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Variation of the geomagnetic intensity in Japan over the last 2000 years

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We constructed a reference curve of the paleointensity variation in Japan for the past 2000 years using new data obtained in the present study from the basaltic rocks of Izu-Oshima and Mt. Fuji and archaeointensity data previously reported by Sakai and Hirooka (1986). Samples used for the paleointensity determinations in the present study were collected from nine lava flow units included in the Younger Oshima group of Izu-Oshima which erupted between ca. AD 500 and AD 1950, and Aokigahara lava flow derived from Mt. Fuji in AD 864. Almost all of the samples are stable to thermal demagnetization and have single-component remanent magnetizations, which are unblocked at the Curie temperature of magnetite. Hysteresis measurements and thremomagnetic analyses reveal that the main carrier of the magnetizations in the samples is magnetite or titanomagnetite, whose grain size is small enough to be in the PSD state. The degree of chemical alterations of the magnetic properties by laboratory heating was examined by hysteresis measurements after stepwise heating. The Thelliers' method and the double heating technique (DHT) of the Shaw method (Tsunakawa and Shaw, 1994) were used for paleointensity determinations. For data analyses of the plaeointensity experiments, the results of hysteresis measurements after stepwise heating were used as constraints on the temperature range selection. The paleointensity determinations were successful for 3 to 11 samples for each unit. Similarity of the paleointensity values obtained by the Thelliers' method and the DHT Shaw method suggests the reliability of these results. The unit-mean paleointensity values of 10 units are ranging from 39.4 to 68.5 micro T. These unit-mean values are consistent with the archaeointensity data obtained from western Japan by Sakai and Hirooka (1986), allowing us to construct the reliable reference curve of the paleointensity variation by combining these two data sets. The reference curve shows general trend of decreasing intensity with time, while there are two peaks of large intensity around AD 500and AD 1300. This fluctuation with the period of about 800 years can be observed in some paleointensity variation curves in Europe, whose intensity peaks are out of phase with those of Japan. Therefore, the main part of the fluctuation seems to be attributable to a drifting non-dipole field component. From the time lag of the most significant intensity peak between Japan and Europe, a westward drift rate of about 0.2 degrees per year was evaluated, which is almost the same value as a lot of previous reports. Using the ratio of the Gauss coefficients for the dipole component to those for the non-dipole components derived from the global geomagnetic field models for the past 2000 years produced by Hongre et al. (1998) and Constable et al. (2000), we attempted to separate the variation of the dipole component from the reference curve. Although these models cannot explain the intensity peak around AD 500 observed in Japan, the absolute values and the rate of decrease of the dipole moment for the past 2000 years calculated from the reference curve are well consistent with those obtained from the worldwide compilation of paleointensity data reported by McElhinny and Senanayake (1982).