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S, Pb and Cu isotopic characteristics of PGE-Cu-Ni ores from the Noril'sk-Talnakh deposits (Russia)

K.N. Malitch (1), **O.V. Petrov** (1), V.V. Distler (2), S.F. Sluzhenikin (2), I.N. Kapitonov (1), R.S. Krymsky (1), K.I. Lokhov (1), E.B. Prilepsky (1), E.O. Petrov (1), S.A. Sergeev (1)

(1) All-Russia Geological Research Institute, St. Petersburg, Russia (Kreshimir_Malich@vsegei.ru), (2) Institute of Geology, Petrography, Mineralogy and Geochemistry of Ore Deposits, Russian Academy of Sciences, Moscow, Russia

This study presents the first extensive data on S, Pb and Cu isotopic compositions of platinum group element (PGE)-Cu-Ni sulphide ores from the Noril'sk-1, Talnakh and Kharaelakh deposits, which are located in the northwestern corner of the Siberian craton, Russia. The deposits are hosted within intra-continental palaeorift-related mafic-ultramafic intrusions that range up to 360 m in thickness and up to 25 km in length.

A suite of 110 samples from drill cores MN-2 (Noril'sk-1), OUG-2 (Talnakh) and KZ-844 (Kharaelakh) characterize three different types of PGE-Cu-Ni ores. Type 1 ore is massive in nature and is situated close to the bottom contact of intrusions. Type 2 ore is disseminated ore and occurs in both the ultramafic and the lower "taxitic" parts of intrusions. Type 3 ore is from the upper low sulphide zone, which is enriched in PGE. Pyrrhotite, chalcopyrite and pentlandite are predominant minerals in the ores.

The Talnakh and Kharaelakh deposits are the most homogeneous with respect to **lead** and **sulfur** isotopic compositions. Disseminated Cu-Ni sulphide ores at Noril'sk-1 have a significantly larger variation in sulfur isotope compositions, but its lead isotopic compositions are similar to those from the disseminated and massive Cu-Ni sulphide ores of the two other deposits.

The sulfur isotope results (+8.3 to +13.5‰, δ^{34}S) indicate a significant contribution of "isotopically-heavy" sulfur. The relatively homogeneous sulfur isotope compositions in cross-sections at Talnakh (+10.9±0.4‰, δ^{34}S) and Kharaelakh (+12.9±0.5 ‰, δ^{34}S) likely indicates that homogenization took place at deeper levels of the

tectonosphere, presumably close to the *mantle-crust* boundary. The increase in the range of δ^{34}S values negatively correlates with ore deposit reserves: a feature that can be employed as a criterion in the assessment of deposit productivity.

Lead isotope compositions of PGE low sulphide ores differ from disseminated and massive Cu-Ni sulphide ore types, thus implying that the low sulphide and copper-nickel sulphide ores are distinct in origin.

The **copper** isotope compositions in Cu-Ni sulphide ores at Kharaelakh are characterized by “isotope-light” copper (-1.35 - -1.92‰ δ^{65}Cu/^{63}Cu), while Cu-Ni sulphide ores of the Talnakh deposit demonstrate a range of Cu isotope compositions between -0.04 and -0.59‰ δ^{65}Cu/^{63}Cu. Furthermore, a slight shift for “isotope-heavy” copper compositions characterize disseminated Ñu-Ni ores from Noril’sk-1 (+0.02 - +0.61‰ δ^{65}Cu/^{63}Cu). The “heaviest” copper isotope composition is typical of the low-sulphide ores.

The simultaneous isotopic variations in copper and sulfur between the Noril’sk, Talnakh and Kharaelakh deposits have been preliminary specified. We propose that the PGE-Cu-Ni ores at Talnakh are characterized by the most primordial signatures.