DETERMINING ANCIENT FIELD INTENSITIES FROM CHEMICAL REMANENT MAGNETISATIONS IN ROCKS AND METEORITES

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Background
To understand how the geomagnetic field has changed in the past, we look at the magnetic remanence recorded by rocks and meteorites. Determining the ancient geomagnetic field direction is relatively straightforward, however, estimating the ancient geomagnetic field intensity (palaeointensity) is more difficult. Currently all palaeointensity determinations are obtained from minerals whose natural remanent magnetisation (NRM) is thought to be a thermoremanent magnetisation (TRM) in origin. A TRM is the remanent magnetisation acquired by magnetic minerals as they cool from above their ferromagnetic ordering temperature (the Curie temperature) to ambient temperature in the presence of a field, e.g., lavas normally carry TRMs. Such magnetisations can be stable for billions of years, however, there are many cases in nature where the magnetic minerals are formed below the Curie temperature, i.e., the NRM is not a TRM but a grain-grown CRM (chemical or crystallization remanent magnetisation)? A grain-growth CRM is acquired as magnetic crystal grows in size: when a crystal is small, thermal fluctuations randomise the orientation of its magnetic moment, however, as the volume increases the relative importance of the thermal fluctuations decreases and the magnetisation becomes frozen. Such CRMs are recorded in diagenetic greigite (an iron sulphide) (Figure 1) and in hydrothermal alteration in meteorites. Similarly change of iron oxide phase, e.g., magnetite to maghemite, can lead to a change in the magnetic remanence state (Figure 2.)

Project
The aim of this studentship is to develop and empirically test a Preisach-based protocol that will use only room-temperature measurements to determine the palaeointensity recorded by a grain-growth CRM. Dr. Adrian Muxworthy has previously developed a Preisach-based protocol for determining palaeointensities from rocks carrying TRMs (Muxworthy & Heslop, 2011; Muxworthy et al., 2011]. A similar Preisach CRM model will be developed. The proposed new method will be empirically tested using both synthetic samples induced with a CRM, and historical samples from Hawaii, previously identified as carrying a grain-growth CRM where the geomagnetic inducing field is known.

Student Profile
This project is primarily lab-based in nature and would suit a candidate with strong interest in cutting edge rock magnetism and possessing excellent organizational and time management skills. Candidates should have a degree in Earth Science, Material Science or Physics and a good background in laboratory-skills.


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