Re-Os variations in North Sea shales and oils

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Introduction and Analytical Methods

We have determined the Re and Os concentrations and Os isotopic composition in a range of shales and oils from the North Sea. Rock samples were loaded into Carius tubes and digested in 6 – 9ml reverse aqua regia. For oil samples, metal-rich ashphaltenes were removed from betweeen 10 and 30 grams of topped crude oil via a hexane precipitation method and digested in Carius tubes. Recovered ashphaltines represent ~1-2% of the initial oil weight.

Os was purified by using $CHCl_3$ and Re by anion chromatography. After solvent extraction Os was back-extracted into HBr in a 33 ml Teflon vial and dried. Os isotope ratios were measured on Faraday cups by adding H_2SO_4 directly to the Teflon vial and sparging Os into the MC-ICPMS source. Isotope ratios were measured for between 5-10 min, with 10 min washouts. The precision on measured isotope ratios are indistinguishable to that reported for TIMS measurements. Re isotopes were measured in solutions on either Faraday cups ion multipliers.

Results

Os concentrations in SR-1, an international organic-rich reference material from Spitsbergen, range between 0.2 – 1.2 ppb, Re concentrations are constant at ~31.2 ppb. Nine aliquots of this rock yield an isochron age of 172.1 ± 4.8 Ma (MSWD = 1.7). This age questions the previously poorly constrained palynological mid-Triassic age and the geological interpretation of the region where the sample was taken. The initial $^{187}Os/^{188}Os$ isotope ratio, 0.201 ± 0.023, is low for a crustal system, but consistent with previous Os isotope data from English Jurassic shales [1].

Spitsbergen shales spanning the Jurassic-Cretaceaous bounday show a pronounced Os anomaly that correlates with the nearby Mjølnir impact structure. Jurassic samples from the transgressive sequence below the boundary are poorly consolidated and show evidence for Re-addition. However, 3 deepwater samples above the boundary indicate an age of ~140 Ma and an intitial $^{187}Os/^{188}Os$ ratio of ~0.2, consistent with their stratigraphic position. We have obtained fresh drill core material to further investigate the Os anomaly associated with the Mjølnir structure.

Oil ashphaltenes have an Os concentration of ~1.6 ppb and a low Re/Os ratio of 0.68. The $^{187}Os/^{188}Os$ ratio of ~0.18 (at 150 Ma) likely precludes a "Jet-Rock" ($^{187}Os/^{188}Os$ = 0.8 [1]) source for the oil and points to other, possibly, late-Jurassic shales. Further work will focus the geochronological relationship of well constrained source rocks and oils.

References

[1] Cohen, A., 2004, J. Geol. Soc. Lon. **161**, 729-734