ÉCOLE DOCTORALE SCIENCES DE LA TERRE

Subject offered for a contract starting october 2014

SUBJECT TITLE: Paleovariations of the geomagnetic field intensity

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Host lab/ Team : **IPGP- Paléomagnétisme – UMR7154**

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

Sedimentary and volcanic records of the geomagnetic field intensity provide the unique source of information on the evolution of the geodynamo. The paleomagnetic data contain a broad spectrum of dipole moment fluctuations with polarity reversals and excursions that typically occur during periods of very low field intensity. The variability of the dipole with rapid fluctuations combined with long-term changes must be clarified to understand what controls the dipole strength, why it fluctuates and what is the cause of polarity reversals. Much has been learned for the past 30 years from records of paleointensity relying on natural remanent magnetization of sediments, but uncertainties persist concerning the amplitude and the timing of the variations. A first problem is the differences between the amplitude of distinct records within a common time interval (while a second one is the mismatch introduced by inaccurate time-scales when comparing different records.

The ^{10}Be cosmogenic nuclide provides an alternative approach to study changes in geomagnetic intensity and thus to address the first aspect. During periods of low geomagnetic dipole strength and, therefore, lower shielding (cut-off rigidity), the flux of galactic cosmic rays to the atmosphere increases and generates additional collisions with atoms which increase the production of cosmonuclides. The relationship between geomagnetic dipole strength and cosmogenic nuclides production is well understood and has been quantitatively determined. The second aspect requires very accurate age-model for each sediment column. We will favour carbonated sediments in order to (i) perform ^{14}C dating of planktonic foraminifera shells for sedimentary records spanning the last ~40 kyr, and (ii) acquire detailed oxygen isotopic stratigraphies from the variations of the ^{16}O /^{18}O ratio measured in planktonic and/or benthic foraminifers.

A first objective of this study is to acquire detailed records of relative paleointensity and ^{10}Be signals from a north-south geographical distribution of marine cores. In parallel, high resolution measurements of oxygen isotopes will be performed to establish the detailed time scale of each record. We will focus first on major geomagnetic events such as the last reversal or large excursions during the past 1Ma. The reason for a north-south transect is to constrain the amount of meridional mixing of ^{10}Be in the upper atmosphere. In the present dipolar field configuration, calculations of ^{10}Be production rate as a function of latitude show very little production below 30° of latitude, most of it being concentrated close to the pole. However, there

are evidences of ^{10}Be production at low latitudes during large geomagnetic events, suggesting either the existence of inter-latitudinal mixing in the atmosphere or the proximity to a pole since the field geometry is likely not dipolar any more during such events. The relationship between the ^{10}Be signal and relative paleointensity will make it possible to constrain the distance to the closest pole and therefore the field geometry. This work will represent a significant step in building a long-term global record of the geomagnetic field changes, analyzing their characteristic times and hence their origin.

The magnetic measurements will be conducted at IPGP while the isotopic data will be acquired at LSCE (Gif/Yvette). The ^{10}Be measurements will be conducted on the mass accelerator (ASTER) of Cerege (Aix en Provence). A large part of the work will also be devoted to data interpretation and modeling.

If you are interested, please send a CV and a motivation letter to Jean-Pierre Valet and apply on the Doctoral School website.