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Archeointensity trend between 7th and 10th century in Japan

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Earth's magnetic field is known to show complicated, and irregular variations in time. It is important to investigate a paleomagnetic secular variation to deepen our understanding of the geodynamo. An approach based on the paleomagnetism is a powerful tool to obtain the information of geomagnetic variation before the 16th century when modern observations started. Especially, a technique based on the archeomagnetism is expected to provide high quality information. There has been much progress in archeomagnetism in Europe recently: for example, Donadini et al. (2009) complied the published direction and intensity data for the past 2,000 years, and Korte et al. (2009) proposed a global field model.

In Japan, archeomagnetic directions have been studied activery since 1960's, and the resultant 'master curve' has been utilized in scientific studies in cultural properties (e.g. Hirooka et al., 2006). In contrast, archeointensity data have been published only in the four papers (Nagata et al., 1963; Sasajima and Maenaka, 1966; Sakai and Hirooka, 1986; Yoshihara et al., 2003). Considering a set of statistical selection criteria, they provide only 43 high quality data which were also obtained by the Thellier method without a pTRM check. It is thus necessary to obtain new data by modern experimental techniques with modern selection criteria. This study presents new archeointensity data between 7th and 10th century which are obtained from backed-clay samples taken from the Oku kilns in Okayama prefecture and the Sue-Mura kilns in Osaka prefecture. The experimental techniques used in this study are the IZZI-Thellier method (Tauxe and Staudigel, 2004) and the Tsunakawa-Shaw method (Tsunakawa and Shaw, 1994; Yamamoto et al., 2003).

Various rock magnetic experiments revealed that (1) the samples are generally resistant to laboratory heating, (2) main magnetic carriers are non-interactiving SD-like Ti-poor titanomagnetite, and (3) blocking temperatures distributed widely between 100 and 600 ^{o}C. It is considered that the IZZI-Thellier method and the Tsunakawa-Shaw method are applicable to the samples. We obtained 41 successful results by the IZZI-Thellier method and 23 successful ones by the Tsunakawa-Shaw method. We screened these data by selection criteria as follows: (1) at least three successful results are obtained from a site, (2) a standerd deviation of these results is less than 20 %. The screening resulted in seven reliable site-mean archeointensities: (1) 48.0 +/- 9.6 uT for KM-11 kiln (A.D. 630 +/- 10), (2) 45.4 +/- 2.0 uT for TG-38-III kiln (A.D. 720 +/- 10), (3) 55.3 +/- 8.4 uT for KM-102 kiln (A.D. 750 +/- 10), (4) 50.0 +/- 4.3 uT for KM-38-II kiln (A.D. 770 +/- 10), (5) 55.9 +/- 8.4 uT for Sayama Shin-Ike 1st kiln (A.D. 775 +/- 25), (6) 48.9 +/- 7.4 uT for Sayama Higashiyama kiln (A.D. 775 +/- 25), (7) 49.4 +/- 4.5 uT for Sayama Higashiyama-Oku kiln (A.D. 900 +/- 50).

The former published high-quality archeointensity data in Japan indicated a decreasing trend approximatery from 70 uT at A.D. 600 to 50 uT at A.D. 900. In contrast, the presently obtained data rather suggested a constant trend about 50 uT for the same period. This constant trend appeared to be consistent with the recently reported archeointensity data from Korea and China by the IZZI-Thellier method (Hong et al., 2013; Cai et al., 2014). New data also appeared to be consistent with the world VADM data extracted from the GEOMAGIA50 database (Donadini et al., 2006; Korhonen et al., 2008), showing a decreasing trend approximately from $11*10^{22}$ Am^2 at A.D. 0 to $8*10^{22}$ Am^2 at present.

Keywords: archeointensity, secular variation, climbing kiln of Sue ware, high-quality data, IZZI-Thellier method, Tsunakawa-Shaw method