Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.20556

Rhenium Isotope Reconnaissance of Uranium Ore Concentrates

DAN L. SULLIVAN[1], GREGORY BRENNECKA[2], KATHERINE E GRANT[2] AND ARIEL D. ANBAR[1]

[1]Arizona State University

[2]Lawrence Livermore National Laboratory

Presenting Author: dan.sullivan@asu.edu

Exploration of isotopic variation for the element rhenium (Re; $^{187}Re/^{185}Re$, hereafter presented as $\delta^{187}Re$, relative to NIST 3143) is in its infancy. Initial data [e.g., 1-4] indicate $\delta^{187}Re$ fractionation is present in geologic material, providing the potential to use Re as a paleoredox proxy, oxidative weathering proxy, and a nuclear forensics tool.

In this study, we present the first $\delta^{187}Re$ data from uranium ore concentrates (UOC) utilizing a novel ion exchange protocol to separate Re from matrix elements. UOCs represent products of unstudied geologic environments that can improve our understanding of Re isotope fractionation. The UOC samples span a range of depositional ages, locations, and geologic settings. Ore types included in the study are sandstone, unconformity, and QP conglomerate. We found that UOC $\delta^{187}Re$ values have a significant range in Re isotopic compositions from -0.99 to +1.33‰ for a total range of 2.32‰. This has greatly expanded the previously reported range of 0.93‰ (-0.97 to -0.04‰) found in the peer-reviewed literature [1-4].

We found that UOCs derived from sandstone ore are, on average, isotopically lightest in $\delta^{187}Re$. Both sandstone and unconformity deposits form under reducing conditions, however sandstone deposits form in low-temperature settings, whereas unconformity deposits form in high-temperature settings. QP conglomerate ore deposits, with the heaviest isotopic values, formed prior to the Great Oxidation Event, meaning redox likely did not play a role in their deposition.

In addition to providing a better understanding of Re isotope systematics, $\delta^{187}Re$ data from UOCs can aid in provenance assessment of samples found outside regulatory control. Combining isotopic values such as $\delta^{187}Re$, $\delta^{238}U$, and εNd values provides unique geochemical signatures for each sample. As such, different mining and milling locations can be identified, making $\delta^{187}Re$ a useful signature in nuclear forensic studies.

[1] Miller, C.A., Peucker-Ehrenbrink, B., and Schauble, E. A. (2015) EPSL, 430, 339-348. [2] Liu, R., Hu, L., Humayun, M. (2017) Met. and Plntry. Sci., 52, 479-492. [3] Dellinger, M., Hilton, R. G., Nowell, G. M. (2021) EPSL, 573, 117131.[4] Dickson, A. J., Hsieh, Y., Bryan, A. (2020) GCA, 287, 691-698.