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Quantifying the fluvial transport rate of detrital Pt3Fe grains from Kondyor River using cosmogenic 3He: how long does it take to form a placer deposit?

Olga Yakubovich (1,2), Finlay Stuart (3), and Alexander Mochalov (1)

(1) Institute of Precambrian Geology and Geochronology RAS; Saint-Petersburg, Russian Federation (olya.v.yakubovich@gmail.com), (2) Saint Petersburg State University, Institute of Earth Sciences; Saint-Petersburg, Russian Federation, (3) Scottish Universities Research Environmental Center, East Kilbride, UK (fin.stuart@glasgow.ac.uk)

Detrital metal and alloy grains are highly resistant during transportation in fluvial systems. Where placer deposits can be linked to unique mineral deposits the accumulation of cosmogenic 3He in detrital grains has the potential to be used to determine the timescales of transport and storage that have hitherto been unquantified.
The Mesozoic alkaline-ultramafic Kondyor Massif (Russian Far East) is the source of several major (>100 tons) Pt placer deposits in the valleys of the Kondyor and Uorgalan Rivers. The massif is a ring structure (diameter 8.5 km) that rises 500 m high above Neoproterozoic sediments and Archean basement of the Omninsko-Maya highlands. It is drained by low order channels that feed into the 30 km long Kondyor River. Platinum-bearing sands lie on the bedrock of the valleys, primarily as terraces and bars. The average thickness of the platinum-bearing sand deposits is 2.4 m, while the overlying peats may be up to 5.5 m thick.
We have analysed 17 grains (∼1 mg) of isoferroplatinum (Pt3Fe) from within the massif and from placer deposits the length of the Kondyor River. No cosmogenic 3He is present in grains from the low order streams in the Kondyor Massif indicating that the erosion of the grains from the bedrock is rapid in comparison to transport and storage in the fluvial system. Cosmogenic 3He concentrations in Pt3Fe grains from placers in the Kondyor River increase with distance from the massif. There is also a local maximum in cosmogenic 3He concentration where the river flows through steeply dipping Archean schists, which works as a mechanical trap for heavy detrital metals. Converting cosmogenic 3He concentrations to surface residence times by correcting for the depth in the river system (∼1 m) we see that grains in the Kondyor River have been at surface for at least 6 million years. From the age-distance relationship we estimate that the Pt3Fe grains move through the fluvial system at a mean rate of between 0.5 and 7 cm/yr. This is orders of magnitude slower than typical bed load transport rates and can only be explained by the long-term storage of the detrital metal grains in the fluvial system. This implies that the formation of the large alluvial placer Pt deposits along the Kondyor River requires multiple cycles of transport and deposition that have operated for millions of years. More generally, this technique allows us, for the first time, to put quantitative constraints on the duration of processes essential for the accumulation of major economic metal and mineral deposits and may be used to understand how fluvial systems have responded to changes in climate and tectonics.

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