Palaeointensities from Pliocene lava sequences in Iceland: Emphasis on the problem of Arai plot with two linear segments

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Palaeointensity experiments were carried out to a sample collection from two sections of basalt lava flow sequences of Pliocene age in north central Iceland (Chron C2An) to further refine the knowledge of the behaviour of the palaeomagnetic field. Selection of samples was mainly based on their stability of remanence to thermal demagnetization as well as good reversibility in variations of magnetic susceptibility and saturation magnetization with temperature, which would indicate the presence of magnetite as a product of deuteric oxidation of titanomagnetite. Among 167 lava flows from two sections, 44 flows were selected for the Konigsberger-Thellier-Thellier experiment in vacuum.

In spite of careful pre-selection of samples, an Arai plot with two linear segments, or a concave-up appearance, was often encountered during the experiments. This non-ideal behaviour was probably caused by an irreversible change in the domain state of the magnetic grains of the pseudo-single-domain range. This is assumed because an ideal linear plot was obtained in the second run of the palaeointensity experiment in which a laboratory thermoremanence acquired after the final step of the first run was used as a natural remanence. This experiment was conducted on six selected samples, and no clear difference between the magnetic grains of the experimented and pristine sister samples was found by scanning electron microscope and hysteresis measurements, i.e. no occurrence of noticeable chemical/mineralogical alteration, suggesting that no change in the grain size distribution had occurred.

Hence, the two-segment Arai plot was not caused by the reversible multidomain/pseudo-single-domain effect in which the curvature of the Arai plot is dependent on the grain size. Considering that the irreversible change in domain state must have affected data points at not only high temperatures but also low temperatures, $f_v >= 0.5$ was adopted as one of the acceptance criteria where f_v is a vectorially defined fraction of the linear segment. A measure of curvature k' was also used to check the linearity of the selected linear segment. It was avoided, however, to reject the result out of hand by the large curvature k' of the entire data points because it might still include a linear segment with a large fraction.

Combining with the results of Shaw's experiments, 52 palaeointensities were obtained out of 192 specimens, or 11 flow means were obtained out of the 44 lava flows. Most of the palaeointensities were from the upper part of the lava section (Chron C2An.1n) and ranged between 30 microT and 66 microT. Including two results from the bottom part of the lava section, the mean virtual dipole moment for 2.5–3.5 Ma is 6.3 +/- 1.4 10^{22} Am^2 (N=11), which is about 19% smaller than the present-day dipole moment.

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