

Mantle-like fluid interaction with the Miller Oil Field, UK North Sea: disturbance of oil Re-Os systematics

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Rhenium and Os in petroleum are predominantly bound within the asphaltene fraction, which approximates the Re-Os isotopic composition of whole oil [1]. Herein we present a Re-Os study of asphaltene extracted from 14 oils (0.5 to 5.5 wt. % asphaltene) representing 11 North Sea oil fields. Ten of the 11 North Sea oil field asphaltenes contain Re and Os abundances of 0.13 to 4.24 ppb and ~2 to 630 ppt respectively, with ¹⁸⁷Re/¹⁸⁸Os ratios between 168 and 1201, and ¹⁸⁷Os/¹⁸⁸Os ratios of 1.03 to 4.90. In contrast, 3 asphaltenes from the Miller field contain elevated Os (1.8 to 4.1 ppb), low ¹⁸⁷Re/¹⁸⁸Os values (1.57 to 29.58) and unradiogenic ¹⁸⁷Os/¹⁸⁸Os (~0.14). These values are uncharacteristic of asphaltenes worldwide, but are similar to Re-Os asphaltene data from the Brent oil field (~300 km to the north) [2].

The Kimmeridge Clay Fm (KCF) is the main source of North Sea oil. In the Miller field the KCF is enriched in Re (50 to 115 ppb) and Os (600 to 1697 ppt), and possesses high ¹⁸⁷Re/¹⁸⁸Os (346 to 484) and ¹⁸⁷Os/¹⁸⁸Os (1.41 to 1.65) values. The Re-Os data yield a Re-Os age of 147±13 Ma. If oil inherits the ¹⁸⁷Os/¹⁸⁸Os of the source at the time of formation [1], then the Miller oil would have an ¹⁸⁷Os/¹⁸⁸Os between 0.9 and 1.1 at the time of oil generation. However, the Miller oil is unradiogenic, suggesting that either oil does not inherit the ¹⁸⁷Os/¹⁸⁸Os of the source rock, or that the Re-Os systematics have been disturbed. Given that oils from 10 of the 11 North Sea fields possess Re-Os isotope systematics that may reflect their KCF source, the Re-Os asphaltene systematics of the Miller field may have been disturbed. δ¹³C_{CO2} studies (-5.6 to -7.5 ‰) of the Miller oil suggest that the oil has interacted with a mantle-like fluid. This is further supported by the elevated Os abundances and unradiogenic ¹⁸⁷Os/¹⁸⁸Os of the Miller asphaltene. The timing of this fluid interaction with the Miller oil field may have occurred during migration or more recently within the reservoir.

[1] Selby *et al.* (2007) *Geochim. Cosmochim. Acta.* **71**, 378-386. [2] Graham *et al.* (1996) *Geochim. Cosmochim. Acta.* **70**, 211.

Global variability in the platinum-group element contents of komatiites

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We report a large volume of high-precision platinum-group element (PGE) data generated from Archaean and some Early Proterozoic komatiites and komatiitic basalts spanning a wide range of ages, petrological affinities and locations. We observe that PGE baseline concentrations in komatiites of different petrological affinity, lithofacies type and emplacement style are generally similar worldwide. All komatiites have relative PGE patterns showing a slight enrichment of PPGEs over IPGEs attributable to limited retention of IPGEs in mantle sources, coupled with saturation in Ir-(Os) alloys.

Barberton-type komatiites are variably depleted in all the PGEs relative to 2700 Ma old Munro-type komatiites, but have similar abundances to Munro-type komatiites from greenstone belts over 3000 Ma old. There is a roughly linear secular trend of increasing Pt/Ti from 3500 Ma to 2700 Ma. We observe that Barberton-type komatiites are slightly depleted in all the PGEs relative to Munro-type, consistent with depletion due to sulphide in the source. However, the Munro-type komatiites in the east Pilbara, which presumably formed sulphur-undersaturated at source, are strongly depleted in PGEs.

We put forward two alternative hypotheses: either Barberton-type komatiites are slightly PGE depleted due to S-saturation at source, and the east Pilbara Munro-type komatiites are an unexplained anomaly; or else the difference is related to a secular variation in the PGE content of komatiite source regions. If the latter hypothesis is true, we envisage that Early Archaean komatiites are derived from plumes sourced in the deep mantle which had been stripped of its highly siderophile element budget during core segregation, and not yet refertilized by the late veneer. Late Archaean komatiites contain higher PGE contents as a result of progressive mixing-in of late veneer over the period between the Late Heavy Bombardment (4.3 to 3.9 Ga) and 2700 ga, at which time the mantle had become effectively homogenous with respect to PGEs.