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Research Interests: Behavior of the ancient geomagnetic field. Statistical analysis of paleomagnetic data. Applications of paleomagnetic data to geological problems.

This year, the research in my group has focused primarily on improving our knowledge of how the strength of the ancient geomagnetic field has varied in the past. Research highlights from this year are 1) an effort to improve the paleointensity experiment and the interpretation of data thus obtained (Shaar and Tauxe, 2013), and 2) an exploration of the Jurassic paleointensity database, a period of time with exceptionally low field strength (Tauxe et al., 2013).

Improving the technique:

The standard paleointensity experiment requires samples with extremely fine grained magnetic material that does not change while laboratory heating to some 600°C. Paleointensity is one of the most challenging experiments in the field of paleomagnetism because of the highly restrictive requirements for the material. While what constitutes an ideal result (e.g., Fig. 1a) is not controversial, the degree to which data can depart from that ideal most certainly is. For example, should we use data like those in Fig. 1b?. Because of this, there is a great deal of debate on what even the average geomagnetic field strength has been and how it has varied through time. Shaar and Tauxe (2013) presented new analytical tool (the Thellier_GUI) which allows consistent and (we hope) robust interpretation of paleointensity data with an easy to use interface. It is designed to work with the MagIC database format (http://earthref.org/MagIC), intended an online repository of all published paleo and rock magnetic data. This will allow the re-interpretation of existing data according to new understandings of the limitations of the method.

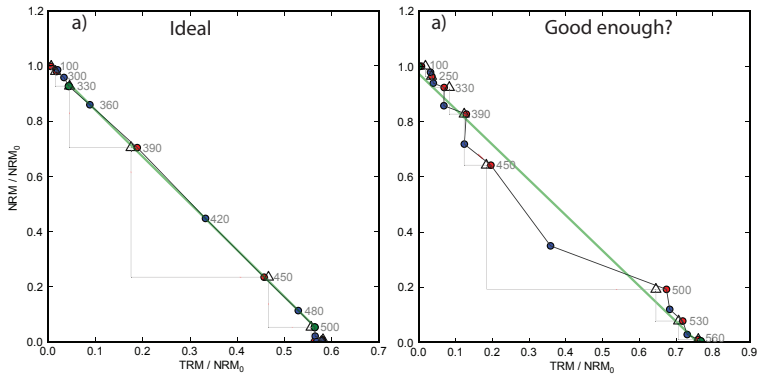

Figure 1: Examples of data from the paleointensity experiment. a) 'Ideal' results with straight-line behavior of the NRM/NRMo versus TRM/NRMo, where 'NRM' is the original magnetization and TRM is a laboratory induced magnetization. b) 'Non-ideal' results. (Figure modified from Shaar and Tauxe, 2013).

Jurassic field:

Despite numerous compilations of data on the strength of the geomagnetic field over time, fundamental properties such as the average strength remain hotly debated. Most data come from the last few hundred thousand years, and the data become increasingly sparse with age. As a

result, there are competing views as to whether there was a period of unusually low geomagnetic field strength in the Jurassic and early Cretaceous, a period known as the "Mesozoic Dipole Low" (MDL). Recently, champions for the existence of the MDL have sought to tie it to changes in whole mantle convection processes. However, there remains much debate in the literature on the related problems of what the long term average value of the field is, and the duration or even existence of the MDL.

Tauxe et al., (2013) presented new results from Jurassic aged submarine basaltic glass recovered from ODP Hole 801C, drilled in the western Pacific Ocean during Leg 185 and at ~167 Ma. Their results combined with a re-analysis of the published database (Figure 2) point to an extended period of time with field values consistently lower than the long term average field strength since 140 Ma. How this relates to geodynamical events remains uncertain and the subject of continued investigations.

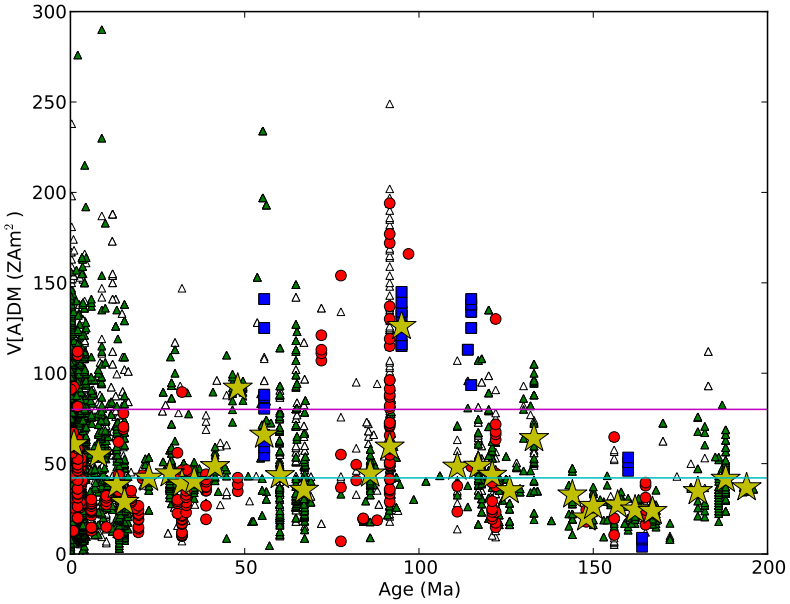

Figure 2: Summary of published data downloaded from the MagIC database. Various symbols are different materials and data quality; V[A]DMs are Virtual [Axial] Dipole Moments. Magenta dashed line is present field and solid cyan line is long term stable value for the last 140 Ma. Data from about 140- 180 Ma are consistently lower than the long term average. (Figure modified from Tauxe et al., 2013).

Relevent Publications:

Shaar, R, Tauxe L. 2013. Thellier GUI: An integrated tool for analyzing paleointensity data from Thellier-type experiments. Geochemistry Geophysics Geosystems. 14:677-692. 10.1002/ggge.20062

Tauxe, L, Gee JS, Steiner MB, Staudigel H. 2013. Paleointensity results from the Jurassic : New constraints from submarine basaltic glasses of ODP Site 801C. Geochemistry, Geophysics, Geosystems. 8 10.1002/2013GC004704