

Full vector archaeomagnetic dating of a medieval limekiln at Pinilla del Valle (Madrid, Spain)

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Abstract: Despite its evident importance in archaeology, the potential of limekilns for archaeomagnetism is surprisingly poor explored. Here we report a detailed archaeomagnetic study carried out at a limekiln from Pinilla del Valle archaeological site (Madrid, Spain). Documental sources from a nearby monastery indicate its use during the mediaeval times but its last use remains unknown. Taking into account that this type of structures reaches high heating temperatures (> 900 °C) and its good preservation state, we carried out a detailed directional and absolute intensity investigation for dating purpose.

24 oriented cores were collected from different parts of the limekiln mainly comprising baked clays and limestones. The NRM of 35 specimens was stepwise demagnetized by alternating fields (peak fields of 100 mT) or thermal demagnetization (up to 680 °C). Rock-magnetic analyses comprised the measurement of IRM acquisition curves, hysteresis loops (± 1 T), backfield curves and thermomagnetic curves up to 700 °C in air. Three-axial thermal demagnetization of the IRM was also performed on representative samples to better constrain the magnetic carriers. Archaeomagnetic and rock-magnetic analyses were carried out at the laboratory of Palaeomagnetism of Burgos University (Spain). Additionally, 22 specimens were subjected to palaeointensity (PI) experiments with the Thellier and Thellier (1959) method as modified by Coe (1967) in the paleomagnetic laboratory of UNAM, Campus Morelia (Mexico). p-TRM checks and cooling rate effect upon TRM intensity acquisition were investigated in all the samples. Most samples are characterized by pseudo-single domain (PSD) Ti-magnetite to almost pure magnetite as main carrier with evidences also of haematite and goethite. The mean archaeomagnetic direction obtained was successfully determined on 29 specimens (Dec: 1.4°; Inc: 44.8°; k : 175.8; α_{95} : 2.0°). Satisfactory PI determinations were obtained from 16 specimens, although nearly half

of them were rejected because of concavity in their Arai diagrams, weak remanences or mineralogical alterations during the experiment. With the exception of two anomalously high PI values from the same sample (79.5 ± 4.2 and $74.5 \pm 2.5 \mu\text{T}$, respectively), most values are comprised between 34.4 ± 0.5 and $54.1 \pm 4.1 \mu\text{T}$. Since we had no criteria to reject that high values, they were included to calculate the mean PI ($54.6 \pm 3.9 \mu\text{T}$), which is in good agreement with that reported by Gómez-Paccard *et al.* (2008) in Iberia for coetaneous materials. Dating was performed combining both directional and archaeointensity data with the MATLAB tool of Pavón Carrasco *et al.* (2011) using a CALSK10.1b model. The most likely age of the last use determined for the limekiln was 1297 – 1390 AD at the 95 % of confidence level, which agree very well with two radiocarbon dates available to us after the archaeomagnetic study. These results shed new light on the archaeomagnetic dating of this type of structures as well as contribute with new full vector data of the Earth's magnetic field at Iberia.

Keywords: archaeomagnetism, palaeointensity, rock magnetism, limekiln.

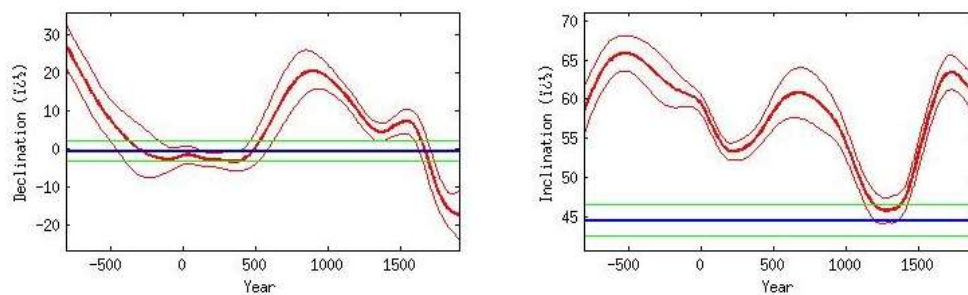


Figure 1: Comparison of the mean direction with the MATLAB tool of Pavón Carrasco *et al.* (2011) showing different age solutions. Left (Declination), Right (Inclination).

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