DETERMINING THE MAGNETIC SIGNATURE OF HYDROCARBON-RICH ENVIRONMENTS: A NUMERICAL APPROACH

Dr. Adrian Muxworthy (Imperial College) & Prof. Wyn Williams (University of Edinburgh)

Background

From aeromagnetic surveys there is evidence of large magnetic anomalies around many hydrocarbon reservoirs. It is thought that these magnetic signatures have the potential to be used in both detecting hydrocarbons and in understanding migration in hydrocarbon reservoirs, thereby improving yield from mature oil fields like those in the North Sea. Many approaches have been taken to study the origin of these magnetic signatures: (1) direct sampling of cores from numerous countries (e.g., Emmerton et al., 2013), and (2) through simulation of the 'oil-kitchen' in the laboratory through controlled pyrolysis (Abubakar et al., 2015). By using electron microscopy there was found to be abundances of both iron oxide and/or sulphide framboidal aggregates in both the natural and laboratory samples; framboids are structures formed of symmetric grains that have spontaneously assembled in raspberry shapes (Fig. 1). It is thought that the magnetic signature of these framboids has the potential to be used as a magnetic proxy for hydrocarbon formation and movement. However, in both the natural and synthetic samples, it has proven difficult to isolate the magnetic signature of these framboids from bulk samples, which contain distributions of other magnetic particles.

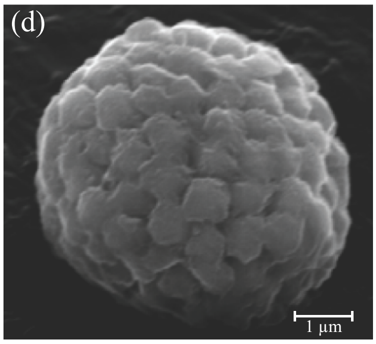

Figure 1. Framboidal iron sulphide. S. Emmerton.

Project

The aim of this proposal is to use three-dimensional numerical models (micromagnetic models) to isolate and quantify the magnetic signature of these framboids, to allow us to optimise protocols for their detection in hydrocarbon systems. Recently, Edinburgh and Imperial have jointly successfully developed the next generation of micromagnetic code that has been optimised to run on large HPC (High Performance Computing) facilities. This code is a step-change from previous models, and allows for the numerical study of much larger magnetic systems (an order of magnitude bigger, i.e., up to 10 μm), in particular the magnetic response of framboidal aggregates.

The student will use the micromagnetic Finite Element Model (FEM) to determine and quantify both the signature of isolated framboids, plus the response of bulk samples containing other magnetic materials (Valdez-Grijalva et al., 2018). The effect of size will also be investigated: If the magnetic minerals migrate it is expected that they will travel greater or shorter distances according to their size, and since the magnetic properties are highly size dependent, this will be key to understanding oil migration.

Knowledge of computer programming and/or mathematics/physics would be beneficial.

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Please do not hesitate to contact me for further information and informal enquiries:
adrian.muxworthy@imperial.ac.uk