Geophysical Research Abstracts
Vol. 16, EGU2014-4705, 2014
EGU General Assembly 2014

Decadal to millennial scale geomagnetic field variations in the Levantine archaeointensity curve (LAC): methodology and applications

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Recovering the absolute intensity of the geomagnetic field on historical and archaeological timescale (archaeointensity) in a sufficient resolution is a fundamental effort in the paleomagnetic research. However, it is a complicated task hampered by some serious methodological difficulties. First, paleointensity experiments should be carefully designed using sufficient number of specimens, and accurate correction for remanence anisotropy, cooling rate effects, and non-linear TRM (NLT). Second, the basic assumption of the paleointensity method - that the natural remanence magnetization (NRM) is a stable thermoremanent magnetization (TRM) carried by single domain (SD) like particles - is hard to test using non-destructive methods. Third, the interpretation of the experimental results is non-unique leading to uncertainty in the final paleointensity calculation. These experimental difficulties compound with dating problems, which are not always easy to overcome.

Here, we address each of the issues pointed above in order to construct a high-resolution archaeointensity curve of the Levant using a comprehensive dataset consisting of more than 2000 specimens from over 400 samples. The experimental difficulties are overcome by applying the same treatments to all specimens: Thellier-type IZZI protocol with pTRM checks every second step, and additional anisotropy, cooling rate, and NLT experiments. To ensure consistency, comparability, and objectivity of the interpretations we apply an automatic data analysis technique using a recently published open code computer program (PmagPy Thellier-GUI). We use strict selection criteria for the specimens/samples level and for the correction to screen out any unreliable data. For transparency, we make all the raw data, which include over 80,000 individual measurements, available in the MagIC database for the use of other researchers. We treat the dating problems by assigning a six-level quality scale (form controversial to excellent) according to the dating method employed (archaeological, historical, radiocarbon). In addition, we cross check results from multiple archaeological sites using different source materials dated using different methodologies.

The results of this effort are summarized in a regional compilation namely Levantine Archaeomagnetic Curve – LAC. The initial version of the LAC includes recently published data from ancient copper production sites, and new data from two important biblical archaeological mounds in Israel – Tel Megiddo (“Armageddon”) and Tel Hazor. In this talk we review our working methodologies, report the current status of the LAC, and discuss its implications on our understanding of geomagnetic secular variations.