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Ore Mineralogy and Geochemistry of PGE-Ni-Cu Deposits: Applied Aspects

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Sulphide Ni-Cu and PGE deposits form a large compositionary discontinued range of ore objects of different industrial importance. Their economic availability can be ranked by their ore tenors and mineral reserves. Difficulties of ore targets identification and assessment of their practical values can be eased by analysis of their ore mineralogy and geochemistry at grassroot stages of exploration.

All PGE-Ni-Cu deposits are originated and hosted by basic and ultrabasic ore-magmatic systems (OMS) over diverse geodynamic regimes: destructive and constructive. Their sources (geophysial data) are different-scale basic-ultrabasic magmatic plumes from little (first km) to giants and super giants (hundreds-thousands km).

Various combinations of ore components of such OMS include Fe, Ti, Cr, V, Ni, Co, Cu, Pb, Zn, Sn, As, Sb, Bi, Se, Hg, PGE, Ag, Au, etc., with O, C, OH, S, Cl, F and other ligands. Combinations of ore mineral species and their associations usually repeat in all sulphide Ni-Cu and EPG deposits and have been systematized into several mineral classes - sulphide, sulphosalts (sulfarsenide, -antimonide, -bismuthide, -selenide, etc.), arsenide, antimonide, bismuthide, selenide etc., and native element (or their binar, triple, etc. alloys) species.

Ore-forming sequences in all PGE-Ni-Cu OMS are ordered by fundamental laws of sulphur and main metal resources exhaustion and building-up of accessory incompatible elements (Pb, Zn, Sn, As, Sb, Bi, Se, PGE, Ag, Au, OH, C, Cl, F), especially PGE, Au, Ag, during each ore-forming stage from primary magmatic, pegmatite, fluid and hydrothermal-metasomatic and to late low temperature hydrothermal one. The most famoust examples are ore mineral associations in Norilsk deposits. Those regularities have been modelled in experimental systems and were found in metallurgical processes of ore treatment and used in metal refining technologies (zone melting). Precious metals contents in modern volcanic exhalations (Merapi, Erebus, Kudryavy, etc.) confirm these regularities. There were some exceptions to this rule in regenerated (metamorphized) deposits.

So, quantities of incompatible elements, their mineral forms and concentration relations in ores can indicate the scale of ore-forming processes, element accumulation and their possible duration (or abortion) in OMS. Mineralogical data (quality assessed), those element absolute and relative concentrations including additive relations (PGE/Se, Au/Ir, etc., PGE/Ni+Cu, etc.) point to geodynamic regime, volume and quality of ores in OMS as a whole and in their subsystems.

Compiled and studied ore mineralogical and geochemical data in the latest mineralization stages associations, Ni/Cu-Pd/Ir, Cu/Ir-Ni/Pd, PGE/Ni+Cu, PGE/Se, Au+Ag/Se, Au/Ir, etc. diagrams reflect source volume and accumulation scale of accessory ore elements in OMS and characterize possible metallogenic potential, resources and reserves of OMS and their PGE-Ni-Cu deposits. Selected and tested examples of PGE-Ni-Cu deposits from different geodynamic regimes and tectonic settings over the world have revealed five trends: chromite, layered intrusive, platobasalt, central type intrusive complex (alaskan/alkaline-ultrabasic) and copper- rich ones. Their deposits have common and individual regularities of ore and accessory element accumulation. These regularities were assessed, quanified and obtained preliminary data can be useful in exploration work.