IDENTIFICATION OF THE SHOCK EFFECTS IN THE THE AVANHANDAVA H4 CHONDRULES BASED ON THE COERCIVITY SPECTRA OF THE REMANENT MAGNETIZATION. T. Kohout[1, 2, 3], G. Kletetschka[3, 4] and L. J. Pesonen[1], [1]Division of Geophysics, Faculty of Science, University of Helsinki, Finland, e-mail: tomas.kohout@helsinki.fi, [2]Department of Applied Geophysics, Faculty of Science, Charles University in Prague, Prague, Czech Republic, [3]Institute of Geology, Academy of Sciences of the Czech Republic, Prague, Czech Republic, [4]Catholic University of America, Washington, D.C., USA.

Introduction: The extraterrestrial material can carry remanent magnetization of the space origin. The possible space magnetizing processes can be TRM (Thermo-Remanent Magnetization - generated as the material is cooling through its blocking temperature in the presence of ambient magnetic field), CRM (Chemo-Remanent Magnetization – generated as the mineral grain is growing through its blocking size in the presence of ambient magnetic field) or IRM (Isothermal Remanent Magnetization – generated by exposure to strong ambient magnetic field at temperatures lower than blocking). The ambient magnetic field can be represented by the solar magnetic field, magnetic field generated in cores of planetesimals and planets or by the lightnings in the early solar nebula.

REM (AF) analysis technique: The magnetized space material can be later exposed to various shock events (impacts, collisions, Hayabusa type sampling procedure) which can have significant demagnetization effect. The efficiency of the impact demagnetization depends on the mineral grain size. The large, multi-domain, low coercivity grains demagnetize much effectively than the small, single domain high coercivity ones. Thus the coercivity spectra analysis of the remanent magnetization can reveal the evidence for the shock history.

In order to analyze the coercivity spectra of studied material and evaluate the shock demagnetization level the method based on REM (AF) ratio is applied [1]. The technique utilizes a detailed AF (Alternating Field) demagnetization of NRM (Natural Remanent Magnetization), followed by demagnetization of the SIRM (Saturation Isothermal Remanent Magnetization) in the same AF demagnetization steps.

The constant REM (AF) ratio represented by flat curve is typical for TRM or CRM in SD (Single Domain) and MD (Multi Domain) materials with no significant SP (Super-Paramagnetic) component. The shock demagnetization in such a materialwill result in the REM (AF) curve with positive slope (low coercivity grains are demagnetized more progressively, fig. 1). The REM(AF) curve with negative slope represents the NRM with viscous or artificial overprint and thus not suitable for further study.

Coercivity spectra of Avanhandava H4 chondrules: The REM (AF) method was applied on chondrules from Avanhandava H4 meteorite. The REM (AF) curve of some chondrules showed positive slope with the initial REM ratio ~0.002 (Fig. 1). This is consistent with what we would expect for the case of impact demagnetization (the shock-induced demagnetization will result in the REM (AF) curve with positive slope as the low coercivity grains are demagnetized more progressively than the high coercivity grains).

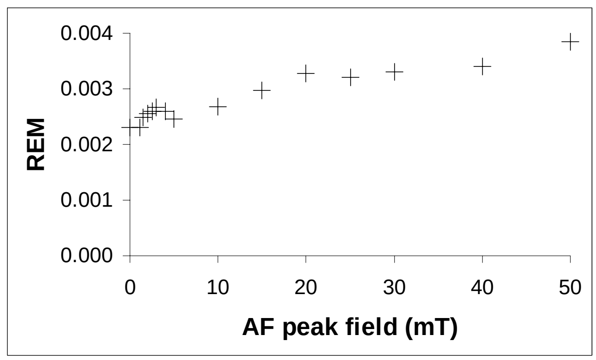

Figure 1: REM (AF) ratio of the Avanhandava H4 chondrule is characteristic with trend showing positive slope.

Experimental verification: The chondrules were then saturated in the laboratory 1T field and subsequently shocked with ~0.2 GPa pressure in the controled < 500 nT field. The coercifvity spectra analysis revealed positive slope of the REM (AF) curve (calculated from pre-shock and post-shock SIRM) as a result of the shock (Fig. 2). The overall remanence dropped by 20% (initial value of the REM ratio calculated from pre shock SIRM andpost shock SIRM is 0.8). The general trend of the REM (AF) curve obtained from shock experiments (fig. 2) is similar to that the REM (AF) curve constructed from NRM (Fig. 1) of the Avanhandava chondrules giving the evidence for the shock history of the Avanhandava material. The three distinct slopes on the REM (AF) curves may be attributed to either distinct grain sizes of kamacite or distinct shock effects (i. e. shock wave reflection and).

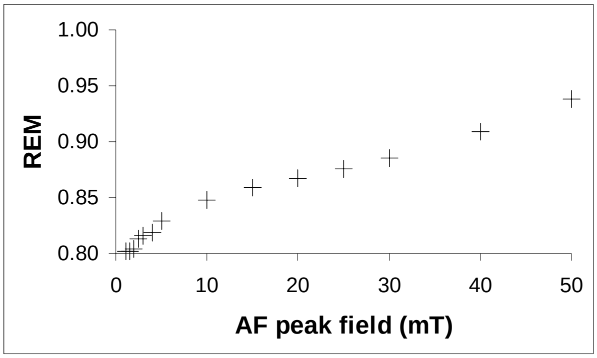

Figure 2: REM (AF) curve of the Avanhandava H4 chondrule as the result of the shock experiment. As the result of the shock the overall remanence dropped by 20%. The positive slope indicates the low coercivity grains to be demagnetized more progressively that the high coercivity grains.

Conclusions: The method can be used for identification of the shock history of space materials (chondrules, meteorites, sample returns) after careful exclusion of the meteorites containing superparamagnetic component. Both natural (impacts, collisions) and artificial (Hayabusa type sampling procedure) shock events can be identified. The efficiency of the shock demagnetization is material dependent and thus must be calibrated for each rock type.

References: [1] Kletetschka G., Kohout T., Wasilewski P. J. and Fuller M. (2005) 10th Scientific Assembly of the International Association of Geomagnetism and Aeronomy, Toulouse, France, IAGA2005-A-00945, p. 53.