Chondrite-normalized PGE + Au patterns of interstitial and disseminated types of ores are very similar to that of a metamorphosed metaperidotite (serpentinite) — nearly flat with slightly lower Ru value and slightly higher Pd value — but contain much higher values of PGE. A similar PGE pattern is also shown by the breccia ore, although it has been tectonically remobilized after precipitation as massive ore.