Examination of paleointensity determinations on andesitic lava flows: A case study of the Sakurajima 1914 and 1946 lavas

Yuhji Yamamoto[1]; Hiroyuki Hoshi[2]

[1] Geological Survey of Japan, AIST; [2] Dept Earth Sci., Aichi Univ. Educ.

Correct determination of absolute paleointensities is essential to investigate a past environment of geomagnetic field. There are two types of methods to obtain paleointensities: Thellier-type and Shaw-type methods. Many paleomagnetists have so far regarded the former method as reliable. However, it has been becoming clear that it is sometimes not so robust for basaltic lavas resulting in systematic high paleointensities (e.g. Calvo et al., 2003). Even for such basaltic lavas, the double heating technique of the Shaw method combined with low temperature demagnetization (LTD-DHT Shaw method; Tsunakawa et al., 1997; Yamamoto et al., 2003), a lately developed paleointensity technique in Japan, can yield reliable answers (e.g. Yamamoto et al., 2003; Mochizuki et al., 2004; Oishi et al., 2005).

In Japanese archipelago, there distribute not only basaltic lavas but also andesitic lavas. Andesites are typical island-arc volcanic rocks and their volume occupy about 70 percent of Quaternary volcanic rocks in Japan (Aramaki and Ui, 1978). Therefore, they are important candidates of absolute paleointensity determination in Japan. It is need to examine reliability of absolute paleointensity determination on historic andesite lavas. For a case study, we sampled Taisho and Showa lavas in Sakurajima volcano in Kyushu, Japan, which erupted in 1914 and 1946 respectively. Oriented paleomagnetic cores were collected from two sites of the Taisho (TS01 and TS02) and one site of the Showa (SW01). Miki (1999) already obtained correct Coe-Thellier (Coe, 1967; Coe et al., 1978) paleointensity results from these lavas, but his experiment was on four and eight specimens for the Taisho and Showa, respectively. There is a room for systematic investigation.

Weak field thermomagnetic measurements reveal that main magnetic carriers of present samples are titanomagnetites with Curie temperatures of about 300-550 C, and that high temperature oxidation is progressed in order of SW01, TS01 and TS02. Intensities of natural remanent magnetization (NRM) also increase in the same order. Hysteresis parameters for about 250 chip samples result in ranges between 1.7 and 8.3 for Brc/Bc and 0.04 and 0.37 for Mr/Ms, suggesting a relatively large contribution of multi domain (MD) particles. Their distributions in the Day-plot (Day et al., 1977; Dunlop, 2002) move toward a region of single domain (SD) also in the order of SW01, TS01 and TS02. All these results indicate that present samples were formed from titanomagnetites of same origin with different degrees of high temperature oxidation.

We have performed the LTD-DHT Shaw and the Coe-Thellier experiments on 72 and 27 specimens, respectively. The latter experiment is still going on. If results are normalized by expected field intensity calculated from IGRF-9 (Macmillan et al., 2003), their averages and standard deviations (1 sigma) are as follows.

[TS01] LTD-DHT Shaw: 1.03+/-0.11 (N=21), Coe-Thellier: 1.07+/-0.09 (N= 6)
[TS02] LTD-DHT Shaw: 0.90+/-0.06 (N=25), Coe-Thellier: 1.14+/-0.06 (N=14)
[SW01] LTD-DHT Shaw: 1.06+/-0.05 (N=18), Coe-Thellier: 1.10+/-0.03 (N= 6)

Considering uncertainties of 2 sigma (95 percent), it can be said that the LTD-DHT Shaw method gave correct answers for all sites while the Coe-Thellier method recovered expected field intensity only from the site of TS01. Miki (1999) reported that one result of Coe-Thellier experiment on the Taisho lava was improved when 10 mT alternating field demagnetization was performed for each measurement step. The present undesirable results of the Coe-Thellier experiment on TS02 and SW01 specimens might be originated from presence of MD particles.