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SPECIFIC MAGNETIC MINERALOGY OF FIRED CLAY ARCHAEOLOGICAL ARTEFACTS. ARCHAEOMAGNETIC DATING

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ABSTRACT. Archaeomagnetism is an interdisciplinary branch of geophysics. It is the only approach that examines the variation of geomagnetic field elements in the past. The physical basis of the method is the capability of the fired clay to preserve information about the direction and intensity of the Earth's magnetic field in the place and time of its last burning. The information obtained from archaeomagnetic studies is very valuable for the geophysics in connection to the geomagnetic field models (Korte, Constable, 2005), for the study of the geomagnetic field morphology and peculiarities of the secular variations for understanding the dynamics of the Earth's core.

The specific magnetic mineralogy of fired clay is considered, as known from our (Jordanova et al., 1997; Jordanova et al., 2001; Jordanova et al., 2003) and foreign studies (Dunlop, Ozdemir, 1997). Usually the main magnetic carriers are magnetite or titanomagnetites, very rarely hematite. The new moment in this presentation concerning the magnetic properties of fired clay is a recently-diagnosed magnetic phase (HCSLT), widely distributed in the archaeological artifacts in Europe (McIntosh et al., 2007) (Table 1).

The specific properties of this new phase are as follows: very high coercivity (remanence coercivity >600 mT), low unblocking temperatures (~200^{o}C) and high degree of thermal stability – this last property distinguishing it from goethite. Preliminary results of Mössbauer and X-ray diffraction spectroscopy suggest that the phase is more likely to be a substituted hematite, rather than Fe-cristobalite or a variant of e-Fe_2O_3. It appears that the low temperature remanence deblocking could be easily wrongly interpreted if the thermal stability is not studied. Other interesting results of magnetic mineralogy study are presented taking into account the oxidising-reducing conditions at which the burning in the antiquity has taken place (Herries, Kovacheva, 2007). The magnetic mineralogy of differently colored samples (with different provenance) can distinguish them as being burnt at oxidizing or reduced atmosphere thus pointing to the possible usage of each furnace. The comparison is made with the magnetic properties of the pottery discovered at the site proving the similarities between them and differently coloured samples taken from different archaeological structures from the same site.

Table 1
Studied archaeological features[*]

Country (code)	Features (samples) studied	Feature exhibiting HCSLT phase	Material
Belgium (B)	2 (6)	0	BC
Bulgaria (BG)	13 (46)	4	BC; BR
Karelia (CAR)	1 (3)	1	BR
England (EN)	3 (18)	0	BC
Estonia (EST)	1 (4)	1	BR
Finland (FI)	2 (12)	2	BC; BR
Germany (G)	4 (9)	1	BC
Greece (GR)	2 (5)	1	BC
Italy (I)	1 (3)	0	BC
Spain (S)	11 (42)	4	BC; BR
Switzerland (SW)	2 (5)	2	BC

[*]Material refers to samples type (baked clay, BC, or brick, BR)

The longstanding archaeomagnetic investigations in our country have lead to the construction of reference curves, through which archaeological structures can be dated (Kovacheva et al., 1998; Jordanova, Kovacheva, 1998; Lanos et al., 1999; Kovacheva et al., 2004; Jordanova et al., 2004; Kostadinova, Kovacheva, 2008; Herries et al., 2008). The

Bulgarian reference curves cover almost entirely the last 8000 years (Kovacheva, 1997). This is the longest archaeomagnetic data set in the world and it is always under refinement, filling up the gaps and checking the oldest determinations. The most important feature of our reference curves is that they describe the behaviour of the two directional values (declination and inclination) and the intensity of the past geomagnetic field. The principle of dating is to find the consistency between the magnetic characteristics obtained by the collection to be dated with the established reference curves for the territory. The more elements are used for that the better the dating. The accuracy of dating depends at first place on the experimental errors of the obtained geomagnetic elements from the examined collection and by the precision bands of the reference curves for the period in question. In our practice we use the three elements and in this way the obtained dates are well constrained. Examples for the application of this method as a dating tool are given in the above cited papers. The obtained dates correspond to the state of knowledge of the geomagnetic filed reference curves.

The obvious benefit for very different sciences as geomagnetism and archaeology underlines the high value of the interdisciplinary studies.

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