Measure Twice – Rochford-Homestake Gold, South Dakota, USA

Holly J. Stein[1, 2], Zeynep Baran[3], Gang Yang[1]
1. AIRIE Program, Applied Isotope Research for Industry and Environment, Fort Collins, CO, USA, 2. Department of Geosciences, University of Oslo, Oslo, Norway, 3. South Dakota School of Mines and Technology, Rapid City, SD, USA

Re-Os dating of sulfides is now a widely employed analytical tool for providing radiometric ages for ore deposits, yet bold data interpretation and provocative new models lag behind the technology. An Re-Os study of the Rochford Au district, 20 miles south of the renowned Homestake Au mine, affirms widespread Proterozoic Au mineralization in the region. Structural features highlighting ductile-brittle deformation relative to sulfide-forming events are present in the analyzed drill cores. Re-Os dating of unique targeted sulfide occurrences relative to metamorphic fabric in the host rock present a new model for Au formation.

Using a double Os spike, we show *two* distinct generations of arsenopyrite at Rochford (isochrons and model ages). A previously unknown but significant older generation yields a Model 1 age of 1757.8 ± 1.7 Ma (MSWD = 1.7, n = 12, $^{187}Os/^{188}Os \sim 0$). A younger arsenopyrite generation, which includes three pyrrhotite analyses, yields an isochron age of 1735.5 ± 6.2 Ma (MSWD = 2.6, n = 6, $^{187}Os/^{188}Os$ = 0.0006 ± 0.0013, again essentially zero). However, another pyrrhotite analyzed plots precisely on the older arsenopyrite isochron, relating pyrrhotite to both gold generations. These two well-constrained events, both with Os initial ratios of zero, are interpreted as follows: (1) models for Au generation from older continental crust or reconstitution of pre-existing sulfide are conceptually difficult as they are unlikely to yield Os initial ratios of zero, or (2) the presence of Au-rich hydrothermal systems may force exclusion of Os in arsenopyrite in favor of Au. The latter offers a new pathfinder for Au-mineralized systems. That is, if there is common Os in the arsenopyrite structure, significant Au may be absent in the system. Further, this study shows that (some) pyrrhotites can be dated using Re-Os, in contrast to previous suggestions that pyrrhotite Re-Os systematics are easily disturbed.