

Basal Platinum-Group Element Mineralization in the Federov Pansky Layered Mafic Intrusion, Kola Peninsula, Russia

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Abstract

The 2501- to 2446-Ma Federov Pansky layered mafic intrusion in the central part of the Kola Peninsula, Russia, is situated along the northern contact of the Early Proterozoic Imandra-Varzuga rift and Archean granite gneiss. The Federov Pansky intrusion has eight major zones (from bottom to top): (1) Marginal zone mafic schists, 50 to 100 m; (2) Taxitic Gabbronorite zone (bpCa), 150 to 300 m; (3) Norite zone (bCpa, pbC), 200 m; (4) Main Gabbronorite zone (paCb), 1,000 m; (5) Lower Layered Horizon zone (bC, pC, pbaC), 100 m; (6) Gabbro zone (paCb, pbaC), 1,500 m; (7) Upper Layered Horizon zone (poCab), 250 m; (8) Upper Gabbro zone (paCb), 400 m.

The Taxitic Gabbronorite zone is restricted to the Federov and east Lastjavr blocks. This zone is distinctive, due to its pegmatitic taxitic textures and abundant norite xenoliths concentrated near its upper contact with the Norite zone. Chemically, the taxitic gabbronorite is more feldspathic and iron enriched than the overlying MgO- and Cr₂O₃-rich Norite zone and norite xenoliths. The zone hosts Cu-Ni-PGE mineralization with disseminated sulfides, which is continuous for over 2.5 km along strike and 150 to 200 m downdip. 98 percent of the sulfides consist of varying amounts of pyrrhotite, chalcopyrite, and pentlandite. The mineralization is divided into an upper mineralized section with two higher-grade lenses, A and B, and the restricted lower mineralized section with six narrower lenses. The lower mineralized section is less continuous and less uniform in terms of Cu-Ni-PGE distribution. The norite xenoliths and blocks occurring within the Taxitic Gabbronorite zone are practically barren of sulfide and can dilute higher PGE and base metal grades in the gabbronorite matrix.

Average total PGE grades in rocks do not exceed a few grams per tonne. The mineralization is palladium rich with a Pd/Pt ratio from 4.22 to 4.34. Rh and Au grades are 0.1 to 0.5 g/t. Os and Ir grades are <0.1 g/t. Cu grades are from 0.1 to 0.4 percent, and Ni from 0.1 to 0.3 percent. The mineralization is copper enriched with an average Cu/Ni ratio from 1.44 to 1.80.

The most common PGE-bearing minerals are merenskyite, moncheite, kotulskite, sobolevskite, and michenerite; less common are sperrylite and vysotskite-braggite. The Cu-Ni-PGE sulfides are primarily magmatic in origin. This is supported by S isotope compositions, with a narrow range of $\delta^{34}\text{S}$ of -0.2 to +1.4 percent and S/Se ratios of 1,050 to 3,300.

A three-stage process is postulated for the genesis of the Federov mineralization. This involves the intrusion of a more fractionated and sulfur-saturated gabbronorite magma and its brecciation and mixing with a residual, primitive magma, forming immiscible sulfides that scavenged Cu-Ni-PGE. The Federov resembles other contact-type mineralization, such as in the Portimo intrusion in Finland and the Lac des Iles and East Bull Lake intrusions in Ontario, Canada.

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