

Molybdenite ^{187}Re - ^{187}Os age variance at the macroscale using ID-NTIMS

GANG YANG^{1*}, AARON ZIMMERMAN¹, HOLLY J. STEIN^{1,2}, JUDITH L. HANNAH^{1,2}

¹ AIRIE Program, Colorado State University, Fort Collins, Colorado 80523-1482, USA (*correspondence: gang.yang@colostate.edu)

² Institute of Geosciences, University of Oslo, Norway

Molybdenite ^{187}Re - ^{187}Os geochronology using ID-NTIMS, employed since the mid-1990's^[1], reliably yields model ages and can discern multiple mineralization events in young systems. Recently, a new method of Re-Os dating for molybdenite by LA-ICP-MS/MS^[2] was introduced, based on the erroneous conclusion that ^{187}Re - ^{187}Os decoupling does not occur within molybdenite crystals at the microscale^[3]. In reality, Re-Os model ages for each laser pit are highly *imprecise* and *discordant* suggesting either notable ^{187}Re - ^{187}Os decoupling^[4] or laser-induced isotopic fractionation^[5], or both. Importantly, an accurate and reliable age is solely the result of averaging a large number of spots.

We reinvestigated ^{187}Re - ^{187}Os decoupling at the macroscale using ID-NTIMS on large molybdenite crystals. Two granite-related molybdenite samples from Preissac, Canada, and Mount Emmons, Colorado, USA, were selected. A 12×10mm euhedral molybdenite crystal from Preissac was sampled 7 times by diamond-tipped drilling with 4-6mm² pits spatially distributed over the crystal surface. Model ^{187}Re - ^{187}Os ages range from 2663.1±3.9 to 2684.5±4.4 Ma with no common Os observed. Model ages from a coarse molybdenite clot from Mount Emmons span 15.74±0.02 to 15.85±0.02 Ma. These discordant model ages reveal ^{187}Re - ^{187}Os decoupling at the scale of a few mm² within a crystal or clot. Microscale decoupling, in light of macroscale decoupling, appears inevitable, and thus requires thoughtful sampling technique(s) to minimize and/or overcome it.

In addition to ^{187}Re - ^{187}Os decoupling, overgrowths^[6] and common Os^[7] are also potential concerns when dating molybdenite samples by LA-ICP-MS/MS or any microscale technique. Therefore, robust sampling strategies and ID-NTIMS are essential for meaningful molybdenite Re-Os ages.

[1] Stein et al (1997) *Econ Geol* **92**: 827-835

[2] Hogmalm et al (2019) *Miner Deposita* **54**: 821-828

[3] Barra et al (2017) *Sci Rep* **7**: 16054

[4] Stein et al (2003) *GCA* **67**: 3673-3686

[5] Nowell et al (2008) *Chem Geol* **248**: 394-426

[6] Stein et al (2004) *Precam Res* **134**: 189-226

[7] Markey et al (2003) *Chem Geol* **200**: 395-406