SHOCK NEOFORMATION OF HIGHLY MAGNETIC NANO PARTICLES IN "BROWN" COLOUR OLIVINES IN MARTIAN METEORITES AND IMPLICATIONS FOR THE MAGNETIZATION OF MARS SOILS AND SURFACE ROCKS. V.H. Hoffmann[1,2], T. Mikouchi[3], T. Kurihara[3], M. Funaki[4], M. Torii[5], [1]Institute for Geosciences and ZAG, University of Tuebingen, Sigwartstrasse 10, 72076 Tuebingen, and [2]Department of Geo- and Environmental Sciences, University of Muenchen, Theresienstrasse 41, 80333 Muenchen, Germany, [3]Dept. of Earth and Planetary Science, University of Tokyo, Japan, [4]National Institute of Polar Research, Tachikawa, Tokyo, Japan. [5]Dept. of Geosphere-Biosphere System Science, Okayama Univ. of Science, Okayama, Japan.

Introduction: During the last years, brown-coloured olivines are frequently observed in moderately-highly shocked Martian meteorites (SNC), specifically in lherzolitic and olivine-phyric shergottites. TEM studies revealed that Fe-Ni metal nano-particles are responsible for the dark "brown" colour of olivine in the NWA 2737 chassignite, a shocked dunite, which is interpreted to have formed by reduction of olivine due to heavy shock events [1,2]. Similar brown colour olivine seems to be fairly common among Martian meteorites and thus the widespread presence of Fe-Ni metal nano-particles in these olivine grains can be expected. The formation of nano phases in olivine matrix could be related to shock metamorphism in a degree of at least 40 GPa [2]. Native Fe-Ni or magnetite nano particles in brown/ black Fe-bearing olivines or pyroxenes could be detected in ALH 77005 (Fe-Ni), Y000097 (Fe-Ni), LEW 88516 (Fe_3O_4), NWA 1950 (Fe-Ni), LAR 06319 (Fe-Ni) [2-7] and DaG 476 (in olivine and pyroxene [this study]). [2] reported the results of laboratory shock experiments on natural San Carlos olivines: depending on the sample properties (olivines with/without graphite) and the degree of shock (20–46 GPa) magnetite (Ni free) or Ni-bearing Fe nano phases were found in the olivine matrix by TEM and EDS analyses. Recently the same authors could demonstrate that Fe-Ni metal nano-particles can be produced instead of magnetite nano phases by preheating olivine before performing shock experiments [9,10]. Most likely, temperature difference during shock might control the formation of Fe-rich nano-particles either Fe-Ni metal or magnetite.

The aims of our study are to investigate and to better understand the magnetic signature and record of the "brown" colour olivine bearing Martian meteorites.

Samples and experiments: The magnetic properties of a series of laboratory-shocked olivines were investigated systematically. We used selected samples of the set as described by [2]. All data are compared with the results of a systematic search on the magnetic signature of the forsterite-fayalite series (synthetic material) as reported by [8] and additional systematic low-temperature investigations [this study]. For a detailed description of the samples and their preparation as well as of the shock experiments we refer to [2].

Results: The high sensitivity of our magnetic methods allows very detailed view to the effects of shock, especially dynamics and kinetics of this process, on the magnetic properties of olivines and consequently the shock-induced neoformation of nano sized ferri(o)magnetic phases. The 40 GPa sample (with graphite) behaves differently from all others because it contains a significant amount of native Fe (only neglectible Ni according to our results) while both the 20 GPa and the 40GPa samples without graphite are mainly dominated by magnetite like phases (eventually also maghemite or Mg-ferrite). Our data clearly indicate that already at 20 GPa the magnetic signature and phase composition is significantly modified. In a next step, the olivine samples which have been preheated before the shock experiments, shall be the target of a similar set of magnetic tests.

Conclusions: Presently it is speculated about the potential of these highly magnetic nano particles, native Fe-Ni or magnetite, to act as recorders of stable and reliable magnetic remanences in Martian surface rocks and crust. Large parts of the Mars surface are covered by impact craters, and consequently we should expect to find thick layers of impactites on the Mars surface. [12, 13] reported the finding of high concentrations of strongly magnetic material in the soils around the Phoenix lander. The origin of the different classes of particles is uncertain, only comparison with suitable terrestrial Mars analogue materials could provide some hints in terms of both spectral and magnetic properties [see also 11].

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