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Silver isotope analysis and systematics of native gold from the Rajapalot gold deposit, northern Finland

JOHANNA TEPSELL[1], YANN LAHAYE[2], FERENC MOLNÁR[3], TAPANI RÄMÖ[1] AND NICK COOK[4]

[1]University of Helsinki
[2]Geological Survey of Finland
[3]Eötvös Loráns University
[4]Mawson Gold Ltd.

Presenting Author: johanna.tepsell@helsinki.fi

The Rajapalot gold deposit in Finnish Lapland has been considered as an orogenic gold deposit with an atypical metal association. The origin, depositional environment and ore forming processes in the Rajapalot gold deposit are, however, debated as the deposit displays characteristics that do not fit the conventional classification scheme [1]. Silver isotopes are suggested to be a prime isotopic proxy to track the chemical reactions or source regions of monoisotopic gold [2] and carry a substantial potential to yield new information on the origin and enrichment processes of gold.

A tailored analytical protocol was developed to analyse silver isotopes from native gold from the Rajapalot gold deposit in northern Finland. Gold was hand-picked from samples crushed with selFrag [3]. A two-stage ion-exchange procedure was adapted (following [4]) and samples were analysed with MC-ICP-MS utilising Pd-doping and standard bracketing. The long-term average of Pd bias corrected $^{109}Ag/^{107}Ag$ for SRM 978a was 1.07982 ± 0.0005 (n = 165). On average, the reproducibility of the measurements within a single run for $\varepsilon^{109}Ag$ was 0.2 ε (2SD).

Silver concentration in the analysed samples varies from 0.4 wt-% to 11.2 wt-%. Measured $\varepsilon^{109}Ag$ values show a fairly limited range from -6.8 to 2.1 with a total variation of 8.9 ε-units relative to the NIST SRM 978a international silver standard, with a mean of $\varepsilon^{109}Ag$ = -3.8 ± 1.7 (2SD). Most of the analysed samples have negative $\varepsilon^{109}Ag$ values from -6.7 to -2.0 with only one sample with a positive $\varepsilon^{109}Ag$ value of 2.1 ± 0.5. Varying silver concentrations together with bimodal $\varepsilon^{109}Ag$ distribution reflect varying physicochemical conditions during transportation and/or deposition processes and may be related to multistage ore paragenesis. Because of the established limited range of the analysed $\varepsilon^{109}Ag$ values, however, silver isotopes are applicable as tracers of gold mineralization processes rather than a primary tool for source region footprinting.

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[3] Wang et al. (2012), *Minerals Engineering* 27-28, 28–36.

[4] Brügmann et al. (2019), *Chemical Geology* 516, 59–67.