Dating of tsunami boulders from Ishigaki and Tongatapu Islands

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Fields of reworked boulders are amongst the most impressive sedimentary evidence of past catastrophic tsunami and extreme storm events. Dating the deposition time of these boulders enables prediction of frequency-magnitude patterns of high-energy wave events. Although large radioisotopic age datasets from marine organisms reveal the reworking history at some sites, it is debated how one or several events are identified from individual boulders. As an attempt to overcome challenges for dating the dislocation of single boulders, we used a viscous remanent magnetization (VRM) dating method. Reworked boulders are expected to acquire a VRM approximately parallel to the geomagnetic field. The magnitude of such a VRM depends on several factors, including the time since reworking and ambient temperature for which there are well-known theoretical relationships. VRM unblocking temperatures can, therefore, be a powerful tool for determining the reworking age of boulders and can be used to assess geological hazards. In this study, VRM unblocking temperatures of samples from Ishigaki and Tongatapu Islands are compared with two candidate time–temperature relationships for VRM acquisition. The Pullaiah nomogram is applicable to assemblages of single-domain magnetite particles. Based on the Pullaiah nomogram, some samples appear to have anomalously high VRM unblocking. To estimate reworking ages of anomalous boulders, we use an alternative time–temperature relationship defined by a stretched exponential law. This approach is applicable to assemblages of single-domain, vortex state, and multi-domain magnetite particles. Moreover, we measured first-order-reversal curve (FORC) diagrams to confirm domain state. We suggest that future VRM dating can be undertaken using a combination of two time-temperature relationships and FORC diagrams.