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Title: Why Rhenium-Osmium (Re-Os) Geochronology is Critical to the Resource Industry

Presenter: Holly Stein (AIRIE Program, Fort Collins, Colorado, USA and University of Oslo, Norway)

Summary Abstract: Telling a non-scientist that you date ore deposits usually renders a polite blank stare and occasionally the response “why would anyone care how old it is”? That’s the million-dollar question: Why should we care about the age of our mineral resources? First, it is expensive to poke deep holes in the ground. Second, ages for economic mineralization show time-space relationships within a geologic setting, thus providing a critical constraint for exploration models. Third, Re-Os dating of molybdenite associated with non-economic mineral prospects or present as an accessory sulfide in magmatic-metamorphic rocks gives ages for tectonic reconstruction of terranes with the same efficiency and robustness delivered by U-Pb dating of zircon. Fourth, many sediment-hosted ore deposits form from fluids which also sponsor hydrocarbons, visible in fluid inclusions and even as mm-scale oil inclusions at the hand specimen scale. Conveniently, dating the hydrocarbons gives ages for Pb-Zn-Cu mineralization – and *vice versa* – dating bitumen and oil gives ages for intergrown sulfides, for example, in a hydrocarbon reservoir rock. Re-Os dating adds to (critical) mineral exploration models, providing time pins for resources as diverse as sulfide-bearing REE-rich carbonatites, Cu-Mo-Re porphyry-skarn and Au deposits, and most recently graphite. In the absence of post-sulfide oxidation and armed with geologic understanding and a smart sampling strategy, almost any sulfide holds a piece of the story for the larger geologic history.

Biography: Prof. Dr. Holly Stein is among a handful of scientists with an in-depth understanding of both mineral resources and petroleum geology, and she has used her insights to bring new exploration ideas to industry. In 1996 Dr. Stein founded the soft-money AIRIE Program at Colorado State University (CSU), and in 2000 she established a collaborative research exchange with the Geological Survey of Norway, bringing Re-Os (rhenium-osmium) geochronology to Scandinavia’s bedrock. In September 2022, AIRIE joined Innosphere Ventures as the first commercial Re-Os-Hg laboratory for geochronology and Os-Hg tracer studies, from resource geology (minerals and petroleum) to remediation and nuclear waste sites. Holly and her team pioneered radiometric dating of molybdenite, pyrite, and arsenopyrite, followed by other sulfide and oxide minerals, and most recently dating of graphite. Her work permitted the first direct dating of metallic sulfide ores. Thereafter, she and her team used Re-Os to unravel petroleum system histories, supported by the Norwegian petroleum industry. In 2016 AIRIE produced the first Re-Os age for a single crude oil and subsequently proved why Re-Os dating of petroleum systems works through water-oil experimental work. At present, she and her team are exploring Os-Hg tracer studies to predict economic Au and Cu porphyry mineral systems. Prof. Stein has advised and mentored graduate students and post-docs world-over.

Dr. Stein is a half-time salaried research professor at the University of Oslo. She is the Penrose Gold Medalist to be awarded by the Society of Economic Geologists (SEG) in 2024. Dr. Stein is a Fulbright Scholar, and received the SEG Silver Medal (2005), Helmholtz-Humboldt Research Prize (2008), Bunsen Medal in Geochemistry from EGU (2020), and Scholarship and Innovation Award from CSU (2022). She holds a BS from Western Illinois University and MS and PhD degrees from University of North Carolina at Chapel Hill. She was a post-doc at the USGS working with the late M. Tatsumoto.



Research Areas

Mineral and Hydrocarbon Resources, Ore Deposits, Re-Os Isotope Geochemistry, Mass Extinctions, Mercury, Critical Minerals, Graphite, Black Shales, Trace Metals, Radiogenic and Stable Isotope Applications.