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OSMIUM ISOTOPE MEASUREMENTS OF PT-FE ALLOY PLACER NUGGETS FROM THE KONDER INTRUSION USING A SHRIMP II ION MICROPROBE

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The Konder massif, a 7 km-diameter concentrically zoned ultramafic-alkalic intrusion (Lazarenkov & Malich) 1989, Nekrasov *et al.* 1994), is located in the Ayan-Maya region, northern Khabarovsk Territory, about 200 km west of the Sea of Okhotsk, Far Eastern Russia. It is one of the several concentric ultramafic massifs that intruded the Archean and Proterozoic sedimentary rocks of the Aldan Shield (Fig. 1), classified as a sub-type of forsteritic dunite that intruded into stable platforms as shallow depths (Razin 1976). These concentric massifs, while simplistically comprised of a dominant, dunitic core and a concentric outer rim of alkalic rocks (nepheline and melanite syenites, ijolite, arfvedsonite granite, etc.) actually reveal quite complex lithologic relations (e.g. Nekrasov 1994; Sushkin 1995) and their petrogenesis is the subject of active debate. Fine-grained biotite in cross-cutting veins in dunite and coarse-grained biotite in a magnetite peridotite dike from the Konder intrusion yielded identical $^{40}Ar/^{39}Ar$ ages of 120 ± 1 Ma (Czamanske, unpublished), comparable to the age of 127.6 ± 0.6 Ma reported for biotite in dunite of the Inagli massif (Dalrymple *et al.* 1995). These age data and the similarity of lithologic relations among these several ultramafic-alkalic intrusions call into serious question of belief of some Russian geologists that the dunitic cores for these related intrusions are Precambrian (e.g. Yeremeyev 1979, Nekrasov *et al.* 1994).

Placers containing grains and nuggets of platinum-group minerals (PGM) and gold occur along the Konder River and its tributaries. The placers are being exploited for their precious metal

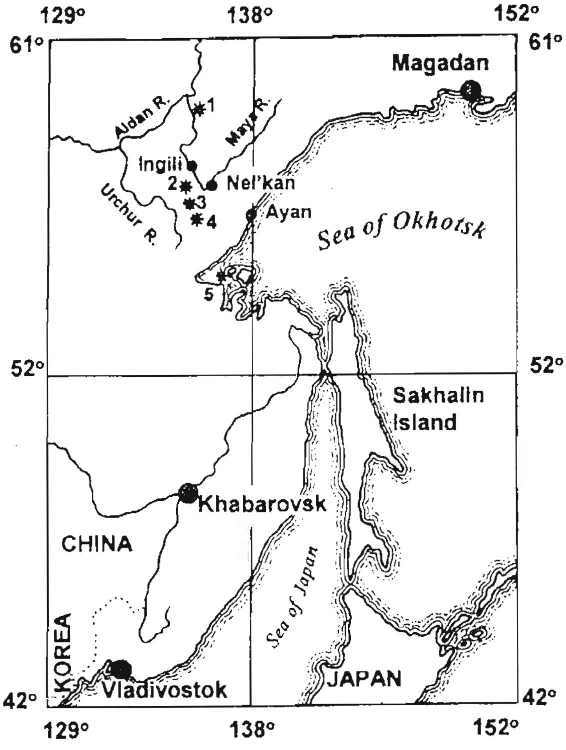

Fig. 1 Location map of some ultramafic intrusions in Aldan Shield: (1) Inagli, (2) Konder, (3) Sybah, (4) Chad, (5) Feklistov's Island.

content, about 3 tonnes of concentrate per year derived from some 20 km of stream beds, making this the second largest Pt source in Russia. The bulk of the Pt occurs as shapeless, angular grains, grain aggregates, lumpy grains and nuggets weighing up to 3.5 kg. The larger nuggets contain chromite phenocrysts ranging from 2 to 7 mm in size (Sushkin 1995). The principal PGM, forming the matrix of the grains and nuggets, is Pt-Fe alloy of Pt_3Fe composition, containing inclusions of a large and diverse suite of PGM (Fig.2). Unusually large (up to 1.5 cm^3), well-formed cubic and octahedral crystals of Pt-Fe alloys occur in certain parts of the placers. These spectacular crystals have unusual trace-element compositions compared to less well-formed grains and nuggets (Cabri *et al.* 1996; Cabri and Laflamme 1997).

