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Anomalously high retention of radiogenic helium in native platinum

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Relatively quick migration of helium from crystal structures has been known for a long time. However there is a group of minerals – native metals - where stability of radiogenic helium is essentially high [1]. Helium, due to its very low solubility in metals, assembles in atomic clusters - "bubbles" of nanometer size. Migration of helium "bubbles" as a whole from the crystal structures needs relatively high temperature near the melting point of metals.

On that ground of special interest are platinoids with melting points (and, consequently, temperatures of "explosion-like" release of radiogenic helium) of more than 1550 ^{o}C In this respect we believe that the method based on natural radioactivity of platinum is promising.

To verify the idea of anomalously high retention of radiogenic helium in native platinum and to check the efficiency of the proposed ^{190}Pt-^{4}He method of isotope geochronology, we studied independent mineral aggregates of native platinum from chromite-bearing dunites of Galmoenan plutonic complex (10 individual samples) (Koryak-Kamchatka belt, Russia) and Konder massif (5 individual samples) (Khabarovsk district,Russia). Because native platinum always has admixture of Fe, Cu etc. for reliable determination of concentration of platinum in the samples in our study we used electron microscope JSM-6510LA with JED 2200 add-on. Amount of ^{4}He in native platinum was determinate on mass-spectrometer complex MSU-G-01-M.

Native platinum consists of 6 isotopes. Among them two isotopes are α-radioactive and decay according to following schemes:

$$^{190}\text{Pt} \rightarrow ^{4}\text{He} + ^{186}\text{Os} \rightarrow ^{4}\text{He} + ^{182}\text{W}$$

$$^{192}\text{Pt} \rightarrow ^{4}\text{He} + ^{188}\text{Os}$$

Presumably, in native platinum there is always a certain amount of uranium and thorium, absorbed in the process of crystallization. However influence of helium generation from uranium becomes more marked at growing of ^{238}U/Pt ratio and beginning with ^{238}U/Pt $\approx 10^{-5}$ should be taken into consideration. For the same reason helium produced by the decay of ^{192}Pt and ^{186}Os can be neglected [2].

Obtained data was used to build a $^{4}\text{He}_{rad}-^{190}$Pt isochrone. The age calculated by the tangent of the isochrone slope angle for Galmoenan massif and for neighbor placer is: 72.3 $\pm$ 3.4 mln years. The obtained age value is comparable with the results of isotope datings, which were made previously by different methods of isotope geochronology. Rb-Sr, U-Pb, K-Ar, ^{39}Ar-^{40}Ar, Sm-Nd isotope systems shown formation of the complex from 80 to 50 mln.years ago.

For the samples from Konder massif was also obtained a good isochrone. The age calculated by the tangent of the isochrone slope angle for Konder "alluvial" placer is 112$\pm$7 mln years. That data is also in a good correspondence with other geological data.

Thus the data provide the ability of direct ^{190}Pt-^{4}He dating of native platinum. And additionally reaffirm the evidence of anomalously high retention of radiogenic helium in native metals up to the temperatures near their melting points.

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References:

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