The Earth's magnetic field in Italy during the Neolithic period: New data from the Early Neolithic site of Portonovo (Marche, Italy)

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ABSTRACT

We present new, full geomagnetic field vector results from three Neolithic ovens discovered at the archaeological site of Portonovo (Marche, Italy). The discovered structures are a rare example of very well preserved underground ovens from the Early Neolithic period. Standard thermal demagnetization procedures were used to isolate the direction of the Characteristic Remanent Magnetization acquired by the baked clay during the ovens' last firing. The corresponding archaeointensities were determined by the multi-specimen procedure (MSP-DSC) and show a clear intensity low during the Neolithic period. Both directional and intensity results are of high quality, offering the first contribution of full geomagnetic field vector data for this period in Italy. The new data are compared with other contemporaneous data from Europe and with global geomagnetic field models. Independent archaeomagnetic dating of the three ovens was also performed by means of the SCHA.DIF.14k model. The obtained results are in excellent agreement with available radiocarbon dates and confirm that all ovens belong to the Neolithic. These new data importantly enrich our knowledge of the geomagnetic field during the Neolithic period that is poorly documented by data, not only in Italy but also in the whole of Europe and show that archaeomagnetic dating can provide precise results even for prehistoric periods.

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1. Introduction

Archaeomagnetic data from ancient baked clay archaeological structures is a precious source of information about the past variations of the Earth's magnetic field. Thanks to archaeomagnetic records from well dated archaeological artefacts, it is possible to model the variations of the geomagnetic field in the past and better understand its past behavior. Up to now, local Secular Variation (SV) curves have been established for several countries, mainly in Europe, and different geomagnetic field models have been pro-

posed based on the available archaeomagnetic data at regional and global level. However, most of the proposed SV curves cover only the last three millennia, while the geomagnetic field variations in earlier times are still poorly described.

In Italy, Tema et al. (2006) have published a preliminary SV curve based on 65 directional results ranging in time from 1300 BC to 1700 AD. More recently, Tema (2011) compiled an updated dataset of Italian archaeomagnetic data, presenting 73 directional and 23 intensity determinations. From these data, only six directional results come from material older than 1000 BC. This significant lack of data from periods previous to the first millennium BC can be attributed to several factors, including the very limited number of well preserved still *in situ* baked clay structures (often due to the use of poor building materials in prehistoric times) and the difficulty of precise independent dating of such old and badly preserved structures.

In this study, we present new, full geomagnetic field archaeomagnetic results from three Neolithic ovens excavated at the archaeological site of Portonovo (Marche, Italy). The discovered ovens

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Fig. 1. a) Map of Italy with the location of the Portonovo archaeological site; b–c) General view of the excavated ovens; d) Photo of the oven 17; e) General view of the ovens 14, 16 and 17, sampled for archaeomagnetic analysis.

are a rare example of very well preserved underground ovens and have the advantage of being from a well dated archaeological context with three radiocarbon dates. The new results are the first full geomagnetic field vector data available for this period in Italy and importantly enrich our knowledge about the geomagnetic field during the Neolithic period.

2. Archaeological site and sampling

The archaeological site of Portonovo Fosso Fontanaccia (43.56 °N, 13.57 °E), is situated on the Conero promontory, along the Adriatic coast of Marche (Ancona, Italy). It is located on a south-facing slope, along the right bank of the river Fontanaccia. It was first identified in the 1990s; since then, several excavation campaigns brought into light a total of 22 underground ovens, at different heights along the hillside (Fig. 1). The ovens were built by digging small cavities into the colluvial layer. Almost all of them overlook large depressions in front of their openings. Six of the ovens were found totally intact (Conati Barbaro, 2013). De-

spite their different states of preservation, all ovens share similar features and dimensions: the base is circular, flat, with a slight central depression, made of yellow-reddish smoothed clay lining, and measuring from 1.8 to 2.0 m in diameter; the vaults are very low, so that the maximum height in the six ovens found intact does not exceed 50 cm; the mouths are between 60 and 80 cm in width. The inner surfaces were partially coated with clay and subsequently consolidated by the firing.

Information about the maximum firing temperatures reached during the use of the Portonovo ovens was provided by X-ray powder diffraction analysis (PXRD), based on the transformation of CaO-rich sediments, structurally modified by exposure to low or high temperatures clay (Muntoni and Ruggiero, 2013). PXRD analysis performed on 12 samples from the hardened baked clay of the ovens inner walls revealed the predominance of calcite, a variable amount of quartz and a small quantity of feldspars in all samples. It also revealed the absence of Ca-silicates newly formed by exposure to high temperatures, such as diopsidic pyroxenes or gehlenite, typical of CaO-rich clay (Muntoni and Ruggiero, 2013).