Constraining the evolution of the Earth's magnetic field from archeological artefacts: new archeointensity results obtained in Bukhara (Uzbekistan, Central Asia)

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Abstract

The Earth's magnetic field is acting as a giant shield, protecting the atmosphere from the solar wind. It is mainly dipolar ($\sim$ 90%) and is generated within the Earth's liquid outer core by fluid motions. It varies in space and time, and the reconstruction of its variations gives insights on core flow dynamics. Since the middle of the 19th century, instrumental (or direct) measurements of the geomagnetic field, both in intensity and direction, are available, which enables an accurate determination of its space and time variations. Before that time (between 1600 and 1840 AD), only direct directional measurements were possible. The construction of global geomagnetic field models thus requires either a specific treatment of the axial dipole field component or the use of indirect field intensity measurements. Paleo/archeomagnetism provides such information. Any material containing magnetic minerals, heated above a certain temperature (mainly the Curie temperature of magnetite), acquires a thermoremanent magnetization, which constitutes an archive of the geomagnetic field at the place and time of the cooling succeeding the heating. This is the main principle of archeomagnetism, focused on the magnetization of archeological artefacts dated using archeological constraints. In this study, we propose to calibrate the global geomagnetic field models during the historical period from the determination of an accurate archeointensity variation curve in Central Asia. We analyze baked brick fragments sampled in Bukhara (Uzbekistan), dated between the end of the 16tth and the beginning of the 19th century. This city is particularly interesting due to the preservation of old buildings constructed using baked clay bricks, which are precisely dated thanks to documentary sources. We obtain a series of archeointensity results, allowing the recovery of the geomagnetic field intensity variations in Central Asia during the historical period. We compare that evolution with the one predicted by a number of global geomagnetic field models. In good agreement with archeointensity data previously obtained in Western Europe, the new Central Asian results show a range of axial dipole variations between 1590 and 1840 wider than previously proposed.

Keywords— magnetism