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Validity and invalidity of the ARM correction technique in paleointensity determinations

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The ARM correction for the laboratory heating in paleointensity determinations has been controversial with respect to the experimental results. At present, the minimum consensus seems to be that the ARM correction is not always applicable to volcanic rocks. Although the Thellier method is thought to be most reliable, the validity of the ARM correction is emphasized from some experimental results by combining the double heating technique and the low-temperature demagnetization (Tsunakawa and Shaw, 1994; Yamamoto et al., submitted). These apparent confusing is caused mainly by the lack of theoretical backgrounds of ARM acquisition. We have analytically formulated the ARM susceptibility more exactly than in the previous studies. Therefore the ARM theory is comparable with the classical single-domain TRM theory (Neel, 1949). Though magnetic interactions seem to be taken into both of the ARM and TRM theories, we could examine the ARM correction technique in ideal cases.

We calculate TRM/ARM ratios for single-domain assemblages with Curie temperatures of Tc= 473K (200C) ~ 853K (580C). It is seen that TRM/ARM ranges from 0.86 to 1.45 against blocking temperatures (Tb) of 0~580C. The lowest TRM/ARM ratio is variable from 0.86 (Tc= 580C) to 1.14 (Tc= 200C). If Tb[C] is between Tc[C]/2 and Tc[C], the change in TRM/ARM is less than +/-10%. Therefore the theoretical TRM/ARM ratio is not so sensitive to the blocking temperature. In the laboratory heating, high temperature oxidation changes the Tc and Tb from relatively lower temperatures to higher ones. However in the above result suggests that the ARM correction is valid for such alterations due to laboratory heatings.

This insensitivity seems not to be cosistent with the experimental results by Bailey and Dunlop (1977), in which TRM/ARM ratios are strongly dependent on blocking temperatures. However, since the magnetic interaction has been suggested to decline ARM intensities from the synthetic samples (Sugiura, 1979) and also from the natural samples (Cisowski, 1981), TRM/ARM ratios may be larger when the interaction is strong.

The theoretical TRM/ARM ratio, which is roughly 1, is compared with the experimental TRM/ARM ratios of various igneous rocks. TRMs and ARMs were given in the known dc fields of 20, 50, 88 or 100 micro-T and their part for coercivities higher than 50 mT were extracted. TRMs and ARMs were normalized to those in 50 micro-T assuming the linearity law. The rock types of the samples consist of basalt, andesite, dacite and granite, which were used in the paleomagnetic experiments (Tsunakawa and Shaw,1994; unpublished data). The major phases of magnetic carriers are titanomagnetites with Tc= 200 ~ 580C. It is recognizable that the measured TRMs are generally not less than the measured ARMs. Some samples show TRM/ARM~1 for wide range of intensities. These suggest that the present ARM theory without magnetic interactions gives a lower limit of TRM/ARM ratios, that is, TRM/ARM~1.

We will further discuss the effects of random magnetic interactions and TCRM acquisitions for single-domain assemblages.