Magnetic property measurements of ferromagnetic minerals under high pressure: method and basic experiments

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Behavior of magnetic properties under high pressure has been the subject of great importance in various fields of material physics for characterization and identification of synthetic, ferromagnetic and in many cases superconductive crystals. Although the highest pressure produced so far is ca. 2 GPa (ex. Umehara et al., 2002), due to constraints derived from difficulties in precise measurements of magnetic properties under extreme conditions, it has been revealed that magnetic susceptibility and Curie temperature show substantial change in the influence of high pressure of that range. We applied in this study a similar method to measurements of rock magnetic properties of natural and synthetic samples, designing a new mini pressure cell, which is capable of producing ca. 1 GPa, coupled with using MPMS, a commercial magnetic property measurements system using SQUID and superconducting magnet. The pressure cell we designed is composed of a non-magnetic cylinder made of CuBe alloy, with the dimension of 8.8 x 60 mm, and a piston of ZrO2. The sample space is sealed by Teflon cell, and Fluorinert is used for pressure transmitter. The mini pressure cell, weighing ca. 60 g, is connected to the end of the sample rod of MPMS, and measured in a regular manner. First of all, we measured the pressure cell itself to evaluate its magnetization and magnetic susceptibility at room and low temperatures. It turned out that the remanent magnetization is ca. 0.15 milli-emu at 300 K, and 0.03 milli-emu at 5 K, substantially smaller than most ferromagnetic materials like magnetite. We then measured a synthetic crystal, CeCuAl3, which has a Neel temperature of 2.5 K at pressure free, and several natural ferromagnetic minerals such as magnetite. We present in this study the change in their magnetic behaviors under high pressure as well as at low temperatures.