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Calibration of initial magnetic susceptibility measurements

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Initial or low-field magnetic susceptibility measurements have been routinely utilized for natural samples beyond the rock magnetic or paleomagnetic community. Instruments, such as Bartington or Kappabridge susceptibility meters, are now commercially available and have enabled us to measure a variety of sample easily. However, inter-laboratory or inter-instrument calibration exercise is not yet well performed in an absolute or even a relative scale. One of the reason is that calibration standard material is still not established. Powder material should be preferable because any shape of specimen can be prepared for a particular instrument. Traditionally iron-bearing paramagnetic salts, such as Mohr's salt, have been used because these materials are commercially available at high purity and low cost and no frequency or grainsize dependence is expected. Nevertheless, their chemical stability is not well secured due to the non-stoichiometry. Gadolinium oxide or other rare earth oxides can be counted as alternative standard materials because of the high chemical stability and the relatively high susceptibility. Unfortunately there is a discrepancy in the initial susceptibility values of gadolinium oxide among major literatures. Tracing the susceptibility value back in their original literatures, we found the erroneously assigned sign for the Weiss constant appeared in the Curie-Weiss law in only one literature [Arajs and Covin, 1962] and this is the case also for dysprosium oxide noted in the same literature. Using MPMS we confirmed the negative Weiss constant for gadolinium oxide and the consistent susceptibility value (1.74x10^-6 m^3/kg) at room temperature calculated from the other literatures. If any instrument is calibrated with a standard material such as gadolinium oxide, we can reliably compared the absolute susceptibility values even if measured with other kinds of instruments at different laboratory. Such a calibration exercise makes it possible to calculate ratios with other kinds of magnetic parameters (e.g., ARM). In addition, we need inter-instrument calibration using different size and shape of specimen, for example between Bartington susceptibility meter and MPMS, as a daily laboratory exercise.

Keywords: initial susceptibility, low-field susceptibility, environmental magnetism, rock magnetism