A new Approach for Absolute Paleointensity Determination

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All the absolute paleointensity determination techniques are based on the comparison of natural remanent magnetization (NRM) of volcanic samples with laboratory produced thermal remanent magnetization (TRM_{lab}). The key question is what kind of TRM_{lab} should be used. The original Shaw's method uses a Full TRM (cooled from Curie temperature to room temperature), which should have the same properties of NRM. However, it is becoming increasingly recognized that thermal alteration will almost certainly occur in laboratory heating experiments, especially when it reaches a high temperature such as the Curie point, thus resulting in unreliable paleointensity estimates. In the Thellier-Coe method which is mostly used today, a TRM (cooled from any given temperature to room temperature) is used for TRM_{lab}. Although Thellier-Coe method can successfully detect the laboratory thermal alteration problem, the magnetic properties of the TRM_{lab} are commonly different from that of NRM (Full TRM), leading the so-called non-ideal behavior for the Thellier-Coe paleointensity experiment. Our recent investigations indicate that it is magnetic grain interaction rather than domain interaction can seriously affect the properties of TRM and generate the non-ideal behavior in the Thellier-Coe method. Here we present a new method for absolute paleointensity determination for the case where magnetostatic interactions among grains generally exist. We group the natural magnetic grains in 3 general types: single-domain (SD)-like, pseudo-single domain (PSD)-like and multidomain (MD)-like, and introduce an important new concept: the completely reset TRM (CR_TRM). Our simple model shows that, for a given assemblage of clustered SD grains at the temperature (T_n) that is higher than the genuine maximum T_{ub} of SD grains, the interacting field will disappear statistically and the grains will be reset to acquire a completely reset TRM (CR_TRM) during successively cooling, which is identical to the Full TRM. When the given T_n is lower than the genuine maximum T_{ub} of SD grains, the grains can't be totally reset, thus acquire a partially reset TRM (PR_TRM) during successively cooling. With the dominant presence of magnetostatic grain interactions, a TRM (cooled from given temperature (T_n) to room temperature) can be written in three terms in the order of its apparent T_{ub} generally: $TRM(T_n) = CR\_TRM(T_m) + PR\_TRM(T_m, T_n) + Tail\ (T_n)$, ($T_m$ lower than T_n). In the case when the last 2 terms of the above equation is much smaller than the CR_TRM, the grains will behave like SD grains (SD-like), and the Thellier method is applicable. In the case when no significant CR_TRM can be found at any given temperature T_n, the grain assemblage is classified as MD-like grains.PSD-like grains are the case when CR_TRM can be found. CR_TRM exists only in the case when grain magnetostatic interaction is dominant and the PR_TRM and Tail is not too great.The phenomena of unblocking temperature spectra of CR_TRM equal to that of Full TRM is the crucial point of our new experimental method for paleointensity determination. We compare the unblocking temperature spectra of the CR_TRM part of a TRM_{lab} with that of natural remanent magnetization (NRM) to estimate paleointensity, rather than comparing the unblocking spectra of NRM with blocking spectra of progressive TRM_{lab}, which is used in the traditional Thellier-Coe method. The premise of our new method is that, if the unblocking spectra of CR_TRM of a TRM_{lab} can be obtained before significant laboratory physicochemical alteration occurs, a reliable paleointensity can be extracted from samples, even for those samples that contain PSD and MD grains. To illustrate these characteristics and validate our method, we have conducted detailed experiments on several representative artificial magnetite samples, historical and Cretaceous lavas samples. We will present these results at the meeting.