R004-16
Zoom meeting A ：11/4 PM2 （15:45-17:30）
15:45-16:00

綱川ショー法の適用に対する「経年」熱残留磁化の更なる検討

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Further investigation of “aged" thermoremanent magnetizations in response to application of the Tsunakawa-Shaw method

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Absolute paleointensity (API) of the geomagnetic field can be estimated from a volcanic rock based on a comparison between an original thermoremanent magnetization (TRM) and a laboratory-induced TRM. The comparison can be made in a blocking temperature space using a Thellier-type method (Thellier and Thellier, 1959), a result of which is usually visualized as a so-called Arai plot (Nagata et al., 1963). It is known that an Arai plot often exhibits a curvature which is regarded as an indication of non-ideal behavior. Shaar and Tauxe (2015) investigated the curvature over time by applying the IZZI Thellier method (Tauxe and Staudigel, 2004) to specimens whose Arai plots were curved in the original studies. They compared the Arai plots obtained from the original studies, “fresh" laboratory TRMs, and “aged" laboratory TRMs for two years. They found that the curvature tended to increase according to age and the resultant APIs were also biased relative to the laboratory field according to age. Santos and Tauxe (2019) built on the results of Shaar and Tauxe (2015) by adding specimens whose original Arai plots were not significantly curved. They examined the curvatures of the Arai plots obtained from the original studies (NRMs) and the “fresh" laboratory TRMs, and categorized the curvatures into either “straight" or “curved". They concluded that the Arai plots resulted in four different types of behavior: “straight-straight" (SS), “straight-curved" (SC), “curved-straight" (CS), and “curved-curved" (CC) (NRM behavior - “fresh" laboratory TRM behavior).
Sister specimens from samples of Santos and Tauxe (2019), which were given “fresh" laboratory TRMs in a 70 uT field, were aged in laboratory for two years also in a 70 uT field but in a different direction. We chose the specimens of the four types which were recategorized based on recalculated curvature values of k (Paterson, 2011). The Tsunakawa-Shaw (TS) method (Tsunakawa and Shaw, 1994; Yamamoto et al., 2003) was applied to the specimens in order to investigate behavior of “aged" TRMs in a coercivity space. First analytical results were already presented in the JpGU-AGU 2020 joint meeting, and we have conducted further analyses in the present study.
For estimation of APIs, we developed a python code to analyze a series of remanence data obtained by the TS method. The analytical procedure is as follows: (1) find a coercivity interval of a primary component (H_1-H_2); (2) calculate API statistics for all possible coercivity intervals between H_1 and H_{max} for first heating plots and 0 mT and H_{max} for second heating plots; (2) discard the statistics not satisfying the usual selection criteria (e.g. Yamamoto et al., 2010); (3) sort the statistics by a fraction of NRM ($frac_n$) and select the best one. Overall, the TS method resulted in a median API of 69.0 uT with a standard deviation of 4.5 uT (N=17). This coincide with the expected filed value of 70.0 uT, and is consistent with the IZZI Thellier results of a median API of 69.8 uT with a standard deviation of 3.3 uT (N=20) for the “fresh" laboratory TRMs. Among the successful API results by the TS method, one API result of 54.2 uT, which was obtained from the CC type specimen, is significantly deviated from the other 16 API results. If we excluded this result as an outlier, a median API is improved to 69.6 uT with a standard deviation of 2.7 uT (N=16). Except the CC type, there are no differences in median APIs according to the types (SS=70.8 uT, N=5; SC=69.6 uT, N=4; CS=69.4 uT, N=6).
Some characteristic remanence behaviors are observed during the TS method according to the types. Percentage fractions of anhysteretic remanent magnetizations (ARMs) erased by low-temperature demagnetization (LTD) were larger in the order of CC (median of 14.5 %), CS (8.7 %), SC (5.1 %) and SS (4.3 %). Curvatures (k) of the NRM-TRM1 plots were also larger in the order of CC (median of 0.29), CS (0.23), SC (0.11) and SS (0.10). Similar tendency was observed for curvatures (k) of the ARM0-ARM1 plots. It is implied that multi-domain (MD) like components are larger in the order of CC, CS, SC and SS, and that ARM corrections work efficiently to give good API results because the curvatures are similar between the NRM-TRM1 plots and the ARM0-ARM1 plots for each type.
When compared the results by the TS method with those by the IZZI Thellier method, positive correlation is found between the percentage fractions of ARMs erased by LTD during the TS method and the curvatures of the Arai plots in the IZZI Thellier method (both NRMs and the “fresh" TRMs). Similar positive correlation is observed between curvatures of the NRM-TRM1 plots of the TS method and the curvatures of the Arai plots in the IZZI Thellier method, and also between curvatures of the ARM0-ARM1 plots of the TS method and curvatures of the Arai plots in the IZZI Thellier method. It is suggested that certain amount of non-ideality in the IZZI Thellier method can be reduced by a combination of LTD and ARM correction in the TS method.