NERC DOCTORAL TRAINING

UK Oil and Gas Collaborative Doctoral Training Centre (2014 start)

Project Title: UNCONVENTIONAL ENERGY SOURCES	
Host institution: University of Nottingham	
Supervisor 1: Sean Rigby	
Supervisor 2 (or more) (& Institution if different from host): Joseph Wood (Birmingham)	

Project description:

Oil companies have previously experimented with electrical heating for oil recovery. The Shell process, known as in-situ conversion process, heats solid oil shale at temperatures in the range 343-399 °C to extract the light oil and gas via heating elements inserted into holes drilled in the ground. It has been trialled in Colorado, USA, producing 1700 barrels of light oil and associated gas between 2003–2005. In-situ combustion methods, such as THAI, for heavy oil recovery, and the in-situ pyrolysis of shale oil, produce large amounts of heat that mobilize the oil. Microwaves have also previously been used to heat tar sand reservoirs as a way of mobilising the oil. However, this heat energy can also be used to do chemistry and further upgrade the oil downhole enhanced by catalysts. It is thus proposed to synthesise catalytic nanoparticles in-situ in the reservoir bed by pressurised injection of the metal precursor solution into the reservoir bed, via the horizontal (ultimately oil producer) well, and preparation of the catalyst in-situ by microwave heating of injected solution to form catalyst particles within the reservoir pores. This is possible because, for heavy oil/bitumen reservoirs, the oil typically forms a thin layer around the grains of the bed packing, and the rest of the void space is occupied by brine, while the necessary channels in shale oil rocks are formed by hydraulic fracturing. Hence, this new catalyst synthesis approach might be adopted for both bitumen and fractured shale oil beds.

Core samples of rubblized shale (to mimic fracked beds) prepared in the lab by collaborators in JilIn University China, and oil shale samples obtained from their field-scale trial at Fuyu City, will be characterised using novel methods, such as integrated gas sorption and mercury porosimetry, and mercury DSC thermoporometry. Computerised X-ray tomography (CXT) and 3D-EM methods will also be employed. Besides the fresh cores, samples with impregnated catalyst will also be characterised using similar methods, and also techniques to detect the spatial distribution and dispersion of the catalyst, such as K-edge CXT and chemisorption analysis. These studies will show how the rock pore structure influences distribution of the catalyst, and how this will impact oil production and upgrading. The results of these studies will be used to interpret studies of catalytic upgrading in the lab and from the field trial.

Research theme: a. Effective production of unconventional hydrocarbons
Project involves novel multi-scale characterisation of cores of oil shales.
Research context: The student will be part of the Nottingham unconventional hydrocarbons group including 1 post-doc and 3 PhDs working in similar areas.

Research costs: Power PC (£1000 – provided by University of Nottingham); Software licences £1500 provided. Access fees to porosimetry and CXT (£2000).

Career routes: The student will have a broad range of career options upon graduating, including further academic career, or working in the oil and gas industries, eg environmental geoscience