

New evidence of polycyclic PGE ore formation in the Kondyor alkaline-ultramafic massif (Khabarovsk district, Russia) revealed by Pt-He dating of PGM grains

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The genesis of platinum mineralization in zoned Ural-Alaska-Aldan type massifs is a subject of ongoing debate. We have developed the Pt-He method for direct dating the native minerals of platinum [1] in order to understand the timescales of processes that lead to the formation of placer forming platinum mineralization. Here we report new ages of isoferroplatinum (Pt₃Fe) from dunites of the Kondyor alkaline-ultramafic massif and unique placer deposits on the Kondyor-Uorganan rivers. Cumulate dunites, the earliest rocks of the massif, underwent syn-magmatic recrystallization and metasomatic transformation under the influence of ultramafic, mafic, alkaline and granitoid intrusions. Five genetically-distinct types of PGMs are distinguished on the basis of mineralogy and PGE geochemistry [2]. The Pt-He ages of 75 grains reveal three age peaks and allow the duration of the formation of the alkaline ultramafic massif Kondyor to be established.

Pt-He ages (n=9) of 143 ± 7 Ma reflects the time of formation of the massif itself and formation of magmatogenic platinum (Pt), magmatogenic-fluid-metasomatic Pt and osmium-platinum (Pt>Os) type grains, as well as PGM fluid-metamorphogenic iridium-platinum (Pt>Ir) type. A Pt-He age peak of 128 ± 6 Ma (n=32) records the time when the early stages of the magmatogenic-fluid-metasomatic palladium-platinum (Pt>Pd) and the late stages of the Pt, Pt>Os and Pt>Ir-type mineralisation. A Pt-He age peak of 115 ± 6 Ma (n=34) is dominantly recorded by late stage Pt>Pd-type grains. The data imply polycyclic formation of PGE mineralisation in Kondyor over 30 Ma.

Thus for the first time based on Pt-He dating results we confirm the model of polycyclic genesis of placer-forming formations of platinum group minerals [3], which suggests redistribution of PGE under the influence of ultramafic, mafic, alkaline and granitoid intrusions.

[1] Shukolyukov et al. (2012), *Petrology*, 20(6), 491-505.

[2] Mochalov (2019), *Mineralogical Almanac*, 23(3), 128 p.

[3] Mochalov (2013), *Geology of Ore Deposits*, 55(3), 145-161.