Assessment of magnetic techniques for understanding complex mixtures of magnetite and hematite: the Inuyama red chert

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Magnetite and hematite mixtures occur widely in nature. Magnetic unmixing of the signals recorded by these minerals can be important for assessing the origin of their respective paleomagnetic remanences and for extracting geological and paleoenvironmental information. However, unmixing magnetic signals from complex magnetite and hematite mixtures is difficult because of the weak magnetization and high coercivity of hematite. We assess here the relative effectiveness of first-order reversal curve (FORC) and extended FORC-type diagrams, FORC principal component analysis (PCA), isothermal remanent magnetization (IRM) curve decomposition, and PCA of hysteresis loops and remanent hysteretic curves for unmixing magnetic components in samples from the magnetically complex Inuyama red chert from Japan. We also further characterize the domain state and coercivity distributions of both magnetite and hematite with FORC-PCA and IRM acquisition analysis in the red chert. We show that end member identification from IRM curve decomposition can provide valuable component-specific information linked to coercivity, while FORC-PCA enables effective magnetic domain state identification. To identify components in complex magnetite and hematite mixtures, we recommend PCA analysis of hysteresis loops combined with FORC analysis of representative samples to identify domain states and coercivity distributions.

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