Comparison of magnetic relaxation-time distributions derived from measurements in frequency-domain and time-domain

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Dynamic magnetization variations in short period of time were measured for a set of volcanic rocks in time domain and frequency domain. The frequency domain measurements were performed with MPMS to measure low-field AC magnetic susceptibility over 1 Hz to 1 kHz in 10 K to 300 K. These frequency spectra showed in common the Debye relaxation pattern indicating a narrow distribution of relaxation time. These susceptibility spectra were analyzed with a least-square inversion algorithm to derive their relaxation time spectra. The relaxation time spectra at low temperature were extrapolated to room temperature based on the Neel's relaxation time theory. Measurements in time domain were performed using the pulsed-field method (Kodama, 2015) to determine a decay constant by fitting the relaxation curve. The estimated relaxation times are in the range of 10^{-5} sec in agreement with those at room temperature determined from the frequency domain data. Additionally, numerical transformation of the frequency domain data into time domain and vice versa were made by digital filters based on linear response theory. The narrow distribution of relaxation time derived from these direct and indirect methods is most likely ascribed to the grain-size distribution of SP particles, the magnetic structure and dynamics of domain walls in PSD and MD particles. Applications of these new experimental and theoretical methods to rock magnetism will be proposed.

Keywords: magnetic relaxation time, frequency spectrum, inversion

