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Origin of platinum-group mineral (PGM) nuggets from the Bor-Uryakh massif (Maimecha-Kotui Province, Russia): evidence from mineral composition

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The Bor-Uryakh massif of ultramafic and alkaline rocks, like other similar complexes (e.g. Guli, Kugda and Odikhincha), is situated in the limits of the Maimecha-Kotui Province, northern part of the Siberian Platform (Kogarko et al., 1995; Vasil'ev, Zolotukhin, 1995; Malitch, 1999, among others). This study focuses on morphology and mineral chemistry of platinum-group mineral (PGM) nuggets closely linked to the Bor-Uryakh massif, a promising target for noble metals.

The Bor-Uryakh massif, discovered by Yu.M. Sheinmann in 1944, occupies an area of 18.5 km2 and intrudes Late Proterozoic (Middle Riphean) and Cambrian terrigenous-carbonaceous rocks, forming a dome-like structure. Core-zone olivinite (metadunite?) comprising olivine and titanomagnetite grades into dunite with nodular chromitite in the outer part of the massif. The core-zone olivinite has been intruded by vein-like course grained ore-rich olivinite (up to 20-50% of titanomagnetite and perovskite), alkaline syenite and rarely by melteigeite and calcite carbonatite. Based on K-Ar dating the age of phlogopite from veins ranges from 215 to 225 Ma (Egorov, 1991).

The central part of the Bor-Uryakh massif represents an erosion crater, which is rimmed by a circular mountain ridge composed of Cambrian and Riphean rocks. The main physiographic structure in the area is the Buor-Uryakh river valley, which originates at the confluence of two streams in the central part of the massif and flows north-eastwards through the circular mountain ridge. According to exploration forecasts given by Polar Geological Prospecting Venture, the Quaternary sediments in the Bor-Uryakh area are promising for PGE-mineralization, with PGE grade up to 0.27 g per cubic meter. This study is based on 19 Os-Ir and Pt-Fe nuggets (size range between 0.1 and 0.25 mm), which were sampled from Quaternary and recent sediments (exploration lines L-130, L-120, L-98) in the northeastern part of the massif.

Initially, morphology of PGM grains, represented by individual crystals and polymineral aggregates, was documented by scanning electron microscopy (SEM). The grains were, then, mounted and polished, described and analyzed by electron microprobe analysis (Camscan-4 with energy-dispersive spectrometer Link-10 000 and wavelength spectrometer Microspec, JSC Mekhanobr-Analyt, St.-Petersburg, Russia and ARL-SEMQ microprobe with four wavelength-dispersive spectrometers and equipped with a LINK energy dispersive analyser, Institute of Geological Sciences, University of Leoben, Austria).

The majority of PGM nuggets at Bor-Uryakh, both single subhedral and euhedral crystals, and aggregates of euhedral crystals, are Os-rich alloys, which prevail over Pt-Fe alloys. According to the classification by Cabri & Feather (1975) and Harris & Cabri (1991), PGM nuggets at Bor-Uryakh are osmium (with considerable inter-nugget variation of Ir and Ru) and possibly ferroan platinum. To avoid confusion with osmium as element, we refer to the Os-rich alloy grains as osmium (Os content > 80 %) and iridian osmium (Os, Ir).

Majority of the Os-rich nuggets at Bor-Uryakh are iridian osmium, with minor amounts of chengdeite Ir3Fe. Os-rich minerals also occur as inclusions and lamellae in Pt-Fe alloy grains, which have a composition close to Pt2Fe. Mineral with composition Pt2Fe is not known in the synthetic system Pt – Fe (Massalski, 1993), although there are many naturally occurring Pt-Fe alloys with a composition close to Pt2Fe (Cabri et al., 1996; Weiser & Bachmann, 1999; Sluzhenikin, 2000; Malitch & Thalhammer, 2002; unpublished data).

Equilibrium phase relationships of solitary Os-rich alloy grains at Bor-Uryakh, based on the binary system Os-Ir (Massalski, 1993), and the presence of inclusions and lamellae of Os-rich alloys in Pt-Fe alloy matrix are

indicative of high-temperature origin of PGM alloy grains. Therefore, the derivation of the studied PGM nuggets from rocks of the Bor-Uryakh massif is obvious. We further propose that grains of Os-Ir and Pt-Fe alloys might have been derived from distinct sources (e.g., chromitite and dunite, respectively). Our study suggests that PGM nuggets at Bor-Uryakh share similar compositional features with those from the Guli massif and several other zoned-type ultramafic complexes of the Aldan Province (Kondyor, Inagli, Chad) and Urals (Nizhny Tagil, Kytlym, etc.) also known as Aldan- and Uralian-type massifs, respectively.

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