PGM Associations in Copper-Rich Sulphide Ore of the Oktyabr Deposit, Talnakh Deposit Group, Russia

Olga A. Yakovleva[1], Sergey M. Kozyrev[1] and Oleg I. Oleshkevich[2]
[1]Institute Gipronickel JS, St. Petersburg, Russia
[2]Mining and Metallurgical Company "Noril'sk Nickel" JS, Noril'sk, Russia
e-mail: smk@nikel.spb.su

The PGM assemblages of the Cu-rich sulphide ores occurring in the western exocontact zone of the Talnakh intrusion and the Kharaelakh massive orebody have been studied. Eleven ore samples, weighing 20 to 200 kg, were processed using gravity and flotation-gravity techniques. As a result, the gravity concentrates were obtained from the ores and flotation products. In the gravity concentrates, more than 20,000 PGM grains were found and identified, using light microscopy and EPMA. The textural and chemical characteristics of PGM were documented, as well as the PGM distribution in different size fractions. Also, the balance of Pt, Pd and Au distribution in ores and process products and the PGM mass portions in various ore types were calculated. As a result, the ores studied were classified with regard to the PGM assemblages and processing characteristics.

The mineral composition of the Cu-rich stringer-disseminated ore is represented by "primary" and "secondary" mineral associations. The major "primary" ore minerals are pyrrhotite, chalcopyrite, pentlandite, pyrite, millerite and magnetite, while the silicate portion is represented by pyroxene, pyroxene-garnet and pyroxene-feldspath hornfels and forsterite-monticellite scarns. The "secondary" ore minerals include pyrite, magnetite, markasite, valleriite, djerfisherite, violarite and mackinawite; the nonmetals are chlorite, prehnite, amphiboe, wilkeite, clintonite, spinel, barite, diaspore, calcite and anhydrite. The accessory and rare ore minerals of both associations are sphalerite, galena, bornite, chalcocite, cobaltite, polydymite, hawleyite, clausthalite, argento-pentlandite, hessite, Au-Ag alloys and PGM.

The Cu-rich ores are characterized by breccia-like, disseminated and massive textures, while the former is dominant (60 to 70%). Four mineral ore types have been recognized: pyrrhotite, chalcopyrite-pyrrhotite pyrrhotite-chalcopyrite, and chalcopyrite.

Pyrrhotite and chalcopyrite-pyrrhotite ores dominate, constituting 70 to 80 vol.% of the Cu-rich ores. These ore types contain from 50 to 70% sulphides and chalcopyrite amount is no more than 6%; the Ni content ranges 0.8 to 1.3%, and the ratio Cu/S = 0.1-0.2.

Pyrrhotite-chalcopyrite ore occurs at the top of ore horizons. The ore-mineral content ranges 50 to 60%, and pyrrhotite amount is <15%. The ore grades 1.1 to 1.3% Ni, and the ratio Cu/S = 0.35-0.7.

Chalcopyrite ore occurs at the top and on the flanks of the orebodies. The concentration of sulphides ranges 50 to 60%, and pyrrhotite amount is <1%; the Ni content ranges 1.3 to 3.4%, and the ratio Cu/S = 0.8-0.9.

The ore types are distinctly distinguished by the PGE content which directly depends on the chalcopyrite quantity, but not on the total sulphide content: pyrrhotite and chalcopyrite-pyrrhotite ores contain 3 to 4 ppm total PGE, up to 0.12 ppm Au and 3 to 5 ppm Ag; pyrrhotite-chalcopyrite ore contains 17 to 30 ppm total PGE, 0.5 to 2.8 ppm Au and 20 to 60 ppm Ag; chalcopyrite ore contains 80 to 400 ppm total PGE, 3 to 15 ppm Au and 60 to 300 ppm Ag.

The ore types have been classified taking into consideration the proportion of PGE distribution in mineral form, mass of each PGM species and gravity processing characteristics such as maximum grain size, PGM distribution in different size fractions and coefficient of metal recovery using gravity concentration; besides, the ratios Pd/Pt, total PGE/S and the content of "heavy" PGE (Ru, Rh, Ir) have been calculated.

Pyrrhotite ore is characterized by a significant portion of noble metals as solid solutions, 97 to 100%. Among the PGM, Fe-Pt and Au-Ag alloys are dominant with minor moncheite and cooperite and none of Pd species has been found. The PGM grains attain 40 μm in diameter, and native Au, 75μm. The coefficient of metal recovery is 0.13.

In the chalcopyrite-pyrrhotite ore, 20% of Pt and less than 1% of Pd are accounted for by the PGM. Twenty-four PGM species have been found including 16 Pd minerals, 7 Pt minerals, one Ru-Os mineral, and Au-Ag alloys. Pt-Pd sulphides dominate (>70%), while Fe-Pt and Au-Ag alloys

make up about 12%; minor PGM are rustenburgite, atokite, paolovite, palarstanide, sperrylite, laurite, sobolevskite, michenerite and kotulskite. The PGM grains average 35 to 40 μm in diameter, attaining a maximum size of about 100 μm. The coefficient of recovery is 0.3-0.5.

In the pyrrhotite-chalcopyrite ore, the mineral species account for 20 to 70% of Pt, 1 to 2.5% of Pd and 10 to 20% of Au. More than 20 noble-metal minerals have been identified, among which Pt-Pd sulphides (95%) and Au-Ag-Pd alloys are dominant; their grains attain 100 μm in size, whereas grains of the other PGM are less than 45 μm. The coefficient of recovery is 0.8-1.0.

Chalcopyrite ore contains 40 to 90% of Pt, 50 to 100% of Au and 5 to 20% of Pd in mineral form. Twenty-seven noble-metal minerals have been found and sulphides (50 to 65%), tellurides (3 to 40%) and Au-Ag-Pd alloys (3 to 40%) dominate; the grains of these attain 1 to 5 mm in size. The coefficient of recovery attains 1.0.

Thus, the pyrrhotite ore type is characterized by an association of Au-Ag and Fe-Pt alloys and is poorly amenable to gravity processing due to small size of noble-metal minerals; pyrrhotite-chalcopyrite and chalcopyrite types contain Au-sulphide and Au-telluride-sulphide assemblages of noble-metal minerals and are amenable to gravity concentration.