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Petrographic study of thermal and shock metamorphism in Mezőmadaras, Knyahinya and Mocs chondrites

I. Gyollai (1), J. Fürj (1), Sz. Bérczi (1), A. Gucsik (2), Sz. Nagy (1), and M. Veres (3)

(1) Eötvös University, Faculty of Science, Institute of Physics, Dept. Material Physics, H-1117 Budapest, Pázmány P. s. 1/a, Hungary (gyildi@gmail.com), (2) Max Planck Institute for Chemistry, Dept. of Geochemistry, Joh.-J. Becherweg 27, D-55128, Mainz, Germany., (3) Institute for Solid State Physics and Optics H-1121 Budapest Konkoly-Thege M. street 29-33

Introduction

We investigated two processes in a series of the Hungarian L-chondrites: shock and thermal metamorphism. Thermal metamorphism transforms the textures in the relatively small chondritic planetary body. Shock metamorphism is caused by hypervelocity impact processes transforming texture and mineral structure mainly in the outermost layers of the chondritic planetary body [1,2]. The purpose of this optical microscopic study is to indentify the degree of thermal metamorphism and stages of shock metamorphism in the selected Hungarian meteorites, which have not been described well, up to date.

Samples and Experimental Procedure

The mineral assemblages and textures were characterized with a Nikon Eclipse LV100POL optical microscope using plane-and cross polarized light modes (at Eötvös Lorand University of Budapest, Hungary). Knyahinya and Mócs sample were prepared with 35 micrometer in thickness. The shocked minarals were measured with a Renishaw-1000 spectrometer, the used lasers wawe lenght was 785 nm. The maximal focus was 1 micrometer. The resulting spectral bands depend upon the crystal structure with its symmetry, the vibrating atoms.

Results and Discussion

Thermal metamorphism

In (L3,7) Mezőmadaras sample, there are a lot of microchondrules, and the boundary of condrules are in a sharp contrast, but in Knyahinya (L5) sample the margin of chondrules is blurry. Mócs sample contain relatively small number of chondrules , which show the recrystallized texture. The grains were grown in the coarse of thermal metamorphism. The matrix of the Mezőmadaras (L3) sample was kryptocrystalline. In a comparison with larger crystals appeared in matrix of the Knyahinya sample the Mócs specimen (L6) shows microgranular matrix. Compared the spherical shape of chondrules in Mezőmadaras to those of Knyahinya sample, the Knyahinya chondrules were greater in size, but they were more deformed in shape containing more chondrule-fragments. According to Miyamoto et al. [3] this optical description predicts that the thermal alteration occurred between 500-800 K in the chondritic parent body.

Shock metamorphism

The shock metamorphism in our sample is a local phenomena, it is not abundant whole rock, but in some ore detail mineral grain. Based on Stöffler [2], we classified the shocked minerals into shock stages, as follows. In Mezőmadaras sample, there are irregular fractrures (S1), and PF-s /planar fractures/ (S3), and mechanical twins in pyroxene. We observed that minerals with mechanical twins exhibit less interference color, compared to the non-shocked minerals, especially pyroxene. It is important to note that, the mechanical twins were difficult to describe, only the direction of the deformation was determined. In Knyahinya chondrite, two phenomena were observed as follows: the weak mosaicism (S4) and mechanical twins in pyroxene. The Mócs sample is characterized by strong shock metamorphic effects such as, high density of fractures and abundant shock-veins. Planar Deformation Features (PDFs) were identified in two olivine grains, and an olivine grain shows well-developed PFs. The shock-induced microstructures such as PDFs, PFs and mosaic texture in minerals of these meteorite samples indicate the peak shock pressure was ranged between 15-35 GPa [4].

Conclusion

The results of Raman spectroscopy suggested for us, that in amorphous PDF's lamellae contains modified spinel structure wadsleyite crystallite, in a highly deformed olivine grains, that is evidence for the localised high stage shock-metamorphism in Mócs (L5) Hungarian meteorite. The changes in FHWM value are also significant in meteoritical pyroxenes. This might be means that structural disordering in Si-O stretching vibrational modes and SiO4 tetrahedra rotational vibrations are considerable due to shock-metamorphism. The FHWM represents growing relative "amorphisation" rate in our investigated meteoritical pyroxenes.

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