

Identifying the when and where of oil generation using platinum, palladium, osmium and rhenium geochemistry

D. SELBY¹, A.J. FINLAY¹ AND M.J. OSBORNE²

¹Department of Earth Sciences, Durham University, Durham, DH1 3LE, UK (david.selby@durham.ac.uk, a.j.finlay@durham.ac.uk)

²BP International Centre for Business & Technology, Building H, Chertsey Rd., Sunbury-on-Thames, Middlesex, TW16 7LN, UK

Understanding the timing and source of petroleum generation permits more successful oil exploration and recovery. Traditionally, oil source rock identification uses organic chemical analysis of light oil fractions. However, common processes such as biodegradation preferentially removes light hydrocarbons from petroleum compromising traditional oil to source fingerprinting techniques. We therefore developed a new geochemical technique, which not only absolutely dates oil generation through Re–Os geochronology, but also enables the identification of source units through the comparison of ¹⁸⁷Osmium/¹⁸⁸Osmium at the time of generation (Os_g) and Platinum/Palladium (Pt/Pd) ratios in oils and their potential source units. We demonstrate the applicability of this method in the well understood United Kingdom Atlantic Margin (UKAM) petroleum system and then apply it to identify the source of the West Canadian Tar Sands (WCTS).

Our data yields a Re–Os age of 68±13 Ma (MSWD=20) for oils of the UKAM, indistinguishable from published basin models. Furthermore, the Os_g and Pt/Pd values of these oils are indistinguishable from those of the known source rock, demonstrating that Os_g and Pt/Pd values can be used to identify oil source. When applied to the WCTS, comparison of Pt/Pd and Os_g values with the three potential source units suggests that the dominant source unit is the late Jurassic Gordondale Fm. with only minor inputs from other sources (e.g. Devonian–Mississippian Exshaw Formation).

Unlike traditional organic geochemistry, Pt/Pd and Os_g fingerprinting is not rendered ineffective by biodegradation allowing oil source correlation in previously unsuitable petroleum systems and the deduction of migration pathways. Combining Re–Os geochronology with Pt and Pd geochemistry has identified the Gordondale Fm. as the source of the WCTS. This now permits both spatial and temporal constraints on petroleum systems to be established and therefore provide a significant tool for petroleum system exploration and development.

Bio-Au nanoparticles on archaeal and bacterial S-layers

S. SELENSKA-POBELL^{1*}, T. REITZ¹, A. GEISLER¹, M.L. MERROUN² AND T. HERRMANNSDÖRFER³

¹Institute of Radiochemistry, HZDR, D-01328 Dresden, Germany (*correspondence: s.selenska-pobell@hzdr.de)

²Microbiology Dept., University of Granada, Granada, Spain

³Dresden High Magnetic Field Laboratory, HZDR, Dresden

Gold nanoparticles with substantially different properties were produced by using two alternative S-layer templates. The first one was a bacterial template, representing sheets of the S-layer of *Bacillus sphaericus*; the second one was in a form of empty cells (ghosts) consisting of the so-called SlaA-layer of the thermoacidophilic archaeon *Sulfolobus acidocaldarius*. The archaeal SlaA-layer is resistant not only to high temperatures and acidity but also to detergents, that allowed to purify the SlaA-layer-ghosts keeping the shape of the cells. The production of the Au nanoparticles was performed according to [1, 2] in a two-step procedure by using DMAB as a reducing agent.

We demonstrate that the SlaA-ghosts of *S. acidocaldarius* serve as a very efficient template for complete reduction of Au(III) to Au(0). In the case of using S-layer sheets of *B. sphaericus* only 40 % of the added Au(III) was reduced to Au(0) [2]. The size of the archaeal bio-Au nanoparticles was about 2.5 nm, while those of the bacterial ones was about 4 nm. The most striking property of the archaeal bio-Au nanoparticles is, however, that they are paramagnetic, in contrast to the bacterial ones and also to bulk gold, which are diamagnetic. As demonstrated by SQUID magnetometry, the archaeal bio-Au possesses an unusually large magnetic moment of about 0.1 μ_B /Au atom. HR-TEM combined with EDX analysis revealed that the archaeal Au nanoparticles are bound to sulfur atoms. The latter originate from the thiol groups of the cysteine amino acid residues which are characteristic for the SlaA-layer of *S. acidocaldarius* but absent in the S-layer of *B. sphaericus*. Surprisingly, the magnetic moment of the archaeal bio-Au nanoparticles is substantially larger than the ones observed for thiol capped, chemically produced Au nanoclusters [3]. We suggest that the unusual shape and the biochemical characteristics of the SlaA-ghosts are responsible for the observed extraordinary properties of the archaeal bio-Au.

[1] Merroun *et al.* (2007) *Mat. Sc. Tech.* **27**, 188–192.

[2] Jankovski *et al.* (2010) *Spectroscopy* **24**, 177–181, 2010.

[3] Crespo *et al.* (2004) *Phys. Rev. Lett.* **93**, 087204.