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Paleomagnetic Field Reconstruction from Mixtures of Titanomagnetites

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A b s t r a c t

Stepwise thermal demagnetization and alternating field (AF) demagnetization are commonly used in paleomagnetic studies to isolate remanent magnetic components of different origins. The magnetically hardest, i.e., highest unblocking temperature/peak field component is often interpreted as the primary magnetization and magnetically softer components as subsequent remagnetizations due to geological events posterior to the formation of the rock, such as reheating or formation of new magnetic minerals. The correct interpretation of the sequence of the geological events such as tectonic rotations from paleomagnetic data often relies on correctly attributing the observed magnetic directions to the remanence carriers and acquisition mechanisms. Using a numerical model to simulate remanence acquisition and stepwise thermal and AF demagnetization experiments, we show that the presence of mixtures of different magnetic minerals, such as magnetite and titanomagnetites of varying titanium – content can have very significant effects on Zijderveld plots. In thermal demagnetization experiments a spurious third component at intermediate temperatures or a continuous curvature may arise from an overlap of the primary remanence with a subsequent thermal or viscous remagnetization carried by small-grained iron-rich magnetite and large-grained titanium-rich titanomagnetite. AF demagnetization plots of magnetic mixtures are even more complex: primary and secondary remanences carried by different minerals may appear as either three or four components in Zijderveld plots. During alternating field demagnetization, the highest coercivity component is not necessarily equivalent to the primary remanence and does not necessarily correspond to the highest temperature component in an analogous thermal demagnetization experiment, i.e., the primary remanence direction cannot be recovered. The effects are shown to be due to the different responsiveness of magnetite and titanomagnetites towards viscous or thermoviscous remanence acquisition: remanent magnetizations with long acquisition times are more effectively recorded by titanium-poor minerals, while short acquisition times are equally well recorded by titanium-rich minerals. In demagnetization experiments on laboratory timescales, the relative contribution of two minerals to Zijderveld plots differs to the relative contribution of remanence acquisition over geological timescales, leading to overlapping components in Zijderveld plots. The model was also used to simulate paleointensity (ancient magnetic field intensity) experiments and it was found that the grain distribution affects the slope of Arai plots, but is negligible compared to the effect of the cooling rate of NRM acquisition. The simulations suggest that for slowly cooled rocks a cooling rate correction of up to 1.5 to 1.6 may be required depending on the mineralogy (Berndt *et al*. 2017).

Keywords: titanomagnetite, magnetic mineral mixture, Zijderveld plot, paleointensity.

References

Berndt, T., R.S. Ramalho, M.A. Valdez-Grijalva, and, A.R. Muxworthy (2017), Paleomagnetic field reconstruction from mixtures of titanomagnetites, *Earth Planet. Sci. Lett.* **465**, 70–81, DOI: 10.1016/j.epsl.2017.02.033.