The length of the Low: how strong was Earth's magnetic field in the Triassic?

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Introduction:

Palaeomagnetism is unique amongst Earth Science disciplines in being able to provide a relatively pristine and time-dependent signal from the deep Earth. Paleomagnetic data can therefore deliver a strong constraint on planetary evolution through the whole of geological history. This is possible because Earth's magnetic field is generated by a geodynamo process in the planet's liquid outer core (at a depth greater than 2900 km) that rises unimpeded through the overlying solid mantle such that it can be preserved in rocks formed at the surface. These records of Earth's magnetic field can be measured, millions or even billions of years later, in the laboratory. Palaeomagnetism is the measurement of the ancient magnetic field preserved in rocks at the surface which, together with independently-obtained age estimates from the rocks, can be used to construct records of how Earth's magnetic field has changed over time. These records provide information about both the core and mantle because they document the thermal coupling between the giant "heat engines" (mantle convection and the geodynamo) within them that convert thermal energy into tectonics and Earth's magnetic field, respectively (Biggin et al., 2012).

There is currently a gap in the record of measurements of the strength of the Earth's magnetic field between 200 and 250 million years ago corresponding to the Triassic Period. This gap exists because there are few large volcanic edifices of this age from which to obtain data. However, some smaller targets of Triassic age do exist and it is vital that we attempt to use them to populate this time period with reliable new measurements of strength of the Earth's magnetic field. We already know that Earth's magnetic field was weak in the Jurassic (145-200 million years), but we do not yet know when this interval of low field strength (referred to as the "Mesozoic Dipole Low"; Prévot et al., 1990) began.

Based on theory, it is hypothesized that the field was stronger in the Triassic because it was already known to have been more stable ("flipping" its polarity less frequently than in the Jurassic). However, measurements made at Liverpool from just rocks dated to just before 250 million years ago suggest that the field was weak then. If new data show that the Mesozoic Dipole Low extended back through the Triassic, our expectation that field strength and stability are linked would be challenged with resulting implications for the whole theory of how Earth's magnetic field is generated.

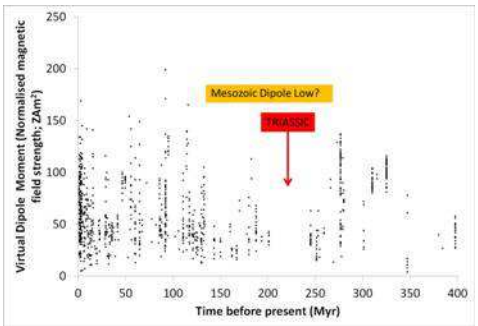
Project Summary:

This project aims to test the hypothesis that Earth's magnetic field was weak throughout the Triassic resulting in a prolonged "Mesozoic Dipole Low" in contrast to what is expected from geodynamo theory. This will be achieved by:

1. Sampling igneous rocks from regions such as central Argentina, NE Italy, and NE USA that are of Triassic age and have been shown to provide reliable palaeomagnetic directions.

2. Performing measurements on these samples in Liverpool to recover the palaeomagnetic field strength recorded in them (Biggin et al., 2011).
3. Collating and statistically analysing the new data together with existing published data from other time periods to assess the validity of the Mesozoic Dipole Low hypothesis.

This project will be best suited to a student with a geophysics or geology degree who enjoys undertaking both field and laboratory work. No prior experience of palaeomagnetism is required as full training will be provided. The student will join the long established and growing Geomagnetism Group at the University of Liverpool and work alongside other researchers (academics, post-docs and PhD students) also interpreting records of magnetic field behaviour in terms of the dynamics and evolution of Earth's deep interior.



Global record of magnetic field strength measurements. This project would populate the Triassic Period where there is a significant data gap and test the hypothesis that the Mesozoic Dipole Low extended through it.

The Dolomites (NE Italy) which also contains igneous rocks that may be sampled for this project.

References

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