Development of the microwave LTD-DHT Shaw method

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Since the 1970s, Thellier-Thellier and Shaw methods have been most commonly used to determine absolute paleointensity. The principles behind these methods are very different and it is important to develop them both. The group at the Tokyo Institute of Technology, Japan, have developed a significantly improved version of the original Shaw method, called the LTD-DHT Shaw method. This method has been successfully applied to several historical lava flows in Hawaii and Japan.

The present protocol, however, uses conventional heating by electric ovens for laboratory acquisition of thermal remanent magnetization (TRM), which can cause excessive laboratory alteration that cannot be corrected for. To further enhance reliability, we have replaced the TRM step with a microwave excitation step. Three types of experiment have been performed using the 14 GHz microwave demagnetizing-remagnetizing system in the Geomagnetism Laboratory, University of Liverpool.

(1) Microwave LTD-DHT Shaw method on samples with laboratory microwave TRM (TmRM)

TmRM (15.0 micro-T) is imparted in 5 mm diameter mini cores of basalt. The applied microwave power is 80 W and the application time is set to 5 seconds. This TmRM is a simulated natural remanent magnetization (NRM). The mini cores are then subjected to the microwave LTD-DHT Shaw experiment.

(2) Microwave LTD-DHT Shaw method on samples with laboratory TRM.

TRM (25.0 micro-T) is imparted in one-inch cores of basalt. The cores are heated in an electric oven to a maximum temperature of 610 C. Hold time at the maximum temperature is 30 minutes and the entire heating-cooling cycle takes about two hours. This TRM is a simulated natural remanent magnetization (NRM). Mini cores are cut from the one-inch cores, and they are subjected to the microwave LTD-DHT Shaw experiment.

(3) Microwave LTD-DHT Shaw method on samples from historical lava flows.

Mini cores are cut from the one-inch cores collceted from historical lava flows. They are then subjected to the microwave LTD-DHT Shaw experiment.

So far, we have performed four type (1) experiments, all of which were successful, and give an average of 15.2+/-0.6 micro-T. From the type (2) experiments four out of seven were successful and give an average of 24.5+/-2.1 micro-T. These values are fairly consistent with the imparted laboratory field. Experiments (2) and (3) are still in progress and new results from these experiments will also be reported.