THE EFFECT OF HYDROSTATIC PRESSURE UP TO 1.45 GPA ON THE MORIN TRANSITION OF HEMATITE-BEARING ROCK: IMPLICATIONS FOR MARTIAN CRUSTAL MAGNETIZATION.

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Introduction: Hematite (αFe_2O_3, further referred to as 'hmt') is a common mineral in paleomagnetic and rock magnetic studies. It occurs in both igneous and sedimentary rocks as well as in meteorites, and it is one of several magnetic phases, which might potentially be in part responsible for the observed Martian magnetic anomalies [1]. The presence of hmt may be diagnosticated via its characteristic magnetic phase transition, known as the Morin transition, from weakly ferromagnetic to antiferromagnetic state at ~ -23ºC [2]. It was previously reported that the Morin transition temperature (T_M) increases with increasing pressure (p) and is very sensitive to pressure transmitting medium [3]. In spite of previous studies (e.g., [3-4] and references therein), direct magnetic measurements of T_M pressure dependence performed on hematite-bearing rock samples under hydrostatic conditions up to 1.5 GPa are still lacking.

Methods: We carried out hydrostatic pressure experiments up to 1.45 GPa on a well-characterized multi-domain hmt-bearing rock sample from banded iron formation [5] and obtained new experimental data on T_M pressure dependence. We used a non-magnetic high-pressure cell of piston-cylinder type [6] for hydrostatic pressure application and a SQUID magnetometer for isothermal remanent magnetization (IRM) measurements under p in the course of warming of the cell with sample from -30ºC to room temperature (T_0). Thus, T_M was always measured on warming. There is a pressure loss (Δp) observed below T_0 (with regards to applied p), so all p values were corrected for Δp.

Results: IRM imparted at T_0 under p in 270 mT magnetic field (IRM_{270mT}) was never recovered after a cooling-warming cycle. One ambient p cooling-warming cycle resulted in 35% loss in IRM (with regard to IRM_{270mT}). Further pressure experiments allowed quantifying thermal hysteresis under p as 49% per GPa loss. T_M reaches T_0 under hydrostatic p ~ 1.2÷1.45 GPa. Pressure dependence of T_M up to 1.45 GPa is linear with the warming rate of 32ºC per GPa. We did not observe any changes in T_M warming rate over 0.6 GPa in accordance with [3] and at odds with [4]. Our experiments are repeatable with <2°C margin.

The first kms of martian crust is close to T_M. If a moderate shock wave (with negligible heating) pass through hematite-bearing rocks just above T_M at normal pressure they can be partially demagnetized or remagnetizated by passing through the transition. This process may thus be relevant to the upper crustal magnetization of Mars.

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