Application of the Tsunakawa-Shaw method on “aged” thermoremanent magnetizations in laboratory

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Santos and Tauxe (2019) examined the behavior of natural basaltic and trachytic samples during absolute paleointensity (API) experiments on both the original and laboratory-acquired thermoremanent magnetizations (TRMs). They separated the samples into “straight” (single-domain-like) and “curved” (multidomain-like) groups based on the API plots obtained from the original TRMs. When they gave a “fresh” laboratory TRMs to the samples in a 70 uT field and conducted an IZZI-Thellier (Yu et al., 2004) API experiments on the samples, the straight-group-samples recovered the laboratory field with high precision (70.5+/-1.5 uT, N=12) while the curved-group-samples resulted in much more scattered results (71.9+/-5.2 uT, N=12). Because the API plots on the fresh laboratory TRMs were also classified into “straight” and “curved”, the sample sets were finally categorized into four types of “straight-straight” (SS), “straight-curved” (SC), “curved-straight” (CS), and “curved-curved” (CC) (original TRM behavior –laboratory TRM behavior).

Sister specimens from each sample of Santos and Tauxe (2019), which were given “fresh” laboratory TRMs in a 70 uT field, were further aged in laboratory for two years also in a 70 uT field but in perpendicular direction. Tauxe et al. (2019 AGU Fall Meeting) reported the API results of the IZZI-Thellier experiments on the “aged” specimens: 70.6+/-4.8 uT for the SS type specimens (k'=0.031+/-0.106; N=6); 71.4+/-5.1 uT (k'=0.191+/-0.184; N=6) for the CC type specimens (N=6). It is noted that k' is the curvature statistic defined in Paterson et al. (2014), which is the value of curvature k (Paterson, 2011) for the measurements actually used in the API calculation.

In the present study, we have applied the Tsunakawa-Shaw (TS) method (Tsunakawa and Shaw, 1994; Yamamoto et al., 2003) to the “aged” specimens of the four types. We adopt usual selection criteria (e.g. Yamamoto et al., 2010). Measurement results are analyzed by a python code specially developed to analyze a series of remanence data obtained by the TS method. The analytical procedure is as follows: (1) calculate API statistics for all possible coercivity intervals; (2) discard the statistics not satisfying the selection criteria; (3) sort the statistics by a value of dAPI (relative difference from the expected API) and select the best 10 statistics; (4) sort the statistics by a fraction of NRM (frac_n) and select the best one.

The TS method resulted in APIs of 71.4+/-2.9 uT (N=5), 70.1+/-0.1 uT (N=4), 69.8+/-0.6 uT (N=7) and 68.3+/-10.0 uT (N=6) for the SS, SC, CS and CC types, respectively. Percentage fractions of anhysteretic remanent magnetization (ARM) erased by low-temperature demagnetization (LTD) are 5.4+/-2.1 % (N=6), 5.4+/-1.9 % (N=4), 7.4+/-3.1 % (N=7) and 11.6+/-5.1 % (N=6) for the SS, SC, CS and CC types, respectively. It is suggested that multi-domain (MD) like components are efficiently erased in the TS method, resulting in the good API estimates even for the CS and CC types. In the NRM-TRM1 diagrams, there are less curvatures for the SS type (k=0.09+/-0.09) and the SC type (k=0.11+/-0.07) than for the CS type (k=0.19+/-0.13) and the CC type (k=0.43+/-0.34). The same is true for the ARM0-ARM1 diagrams, namely, the curvatures are less in the SS type (k=0.04+/-0.04) and the SC type (k=0.03+/-0.04) than in the CS type (k=0.19+/-0.20) and the CC type (k=0.39+/-0.43). Because the curvature values are almost the same between the NRM-TRM1 diagrams and the ARM0-ARM1 diagrams for each type, ARM

corrections are thought to yield linear NRM-TRM1* diagrams even for the CS and CC types.

