Applying paleomagnetic viscous dating to erratic boulders

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Unblocking temperatures of viscous remanent magnetization (VRM) predict the emplacement age of reworked boulders by Neel's magnetic relaxation theory of single-domain magnetite. If a rock is moved or re-oriented by geological processes, the remagnetization occurs partly and progressively with age, parallel to the present Earth' s magnetic field. This remagnetization is probably due to natural VRM acquired at low temperature over a long time, disappears at a higher temperature in a short period in the laboratory. By assuming Neel's theory of magnetite, Pullaiah et al. (1975) have reported that an experimental combination of short relaxation time and high temperature for removing VRM can determine the unknown relaxation time (tsunami age) at room temperature. We have been applied the time-temperature relationship to tsunami boulders in several regions of pacific coast (e.g. Ishigaki Island, Japan), but their estimated ages showed anomalously old due to the high unblocking temperatures. It is believed that the presence of high unblocking temperatures yielding older ages is due to a magnetic aggregate including the admixtures of single-domains, pseudo-single-domains, and/or multi-domain grains. Sato et al. (2016) applied an extended time-temperature relationship based on a stretched exponential law to explain the blocking or unblocking in a complex magnetic aggregate. In our study, the extended time-temperature relationship modifies the curvature of unblocking curves of VRM, agreeing with the the old VRM ages. Moreover, we synthetically magnetized partial thermoremanent magnetization (pTRM) to correctly identify the unblocking temperature of VRM. Particularly, the demagnetized samples were first given an pTRM as an original component. After changing set of sample direction to the magnetic field, these pTRMs were remagnetized in progressively higher temperature to generate the secondaly pTRM which is a synthetic VRM. A secondary pTRM was then demagnetized by progressive thermal demagnetization with various hold durations. This new experimental method provides us multiple unblocking temperatures of VRM from a sample. Therefore, we can estimate the curvature of unblocking curves. Our findings show that the VRM has potential as an absolute dating tool for the determination of geologic events.

Keywords: viscous remanent magnetization, erratic boulder, time-temperature relationship