

The effect of oil and water chemistry on Re-Os partitioning during water-oil interaction

N. C. HURTIG¹, S. V. GEORGIEV^{1,2}, H. J. STEIN^{1,2}, J. L. HANNAH^{1,2}

¹AIRIE Program, Colorado State University, Fort Collins, CO, 80523-1482, USA

²CEED, University of Oslo, PO Box 1028, 0315, Norway

The Re-Os geochronometer [1] has been successfully used to date bitumen and asphaltene (ASPH) fractions of crude oils [2,3]. Single crude oil samples have been dated by analyzing ASPH-crude oil-MALT (maltene) triplets [4,5]. However, the process of setting the Re-Os clock in oils is still poorly understood. Here, we test the hypothesis that water-oil interaction can (re)set the Re-Os radiometric clock, as formation waters and hydrocarbons often co-migrate or coexist in their reservoirs.

Element mass transfer and isotopic equilibration between Re-Os enriched waters and different crude oils were experimentally determined. Investigated parameters include water and oil chemistry, water to oil ratios and time. We evaluated the relative importance of water chemistry (pH, salinity, Re-Os concentrations) versus oil chemistry (ASPH content, initial Re-Os contents, organic compounds).

Results show that Re and Os fractionate across the water-oil interface with Os preferentially partitioning into the oils. Osmium transfer is kinetically faster than minimum experimental run times and Re shows a kinetic barrier at low ASPH contents and low initial aqueous Re concentrations. This behavior is consistent for different oil and water chemistries. The Re kinetic barrier is exacerbated at higher salinities and moderate to high pH, indicating that the Re aqueous compounds are stabilized under these conditions. However, there is no effect on the Os partitioning behavior, which is largely independent of oil and water chemistry.

Our key conclusions are that the Re-Os geochronometer can be reset during water-oil interaction under the right conditions. We also show that water-oil interaction yields fast equilibration of the Os isotopic composition and different ¹⁸⁷Re/¹⁸⁸Os ratios can be achieved through different water to oil ratios, water and oil chemistries.

[1] Stein & Hannah (2014), *Springer Encyclopedia of Dating Methods*, 2nd Ed., 87-118. [2] Selby and Creaser (2005) *Science*, **308**, 1293–1295. [3] Finlay et al. (2011) *Geology*, **39**, 475–478. [4] Georgiev et al. (2016), *GCA* **179**, 53–75. [5] Liu and Selby (2017) *Geostand. and Geoanal. Res* **42**, 97-113.