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Nine month report

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Abstract

It is known from aeromagnetic surveys from Venezuela, China and the U.S. that it is common to find magnetic anomalies on hydrocarbon reservoir sites. It has been suggested that the physical and geochemical conditions of soils sitting above reservoirs are conducive to the formation of ferromagnetic minerals such as magnetite and greigite. From samples drilled in Venezuela it has been observed that these minerals form roughly spherical aggregates called *framboids*. While the specific physical and geochemical processes involved in the genesis of these minerals is an active research topic, I will focus in studying the domain structure and hysteresis parameters of these minerals via numerical simulation of the *micromagnetic* equations. Solving the micromagnetic problem can be done either by minimising the total Gibbs free energy which is a sum of energies associated with different phenomena in a ferromagnetic material or by solving the dynamical equation for the magnetic moments, that is the Landau-Lifshitz-Gilbert equation (LLGE). I will use a finite element method based on the general-purpose package collection for automated solutions of partial differential equations *FEniCS* to solve the LLGE as well as an energy minimising routine, specifically a conjugate gradient method. My aim is to find a conclusive magnetic signal of these mineral aggregates that could be measured in a given sample by standard rock-magnetic and palaeomagnetic techniques. As a first approach to the problem, before scaling up the simulations, I have conducted simulations of hysteresis loops and zero-field domain structure of octahedral-shaped single grains of greigite and compared these with octahedral grains whose corners have been chopped. These shapes are typical morphologies of greigite and these simulations constitute an improvement over previous finite difference simulations that could only study somewhat unrealistic shapes like cubes and rectangular prisms.

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Introduction

1.1 Motivation and Objectives

It has been established via airborne magnetic surveys in the U.S.A. (Donovan et al., 1979) that magnetic contrasts—that is, "magnetisation that is different from background magnetisation and which may give rise to mappable magnetic anomalies detectable by conventional magnetometry" (Machel and Burton, 1991)—are a common feature of hydrocarbon reservoir sites. Donovan et al. (1979) suggested that these magnetic anomalies are caused by near-surface magnetic minerals induced by seepage from the underlying hydrocarbon reservoir. Díaz et al. (2000) and Liu et al. (2006) have confirmed the existence of iron-bearing minerals near the surface in oil fields in China and Venezuela by analysing samples collected from near-surface soils. These investigations confirm the original hypothesis of Donovan et al. (1979) that the reducing environment caused by the upward seepage from the reservoirs is conducive to the formation of magnetic minerals—such as magnetite and other Fe-oxides, and greigite and other Fe-sulphides—and/or the destruction of minerals such as hematite (Machel and Burton, 1991).

1.2 Contributions

Contributions here.

1.3 Statement of Originality

Statement here.

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Bibliography

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