Towards a robust non-heating method of palaeointensity determination from meteorites

Adrian Muxworthy (Imperial College) & David Heslop (ANU, Canberra)

Background
To be able to understand the behaviour of the planetary dynamos in the Solar System we need to know how these magnetic fields varied in the past. To do this we need to examine the magnetic recordings of rocks and meteorites; however, the actual magnetic signal recorded by the minerals can be rather confusing, and it takes geological knowledge as well as a good understanding of physics to be able to unravel their magnetic signal and to interpret it meaningfully. The magnetic minerals not only record the direction of the magnetic signal, but also the intensity (palaeointensity) of the field at the time of rock formation. The direction is easier to unravel than the intensity, however, the intensity is critical if we are to completely describe the field and how it is generated. There have been several methods that claim to determine the palaeointensity, however, they have met with limited success. These methods work by comparing the magnetic remanence of rock with a similar one induced in the laboratory. There are two problems with this approach; first, the method only works for the small grains (< 0.1 µm in diameter) that obey certain rules. Second, to replicate the natural remanence in the laboratory it is necessary to heat rocks and meteorites to over 600°C, which commonly causes unwanted chemical alteration in the samples; this is particularly true of meteoritic material.

Project
The aim of this project is to extend the non-heating absolute palaeointensity method proposed recently (Muxworthy & Heslop, 2011; Muxworthy et al., 2011). This method works by measuring distribution of magnetic particles in a rock using a type of magnetic hysteresis measurement called a first-order reversal curve (FORC) (Figure 1), and using this distribution to predict what palaeomagnetic field intensity would be required to magnetise the sample. The current FORC measurement protocol is limited by poor resolution in the y-axis, which strongly affects the final palaeointensity estimate. The aim of the studentship is to develop a new FORC measurement protocol, which leads towards a robust non-heating palaeointensity protocol, particularly useful for meteoritic studies.

![Figure 1. A FORC diagram of a 2.8 Ga gabbro from Botswana. This is a two-dimensional distribution, which plots on a topographic surface. In the simplest interpretation of the distribution, one direction, the x-axis, is related to grain size whilst the other direction, the y-axis, is related to the degree of magnetic interactions within the system.](image-url)

Student Profile
This project is a combined laboratory and numerical project, and would suit a candidate with an interest in the physics of magnetic systems. Candidates should have a degree in Earth Science, Material Science or Physics. Good laboratory skills, and knowledge of a computing programming language beneficial.


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