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Arsenohauchecornite, ognitite, parkerite, and related minerals from Onça Preta orebody, Carajás, Brazil: Fingerprinting PGE signatures in hydrothermal Ni ores

Yuri Tatiana Campo-Rodríguez[1,2,*], Cristiana L. Ciobanu[1,†], Nigel J. Cook[1,‡], Ashley Slattery[3], Benjamin Wade[3], Sarah Gilbert[3], Maria Emilia Schutesky[2], and Kathy Ehrig[4,§]

[1]School of Chemical Engineering, The University of Adelaide, Adelaide, South Australia 5005, Australia
[2]Geosciences Institute, University of Brasília, Brasília 70910-900, DF, Brazil
[3]Adelaide Microscopy, The University of Adelaide, Adelaide, South Australia 5005, Australia
[4]BHP Olympic Dam, 10 Franklin Street, Adelaide, South Australia 5000, Australia

Abstract

Nickel-rich sulfide mineralization from the Onça Preta orebody, Jaguar orefield, Carajás, Brazil, comprises pentlandite, violarite/bravoite, pyrite, sphalerite, and minor chalcopyrite. The orebody, placed at the contacts between units of the Neoarchean Serra do Puma layered complex and granite, is interpreted as a hybrid of Fe-Zn-Ni skarn and iron oxide-copper-gold (IOCG) mineralization. We use micro- and nanoanalytical methods to characterize the sulfides and their potential for a platinum-group elements (PGE) signature. Sulfide mineralization occurs as disseminations and along shears in magnetite-rich ores. Microtextures preserved in pentlandite are concordant with cycles of replacement via coupled dissolution-reprecipitation reaction (CDRR). Grain-scale element mapping reveals evidence for remobilization and reprecipitation of metals as inclusions and/or at grain boundaries. Rare accessory nickel-bismuth minerals, including arsenohauchecornite [$(Ni_{16.5}Fe_{1.28}Co_{0.39}Zn_{0.17}Cu_{0.01})_{18.35}(Bi_{2.9}As_{0.77}Sb_{0.08}Te_{0.08})_{3.8}(S_{15.85}Se_{0.01})_{15.9}$], ognitite [$(Ni_{1.02}Fe_{0.01}Pd_{0.004})_{1.04}(Bi_{0.58}Pb_{0.002}As_{0.001})_{0.585}(Te_{1.36}S_{0.02}Se_{0.001})_{1.38}$], and parkerite [$(Ni_{2.85}Fe_{0.045}Ag_{0.007}Pd_{0.001})_{2.9}(Bi_{2.024}Pb_{0.005})_{2.03}(S_{2.02}Te_{0.038}Se_{0.008})_{2.07}$] are relatively abundant. The extensive solid solution inferred between ognitite (NiBiTe; Ogn) and melonite ($NiTe_2$; Mlt) is confirmed by imaging and modeling using mixed Bi-Te sites for the intermediate member $Ogn_{60}Mlt_{40}$ found at Onça Preta. The accessory mineral assemblage also includes Bi-tellurides of the tetradymite group and Pb-Bi sulfosalts from the lillianite homologous series. Nanoscale analysis, combined with crystal structure models and simulations of arsenohauchecornite, confirms the *I*-centered tetragonal superstructure previously described. Aggregates of parkerite found at boundaries between ognitite and pentlandite are associated with abundant defects and/or misorientation fabrics crossing into pentlandite. Such nanostructures delineate fluid pathways, as they host nanoparticles of various tellurides (moncheite, volynskite, hessite, altaite, tellurobismuthite, tsumoite), galena, and native bismuth. Self-patterning during crystal growth is considered based on rhythmic chemical banding (Bi) and antiphase boundaries in ognitite. Formation of nickel-bismuth minerals is attributed to CDRR replacement of pentlandite during percolation of Bi-Te-bearing fluids. Likewise, the formation of bismuth tellurides and sulfosalts resulted during CDRR replacement of pentlandite by pyrite or violarite/bravoite. Identification of moncheite and Pd in ognitite (up to 0.68 wt% Pd), pentlandite, and violarite/bravoite (at ppm levels) at Onça Preta further extends the potential for PGE in hydrothermal Ni sulfide ores in the southern Carajás Domain. This finding has implications for exploration in the region and analogous terranes elsewhere.

Keywords: Arsenohauchecornite, ognitite, parkerite, moncheite nanoparticles, PGE signatures, pentlandite, Carajás, Brazil