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Critical controls on the formation of contact-style PGE-Ni-Cu mineralisation: Evidence from the Monchegorsk Complex, NW Russia

Bartosz T. Karykowski*, Wolfgang D. Maier, Nikolay Y. Groshev, Pavel V. Pripachkin, Sarah-Jane Barnes, Dany Savard

*Cardiff University, School of Earth and Ocean Sciences, Cardiff, United Kingdom, Email: bkarykowski@yahoo.com

Layered intrusions around the world are a major target for metal exploration as they host the bulk of global platinum-group element (PGE)-Cr-V resources. Almost all economic PGE deposits are hosted in laterally extensive, but narrow reefs in the inner portions of intrusions, e. g., Bushveld Complex (RSA). The only economic *non*-reef-hosted PGE deposit is the "Platreef" in the Bushveld Complex. As opposed to reef-style mineralisation, these deposits feature a relatively thick succession of mineralised mafic rocks along the basal contact of the intrusion, which is why they are referred to as "contact-style". In fact, most large layered intrusions globally host contact-style mineralisation of variable thickness and metal concentration, the richest being the Portimo Complex (FIN), the East Bull Lake Complex (CAN) and the Fedorova-Pana Complex (RUS).

Another major example of extensive contact-style PGE-Ni-Cu mineralisation is hosted by one of Europe's largest layered intrusion, namely the Monchegorsk Complex (MC), located ca. 120 km south of Murmansk on the Kola Peninsula of Russia. It belongs to a group of Paleoproterozoic layered intrusions occurring across the Fennoscandian Shield and comprises at least two intrusions covering an area of ~ 550 km^2: the predominantly ultramafic Monchepluton and the mafic Main Ridge Massif.

The Monchepluton is horseshoe-shaped and consists of six sub-massifs arranged in two branches: (1) an ultramafic branch (ca. 7 km across) referred to as the "NKT Massif"; and (2) a mafic-ultramafic branch that is slightly longer with 9 km and consists of Mts. Sopcha, Nyud and Poaz. Exploration in the area is currently focused on PGE-Cu-Ni mineralisation associated with the contact between the Monchepluton and the floor rocks.

The mineralisation occurs in the form of small interstitial sulfide blebs accounting for 5 to 7 vol % hosted by different rock types ranging from dunite and harzburgite to orthopyroxenite and melanorite. Historic drilling indicates that this style of mineralisation can be traced for the entire length of the NKT Massif as well as parts of Sopcha and Nyud. Typically, mineralised samples show a strong enrichment of Pd over Pt reaching 3 to 4 ppm Pt + Pd at Pt/Pd ratio < 0.3. Notably, the entire ultramafic portion of the Monchepluton, irrespective of the lithology, is characterised by > 20 ppb Pt + Pd and contains cumulus sulfide implying crystallisation from a sulfur-saturated magma. The only difference between *mineralised* and *unmineralised* sections is the modal abundance of sulfide as PGE tenors are highly consistent across the Monchepluton (50 to 100 ppm Pd in 100 % sulfide). Therefore, the grade is primarily controlled by the physical accumulation of sulfide liquid at the base of the intrusion rather than by higher R factors.

Detailed petrography and core-logging coupled with lithophile and chalcophile element data suggest that the interaction of magma with the metasedimentary floor rocks induced dehydration melting of the latter introducing H_2O to the magma. This resulted in melting of cumulus minerals, which locally enhanced porosity, leading to the accumulation of dense sulfide liquid in these high porosity zones at the bottom of the intrusion.