



Two types of ore-bearing mafic complexes of the Early Proterozoic East-Scandinavian LIP and their ore potential

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Two types of the ore-bearing mafic complexes are allotted in the East-Scandinavian large igneous province (LIP). They differ in geodynamic setting, structure, isotope geochemistry, petrology and mineralogy.

The PGE-bearing mafic-ultramafic layered intrusions are associated with the first complex. They have been formed at an initial (pre-rift) stage of LIP. Features of origin of this complex are: 1) large-scale, protracted, and multiple episodes of deep mantle plume or asthenosphere upwelling; 2) the vast non-subduction-type basaltic magma in an intraplate continental setting; 3) low-sulfide Pt-Pd (with Ni, Cu, Au, Co and Rh) mineralization in different geological setting (reef- and contact type etc.); 4) anomalously high concentrations of PGEs in the bulk sulfides, inferred platinum distribution coefficient between silicate and sulfide melts of >100000 . Deep mantle magma source is enriched in ore components (fertile source) and lithophile elements. It is reflected in the isotope indicators such as $\epsilon\text{Nd}(T)$ from -1 to -3, $\text{ISr}(87\text{Sr}/86\text{Sr})$ from 0.702 to 0.704, $3/4 = (10^{-5} \div 10^{-6})$. Magma and ore sources differ from those of Mid-Ocean Ridge basalts (MORB), subduction-related magma but are similar to EM-I. Ore-bearing mafic complexes formed during a long period of time and by different episodes (2490 ± 10 Ma; 2470 ± 10 Ma; 2450 ± 10 Ma; 2400 ± 10 Ma), and by mixing between the boninitic and anorthositic magmas. It is known about 10 deposits and occurrences in Kola region with total reserves and resources about 2000 tons in palladium equivalent (with an average content $\geq 2-3$ ppm).

Intrusions with the rich sulfide Ni-Cu ore (with Co and poor PGE) are associated with the second mafic complex. Ore-controlling mafic-ultramafic intrusions are formed at a final stage of the intracontinental rifting of the Transitional period (2200-1980 Ma). Initial magma is depleted and similar to the MORB in terms of rare earths distribution. Enriched ferropicritic Fe-Ti derivatives of magma generate single volcano-plutonic rock series. For intrusive ore bodies rock differentiation with the formation of syngenetic wehrlite-clinopyroxenite-gabbro-orthoclase gabbro sequence is typical. Upper mantle source of the depleted magma is characterized by the following isotope indicators: $\epsilon\text{Nd}(T)$ +0.5 to +4, $\text{ISr} = 87\text{Sr}/86\text{Sr}$ 0.703-0.704. Ore-bearing intrusive bodies are injected in the upper part of the Early Palaeoproterozoic volcano-sedimentary cross-section. Ores are located in the basement of intrusions and in the redeposited veined bodies, including offset setting. Numerous Ni-Cu deposits with total reserves and resources of several million tons of Nickel equivalent (with an average grade $\geq 0,3\%$) have been explored, and some of them now is mining.

As a result of our research, the complex of indicators and criteria is suggested for predicting the occurrence, for regional exploration target selection and for regional resource evaluation of PGE and base metals. The studies are supported by the Russian Foundation for Basic Research (project nos. 13-05-12055).