Magnetization of Extraterrestrial Allende material may relate to terrestrial descend, G. Kletetschka[1,2,3], [1]Institute of Geology, Academy of Sciences of the Czech Republic, Czech Republic, [2]Faculty of Science, Charles University, Czech Republic, [2]Department of Geology and Geophysics, University of Alaska Fairbanks, USA (Kletetschka@gmail.com).

Chondrite meteorites are undifferentiated conglomerates of primitive material, containing intermixed grains of olivine, pyroxene, feldspar and metallic Fe-Ni compounds. While ordinary chondrites are the materials most likely matched with the S-type asteroids, carbonaceous chondrites match C-, P-, and D-type asteroids [1].

Magnetic record of the Allende chondrite is complicated be the fact that it contains pyrrhotite grains that were formed by metasomatic processes on the parent body. Resulting chondrule and matrix porosity in Allende is evidence of this mechanism [2]. During this process, Fe,Ni-metal is replaced by Fe,Ni-sulfides and magnetite; the residual metal is Ni-rich (awaruite). Chondrule plagioclase is replaced by secondary minerals (e.g. nepheline, sodalite, corundum); chondrule low-Ca pyroxene is replaced by ferroan olivine. All these secondary mineral assemblages are highly porous [3].

Every pyrrhotite grain in Allende thus contains by definition nearby pore spaces that may have collapsed during the acceleration on the parent body and/or in the atmosphere. In this work, we show magnetic remanence that was formed as inverse thermoremanent magnetization (ITRM) with magnetic transition near 270 K. Magnetic minerals, when warmed from low temperatures, acquire ITRM. This remanence usually relates to magnetic transitions (e.g., Verwey transition at 120 K or pyrrhotite transition near 35 K) [4,5]. In this work we identify in Allende parasitic magnetic transition, generated by translation of decelerating uniaxial pressure and call it *decelerating parasitic magnetic transition* (DPMT).

The change in crystalline anisotropy and DPMT formation was likely triggered by uniaxial pressure (~18 MPa for chondrites) [10] on Allende meteorite during its descent in the atmosphere. Uniaxial pressure causes bolide flattening, generates local forces that exceeds the breakup force causing bolide fragmentation. Such local forces significantly exceed pressures of 18 MPa as they are acting over much smaller area. Break up volumes include pore space collapses, that also amplifies the pressure within these volumes and reaches conditions where the pyrrhotite could accumulate the crystalline anisotropy energy. Since the pore space, in chondrules' rims, contains most of the parent body originated secondary assemblages, including pyrrhotite magnetic carriers, this process is thought here to modify the magnetic record of Allende. Thus, the overall pressure translates to generation of DPMT. This pressure range would reset part of the pyrrhotite's original magnetization and acquire the ambient magnetization [11]. As more of the pore spaces collapsed the crystalline anisotropy energy of adjacent pyrrhotite crystals would sharply change while the temperature of the collapsed pore space increased. Such mechanism would take place during the meteorite deformation in the atmosphere or on Allende's parent body. There is sufficient evidence that Allende contained collapsible pore space even after the meteorite retrieval [9].

Three selected chondrules that originally contained magnetic remanence >1.1 x 10^{-4} Am^2kg^{-1} would contain magnetic record of Allende's matrix [6]. When monitoring their remanent magnetization, for two chondrules with initial intensities >1x 10^{-3} Am^2kg^{-1} it was observed monotonous magnetization increase that flattens out near 270K. The process of cycling through low temperature was repeated for one chondrule with more or less identical result. This observation is indicative of accumulation of crystalline anisotropy near 270 K and thus existence of DPMT, because normally, heating loosens magnetic domain walls configuration while domain walls are "frozen in" during the cooling process. Such anisotropy accumulation spike allowed for magnetic acquisition at temperature 270K for these two chondrules. Another chondrule had much lower room temperature intensity, 5 x 10^{-5} Am^2kg^{-1}, experienced large magnetic fluctuation and showed more or less magnetic noise.

The evidence of crystalline magnetic anisotropy accumulation in form of DPMT is further indicated by regular pyrrhotite magnetic behavior with temperature. Pyrrhotite's remanent magnetization usually decreases with temperature as magnetization unblocks from various imperfections in the lattice with increasing temperature [5]. In case of ITRM, however, the magnetization can be blocked at specific temperature by sharp change in crystalline anisotropy energy and magnetization increases when approaching the crystalline anisotropy change. Data indicated that the ITRM was acquired near the 270K where the magnetization did not change with the temperature. We interpret this observation that the pyrrhotite grains experienced partial thermal remanent magnetization (PTRM)-related ITRM during the transit to terrestrial environment and thus recorded the contributing persistent terrestrial magnetization component [4] along with the paleotemperature of the event.

ITRM observation supports presence of a deceleration parasitic magnetic transition (DPMT) acquired during the Allende descend. Decelerating process allows remanence acquisition at temperature when collapsible deformation took place on Allende. This process may have contributed to the deformational events of the fluffy type Ca-Al-rich inclusions (CAIs) [7,8] matrix material, and chondrules on the Allende parent body [9]. Our measurements indicated that such temperature when deformation occurred was near 270 K.

While the observed magnetization increase over the relevant temperature range is modest, the work demonstrated that Allende meteorite was capable of retrieving measurable ITRM in Allende. The initial state of Allende prior atmospheric descend is difficult to recreate (most pore space is collapsed), however, the observed modest increase in magnetization constrained presence of deceleration parasitic magnetic transition, DPMT, in Allende meteorite.

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