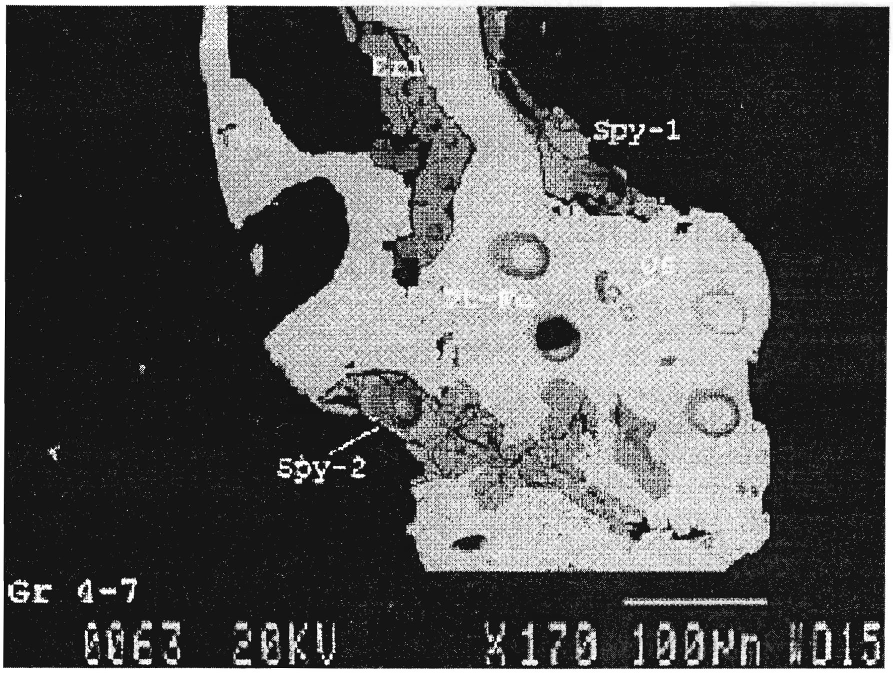

Fig. 2 SEM-BSE image of grain 4-7 showing inclusions of osmium (Os), sperrylite (spy), and erlichmanite (erl) in a Pt-Fe matrix, as well as the 7 and 30 μm craters created during the isotopic analyses.

PGM in selected nuggets (0.5 to 1.0 mm in size) of Pt-Fe alloys, as well as a crystal (7.5. mm in length) were analyzed with the Sensitive High-Resolution Ion Microprobe (SHRIMP II) at the GSC, Ottawa (Stern, 1996). The Au-coated target minerals were sputtered with a mass-filtered O^- primary beam, with spot diameters adjusted between ~7, 30, and 100 μm in diameter. Positive secondary ions were extracted at 10 kV and mass-analyzed at a resolution of 5500(1%). A single electron multiplier operating in pulse counting mode (deadtime = 24 ns) was used to sequentially analyze $^{185}Re^+$, $^{186}Os^+$, $^{187}Os^+$, $^{188}Os^+$, $^{189}Os^+$ and, $^{192}Os^+$, in analyses ~5 min. Mass fractionation was corrected using $^{189}Os/^{188}Os$=1.21978 and based on results from a synthetic Os metal standard and values for the natural Os lathes, mass fractionation was 0.44 ± 0.11%/amu in favor of the light isotope. No significant isobaric interferences were noted for ^{186}Os, ^{187}Os, ^{188}Os and ^{189}Os, but ^{192}Os is unresolved from ^{192}Pt in Pt-Fe alloy and sperrylite. Interference from ^{186}W does not appear to be a problem in these minerals.

$^{187}Os/^{188}Os$ ratios were measured for osmium, erlichmanite and sperrylite included in Pt-Fe alloy nuggets, as well as the Pt-Fe matrix itself (Table 1). This is the first report of *in-situ* $^{187}Os/^{188}Os$ analyses in minerals such as sperrylite and Pt-Fe alloy. The results of all minerals in the Konder nuggets between 0.120 and 0.144, all well within the range of mantle values, suggesting no significant contribution of crustal Os. This result agrees with $^{187}Os/^{186}Os$ data for placer nuggets derived from five different Alaskan-type intrusions and the Nizhni Tagil (Urals) dunite massif (Hattori & Cabri 1992). The data for Pt-Fe alloy and sperrylite require further evaluation of the Re contribution because of the low Os concentrations, estimated to be in the range of 13 to 35 ppm by weight. There appears to be little isotopic difference between inclusions and matrix for individual nuggets, whereas there is an apparent perceptible difference between nuggets (e.g. 3-5 and 2-14). Although Re is insignificant in most of the minerals, additional study is required to assess the results for 4-7 sperrylite (gr. 1) and Pt-Fe alloy, which yielded unrealistically low $^{187}Os/^{188}Os$ when corrected for the presence of Re; data for these are shown uncorrected at present. Improved precision in $^{187}Os/^{188}Os$ for all targets, especially those with low Os., was achieved by averaging several analyses from the same spot as well as different spots on the same mineral. However, it should be noted that the large crystal of ferroan platinum has no detectable Re or Os concentration (<<1ppmw Os), whereas synthetic "spec-pure" Os contains a measurable quantity or Re.

Table 1. Os isotopic analyses

Sample	n	mean value $^{187}Os/^{188}Os$	error (2σ)	Os (ppm by wt.)
3-5 osmium lath	10	0.1280	0.0003	
3-5 Pt-Fe alloy matrix	4	0.125	0.041	25-26
4-7 erlichmanite	9	0.1330	0.0009	
4-7 sperrylite 1	2	0.120*	0.007	
4-7 sperrylite 2	4	0.131	0.018	
4-7 osmium lath	4	0.1310	0.0005	
4-7 Pt-Fe alloy matrix	8	0.122*	0.013	13
2-14B Pt-Fe alloy grain	3	0.144	0.040	35
2-14A erlichmanite	3	0.1428	0.0046	

*uncorrected for Re

The Os-isotopic data are consistent with the nuggets having originally crystallized within the Konder intrusion and, subsequently, having been weathered, eroded, and concentrated in placers by mechanical processes. On the other hand, the extraordinarily low concentrations of Re and Os in the large, ferroan platinum crystal are consistent with mobilization of Pt and dispersal of Os, possibly during serpentinization and alkali metasomatism, as postulated by Nekrasov *et al.* (1994). This process may be considered to be a form of natural zone-refining, whereby the ferroan platinum crystallizes with lower contents of Os and Re than the "spec-pure" man-made product.

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ABSTRACTS

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