ÉCOLE DOCTORALE SCIENCES DE LA TERRE

Subject offered for a contract starting in September 2011

SUBJECT TITTLE: Magnetization of the Moon and Mars

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Host lab/ Team: *please fill in and leave out meaningless information*

IPGP – Equipe de Géophysique Spatiale et Planétaire UMR7154

Financing: **Doctoral contract with or without assignment**

For more information go to http://ed109.ipgp.fr, section: Offres de these (PhD offer), you must apply on the Doctoral School website

Before the Apollo missions, it was often thought that the Moon was a primordial, undifferentiated relic of the early Solar System. A body so envisioned would have never formed a core or a dynamo magnetic field. It was thus a great surprise when the Apollo subsatellites and surface magnetometers detected magnetic fields originating from the lunar crust and paleomagnetic analyses of returned Apollo samples identified a strong, stable remanent rock magnetization. This magnetization must have been produced by ancient magnetic fields, yet the timing and origin of these fields have remained a mystery more than thirty years since the Apollo era. Some researchers have suggested that these magnetizing fields could have come from a core dynamo, whereas others have suggested that the magnetizing fields were more transient in nature and generated by impact events.

This thesis project aims to elucidate the origin of lunar remanent magnetization (and later Martian remanent magnetization) by investigating orbital magnetometer data that were obtained from the Lunar Prospector and Kaguya missions. The primary objectives of this thesis are threefold. First, by using a variety of forward and inverse modeling techniques, the magnetization directions of isolated magnetic anomalies will be solved for. By comparing these directions with those expected for an axial dipolar field, the hypothesis of an ancient lunar dynamo will be tested. Second, by using the obtained magnetizations from these inversions, the composition of the rocks responsible for the magnetic anomaly will be estimated by comparing with measurements of the Apollo and Luna samples. The abundance of metallic iron in these anomalies will be estimated, and this will be used as a further constraint on the origin of these magnetic anomalies. Third, by utilizing spectral analysis techniques, the depths of magnetization will be determined, from which it will be possible to constrain the temperature profile of the crust when these anomalies formed. These same techniques will also be applied to data obtained from orbit about Mars. If there is sufficient interest, the student could focus this thesis project on Mars instead of the Moon.

Students who apply for this project will be expected to have a solid background in mathematics and physics. The student should already have demonstrated a mastery of computer programming, to have demonstrated an interest in solid-Earth and planetary geophysics, and to have demonstrated an independence in solving problems.