

Main types of Ukrainian Shield nepheline rocks: mineralogical and geochemical features

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The Ukrainian Shield (USh) is a classical area of alkaline rocks. Nearly 30 massifs are known in the area, which are situated within the Srednyoprudniprovsky, Pre-Azov and Dnistrovo-Bugsky blocks of the USh (Kryvdik & Tkachuk, 1990).

This work is selectively devoted to mineralogical and geochemical features of typical USh massifs: Proskurovsky, Antonovsky, Chernigovka, Malotersyansky, Oktyabrsky Massifs and the nepheline rocks of the Gorodnytska Intrusion. Traditionally, such rocks are attributed to two alkaline rock formations: alkaline-ultramafic (carbonatite) rocks of ~2 Ga age (Proskurovsky, Antonovsky, Chernigovka Massifs and Gorodnytska Intrusion) and gabbro-syenite of ~1.7 Ga age (Malotersyansky, Oktyabrsky Massifs). All massifs are mainly located in the shield periphery and confined to extended deep seated fault zones (Kryvdik & Tkachuk, 1990). Host rocks of the Proskurovsky and Antonovsky Massifs are granitoids, host rocks of the Malotersyansky and Chernigovka Massifs are granite, gneiss and amphibolite, while the hosts of the Gorodnytska Intrusion are granite and gneiss. Rocks are considered as a potential source of P, Zr, Nb and REE (Malotersyansky, Oktyabrsky and Chernigovka Massifs) and nepheline-feldspar raw material (Donskoy *et al.*, 2004).

All the nepheline rocks of these massifs are generally represented by nepheline syenites (canadites, foyaites, mariupolites, pulaskites). However, Proskurovsky, Antonovsky and Chernigovka Massifs are also characterized by the presence of ijolite-melteigites and ijolite-jacupirangites. The Gorodnytska Intrusion consists of olivine-nepheline-pyroxene rocks (melanocratic ijolite-jacupirangites are dominated).

All massifs have similar nepheline rock content, but both rock-forming and accessory minerals concentrations vary in a wide range in the different massifs. Main rock-forming minerals are feldspar and albite (40-80%), nepheline (5-50%), amphibole (hastingsite), clinopyroxene (aegirine-salite), biotite (5-20%, up to 40-60% in biotite types), calcite (2-7%), while accessory minerals are apatite (< 0.1-15%), zircon (< 0.1-1%), ilmenite (1-6%) and titanite (0.5-5%). The typical accessories of the rocks of Chernigovka Massif are also pyrochlore (up to 1%) and orthite (0.5%). And there are brytholite, bastnasite, rinkite in the nepheline syenites of the Oktyabrskiy Massif (Kryvdik *et al.*, 1990, Nykanorova 2013, Osypenko 2013).

Ijolite-melteigites and ijolite-jacupirangites consist of nepheline (15-65%), feldspars (5-40%), aegirine containing clinopyroxene (10-45%, up to 70% in melteigites), olivine (in Chernigovka – hortonolite 5-20%), amphibole (hornblende and hastingsite 2-10%),

micas (biotite and phlogopite 1-10%). The accessory minerals are apatite (1-3%, up to 5% in Chernigovka), calcite (1-5%), ilmenite and magnetite (3-5%). Besides them, titanite, monazite, phlogopite, graphite and sulphides also occur in Chernigovka (Kryvdik *et al.*, 1990, Nykanorova 2013, Osypenko 2013) and garnet (andradite, melanite), Cr-spinel, albite, rutile occur in the rocks of the Gorodnytska Intrusion (Tsymbal *et al.*, 1997).

However, despite the similarity of mineral composition, geochemical features allow to distinguish separate groups of the rocks of the Proskurovsky and Antonovsky Massifs and the Gorodnytska Intrusion formations. The first one is characterized by low content of such incompatible elements as Nb (3.5-35 ppm), Zr (19-95 ppm) and LREE (10-80 ppm), relatively low TiO₂ concentrations and absence of carbonatites (Dybuna *et al.*, 2011, Tsymbal *et al.*, 2007, Osypenko, 2013).

Available Sr, Nd, C, and O isotopic data (Kryvdik 2000, Tsymbal *et al.*, 2007), in spite of the different contamination level by crustal material, indicates mantle origin for this group of rocks. That is why the observed anomalous geochemical specialization of the studied rocks can be explained by different geochemical specialization of their material source, i.e. mantle reservoirs.

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