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Towards the development of the microwave LTD-DHT Shaw method

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Since the 1970s, the Thellier-Thellier and the Shaw types of paleointensity methods have been most commonly used. Both methods can have very different characteristics when applied to volcanic rocks, and the group at Tokyo Institute of Technology, Japan, has developed a significantly improved version of the original Shaw method, i.e. the LTD-DHT Shaw method. This method has been successfully applied to several historical lava flows in Hawaii and Japan, but the present protocol uses conventional heating by electric ovens for laboratory acquisition of thermal remanent magnetization (TRM). For further enhancing the reliability, we have tried to incorporate the microwave excitation technique into the LDT-DHT Shaw method. Preliminary experiments were conducted as follows, using the 14 GHz microwave demagnetizing-remagnetizing system in the Geomagnetism Laboratory, University of Liverpool.

(1) Microwave TRM (TmRM, 15.0 micro-T) was produced in a 5 mm diameter mini core of basalt. Microwave power applied was 80W and the application time was set to 5 seconds. It was confirmed that the specimen was fully magnetized and this TmRM was recognized as simulated natural remanent magnetization (NRM).

(2) The specimen was subjected to low temperature demagnetization (LTD). Its memory was progressively demagnetized by alternating field (AF) up to 150 mT, and measured at each step using a high temperature SQUID magnetometer [NRM].

(3) Anhysteretic remanent magnetization (ARM) was given to the specimen by a 50.0 micro-T biasing field with a smoothly decreasing AF field of 150 mT. LTD was conducted on the remanence and its memory was measured with the progressive AF demagnetization [ARM0].

(4) Microwaves were applied to the specimen for acquisition of the first TmRM (25.0 micro-T). Power applied was 80W and the application time was set to 7 seconds. The same procedures as in steps (1), (2) and (3) were performed for the TmRM [TRM1] and ARM [ARM1].

(5) Microwaves were again applied for the second TmRM (25.0 micro-T). Power applied was 80W and the application time was set to 9 or 10 seconds. The same procedures as in steps (1), (2) and (3) were repeated for the TmRM [TRM2] and ARM [ARM2].

These procedures are exactly the same as those used in the current LTD-DHT Shaw method except for the microwave applications. Positive results have been obtained from four specimens (two were without the LTD treatment): they give an average and a standard deviation of 15.2 and 0.6 micro-T, respectively. Measurements on samples with laboratory TRM (conventional heating by electric ovens) as simulated NRM are in progress and these will also be reported.