Residency of Rhenium and Osmium in a Heavy Crude Oil

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Little is known about the residency of Re and Os within asphaltene and maltene sub-fractions of crude oil. This information is crucial if we are to successfully interpret Re-Os geochronological data for crude oil and its fractions. This permits us to pinpoint times of oil formation, migration, mixing and/or biodegradation [1, 2].

In this study, a heavy crude oil was separated into n-heptane soluble (maltene) and n-heptane insoluble (asphaltene) fractions. Asphaltenes were separated sequentially into sub-fractions using heptane-DCM and acetone-toluene mixtures; maltenes were separated into saturates, aromatics, and resins using open column chromatography. Asphaltenes and maltene sub-fractions were analyzed for Re and Os; asphaltene sub-fractions and bulk samples were also analyzed for a selected suite of trace metals by ICP-MS.

Re and Os concentrations track each other, and both elements are mostly found in highly polar and aromatic sub-fractions; we also show for the first time that significant Re and Os can be present in the aromatics and resins. The asphaltene and maltene sub-fractions have distinct Re-Os isotopic ratios which are not isochronous, which suggests that separation of asphaltene into its sub-fractions undercuts the isotopic integrity of the chronometer. Re correlates strongly with Mo and Cd among the asphaltene sub-fractions; as Re and Os track each other, this suggests that Re-Os, Mo, and Cd occupy similar sites. Re, Ni, and V budgets also track each other, suggesting that some Re may form metalloporphyrins.

Finally, we suggest that progressive asphaltene precipitation during migration and/or mixing of oils can change the resultant oil’s Re-Os isotopic ratios. This is key to interpretation of Re-Os data for tar mats and live oils, as precipitation of asphaltenes between source and reservoir has the possibility to alter the Re-Os systematics. By combining data from source rocks, oils, and asphaltenes, we are constructing temporal histories for whole petroleum systems.

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