Re-Os isotope systematics from deep water collected from the Western Canada Sedmentary Basin (WCSB)

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For an isotopic system to be potentially valuable as a geochemical tracer it is important to define its reservoirs (e.g. mantle, crust, ocean) and how it is transported between them (e.g. fluids). For the Re-Os system the most poorly constrained system is that of the deep groundwater system (> 100 m), with no previous literature data available. Using a combination of water source wells, oil wells, and CO_2 injection wells, we collected water and oil from the majority of major aquifers of the Williston Basin in the Western Canada Sedimentary Basin. The results of this study represent the first dataset of deep (118 m – 3310 m), natural groundwaters.

For surface water and shallow groundwater (~100 m) the abundances of Re (> ~1000 ppq) and Os (> ~10 ppq) are comparable to previous studies. In the deep subsurface however, abundances decline to near-zero ([Os] < 3 ppq, [Re], < 300 ppq). Interactions with petroleum may explain some observations, however many depleted waters are not in connection with petroleum systems. Additional mechanisms, such as interactions with organic-rich or clay-rich sediments, are required to explain the observed basin-wide depletion of Re-Os at depth. The exceptionally low abundances of Re and Os in sedimentary brines, especially compared to other metals, brings into question the source of Os found in some sediment-hosted ore deposits.

When calculatable, the $^{187}Os/^{188}Os$ typically ranged between 1 and 2, similar to what are observed in surface waters. Anthropogenic contamination and water-injection activities were clearly observed in some samples using Os isotopes, indicating Os was an effective tracer in these situations.

Water-oil interactions typically follow the expected trend, with oils containing a factor of 10-10^6 higher abundances of Re and Os. However, two samples show evidence that isotopic equilibrium between oil and water has not been reached, suggesting that the behavior of the Re-Os system in natural oil-water systems are more complex than suggested through recent experiments [1].

[1] Hurtig et al. 2019, Geochemica et Geochimica et Cosmochimica Acta, 247, 142-161