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Cosmogenic 3He in detrital gold

Finlay Stuart (1), Olga Yakubovich (2), Ana Caracedo (1), and Alexander Nesterenok (3)

(1) Isotope Geosciences Unit, SUERC, East Kilbride, United Kingdom (fin.stuart@glasgow.ac.uk), (2) Institute of Precambrian Geology and Geochronology, Russian Academy of Sciences, Makarova emb. 2, 199034 Saint-Petersburg, Russia, (3) Ioffe Physical–Technical Institute RAS, Politekhnicheskaya ul. 26, 194021 Saint-Petersburg, Russia

Since the measurement of cosmogenic He in an alluvial diamond by McConville and Reynolds (1996) the application of cosmogenic noble gases to individual detrital grains to quantify surface processes has not been vigorously pursued. The likely low rate of diffusion of cosmogenic He in native metals, and their resistance to weathering and disintegration during erosion and transport, makes them a potential record of long-term Earth surface processes. In an effort to assess the extent that detrital refractory metals record the exposure history during transport and storage we have undertaken a reconnaissance study of the He isotope composition in 18 grains (2-200 mg) of native gold, copper, silver, and PtPd, Pt3Fe and OsIr alloys from alluvial placer deposits from around the world. 4He is dominantly the result of U and Th decay within the grains, or decay of 190Pt in the Pt-rich alloys. 3He is measurable in 13 grains, concentrations range up to 2.7E+6 atoms/g. 3He/4He are always in excess of the crustal radiogenic ratio, up to 306 Ra. Although nucleogenic 3He produced by (n,α) reactions on 6Li, and 3He from trapped hydrothermal fluids, are present, the majority of the 3He is cosmogenic in origin. Using newly calculated cosmogenic 3He production rates in heavy metals, and a determination of the effect of implantation based on the stopping distances of spallogenic 3He and 3H, the grains have 3Hecos concentrations that are equivalent to 0.35 to 1.5 Ma exposure at Earth's surface. In a study of detrital gold grains from several sites in Scotland we have found that $\sim$10 % have 3He concentrations that are significantly in excess of that generated since the Last Glacial Maximum. These studies demonstrate that, with refinement, cosmogenic 3He in refractory detrital minerals can be used to quantify sediment transport and storage on the 1-10 Ma timescale.

P. McConville & J.H. Reynolds (1989). Geochim. Cosmochim. Acta, 53, 2365–75.