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The First and Second Opening of Pandora's Box – How Re-Os Changed Resource Geology

Holly J. Stein[1, 2]
1. AIRIE Program, Colorado State University, Fort Collins, CO, USA, 2. Institute of Geosciences, University of Oslo, Oslo, Norway

Throughout the geosciences, the only unifying parameter for correlating and organizing earth processes is absolute time. As a budding young economic geologist working with the mineral industry in the 1980s, I set my sights on dating sulfides, reading with wonderment how two German-Swiss physicists in the 1960's recognized that $^{187}Re \rightarrow ^{187}Os$ formed a radiometric clock for molybdenite. That recognition lay dormant for 30 years as the ability to precisely measure isotopic concentrations for Re and Os was beyond reach, and the ^{187}Re decay constant remained poorly determined until 1996. In the world of ore geology, argon-based dating of non-sulfide (gangue) minerals was fraught with prolonged thermal histories in ore-forming environments, and the human error in picking plateaus to achieve an unjustifiably precise age from a mineral's sometimes complex outgassing spectrum. We needed a way to put the stethoscope directly on the sulfides.

The reducing environment offered by sulfides and organic material provides a haven for chalcophile-siderophile-organophile Re and Os. The Re-Os clock provides dates from Early Archean to Pleistocene. It is not temperature sensitive. It retains primary ages even with granulite-facies overprints. On oxidation, however, whether in the geologic past or in present-day weathering, Re and Os (and other metals) become readily unmoored and the Re-Os radiometric clock is compromised.

Not surprisingly, the critical first step is to turn geologic observation into a thoughtful sampling strategy. Relative time is useful for describing crosscutting relationships, but Re-Os gives us the immediate ability to separate crosscutting events in real time. Re-Os teaches us that crosscutting relationships cannot simply be extrapolated beyond the outcrop scale, or between drill holes. Re-Os shows that all veins of a certain type in a deposit are not necessarily the same age. In some ore systems, Re-Os revealed more than one episode of mineralization with a large intervening time gap. Re-Os gave us our first sense of duration, or time required to build a giant ore system. In a well-known Archean terrane, Re-Os showed that not all gold mineralization fell within a narrow orogenic window. Re-Os upset dogma in the first opening of Pandora's box, and was unpopular and even rejected by some where long-standing ore deposit models were confronted with a new kind of data. Indeed, there were early challenges and hurdles in establishing the credibility of Re-Os within the ore geology community.

Re-Os isotope geochemistry spread quickly beyond the ore geology community as the oil industry realized its potential and was willing to invest financially, long-term, in developmental work. The timing of maturation and migration, and the sorting out of multiple hydrocarbon charges from different source rocks presented new challenges, but surmountable with strategic sampling anchored in geologic relationships. Even at the center of hydrocarbon work, we turn to sulfides again and again, as metals (and sulfur) are integral to petroleum systems. Geologists who can work across the metals-hydrocarbon divide, and who can visualize and model metal sources before the creation of an ore deposit, will be invaluable to mineral exploration in the future.


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