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Rhenium Isotope Variations in Molybdenites

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Despite widespread application of the Re-Os geochronometer, mass-dependent variations in the Re isotope composition of molybdenite and other minerals in ore-forming systems remains uninvestigated. Using recently developed methods, including a desolvating nebulizer system (dry plasma) for increased sensitivity, we measured the δ^{187}Re signatures of molybdenite in well-known mineral deposits to investigate the extent of Re isotope variation. Molybdenites were assessed for inter-grain variability by analyzing various flakes from the same molybdenite mineral separate and show little to no variability with respect to δ^{187}Re. However, there is detectable variation in δ^{187}Re within the Henderson (porphyry Mo) molybdenite nano-powder reference material (NIST RM 8599), which yields an average δ^{187}Re of −0.21± 0.20‰ (n=20), suggesting Re isotope heterogeneity can occur within large (>1gram) mineral separates. Thus far, we have measured the δ^{187}Re of orogenic gold (1.47 ± 0.06‰), porphyry (−0.35 ± 0.15‰), epithermal (−0.56 ± 0.07‰), and greisen-type (−0.19 ± 0.02‰) deposits for a total of 30 molybdenite samples from ~20 different deposits. Individual data varies from 1.47 ± 0.06‰ (Hemlo, Ontario, Canada; disseminated-replacement-type Archean orogenic gold) to −0.61 ± 0.09‰ (Collahuasi, Chile; Eocene-Oligocene porphyry copper-molybdenum) and represents the largest range of Re isotope compositions in geological materials recorded to date. Intra-deposit variation for the Collahuasi deposit ranges from −0.19 + 0.01‰ to −0.61 + 0.09‰, showing significant Re isotope fractionation within a single deposit. The dataset highlights both overlap between deposit types and unusual Re isotope signatures in others, such as the Hemlo deposit. Possible mechanisms for Re isotope variations in a single deposit are mineral crystallization, fluid boiling, redox and temperature controls, variations in the fluid source(s), and Rayleigh distillation along fluid flow paths. The observed range in molybdenite δ^{187}Re suggests that Re isotopes have potential for tracing ore-forming processes, and further insights may come from coupled Re-Mo isotope studies on molybdenite.