New measurement protocols for hysteresis reversal curves and identification of magnetic mineral components

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High-resolution first-order reversal curve (FORC) diagrams are being used increasingly in rock and environmental magnetism, including for detection of biomagnetic signals in sediments. Resolution can be a major barrier to obtaining high-quality FORC diagrams and time-consuming measurements that employ small field steps are necessary to resolve the finest features of a FORC distribution. We have developed a new experimental protocol with irregularly spaced field steps that allows different parts of a FORC diagram to be measured at different resolutions. Larger numbers of measurements can, therefore, be made in key regions of a FORC distribution to resolve diagnostic features at higher resolution. Specification of the field steps in the irregular grid is based on measurement of a major hysteresis loop; no *a priori* knowledge concerning the underlying FORC distribution is required. FORC diagrams obtained with conventional measurements and with our new measurement protocol give consistent results. We have also extended the applicability of FORC-type diagrams through use of a series of hysteresis measurements that provide information about remanent, induced, transient, and transient-free magnetization components. These measurements, and differences between measurement types, enable production of 6 FORC-like diagrams with only double the number of measurements needed for a conventional FORC measurement. These diagrams enable discrimination between magnetic signatures associated with each domain state. When analyzing samples with complex magnetic mineral mixtures, contrasting domain state signatures are mixed in a traditional FORC diagram, but these signatures can be identified individually with the 6 diagrams discussed here. The ability to make different FORC measurements and to identify separately each magnetic component in a conventional FORC diagram by investigating different magnetization types can provide much-improved understanding of the information provided by FORC diagrams. The diagnostic information provided by these additional FORC-type diagrams should assist substantially in magnetic unmixing of complex samples and in quantitative mineral magnetic interpretation.

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