COMPARISON STUDIES OF SHOCK VEIN FORMATION IN TENHAM (L6), NWA-5011 (L6), NWA-4353 (L4), ALH-77005 (SHERGOTTITE) AND MÓCS (L6) METEORITES. I. Gyollai[1,2], Sz.. Nagy[2,3], Sz. Bérczi[2]. [1](University of Vienna, Department of Lithospheric Research, A-1090 Vienna, Althanstrasse 14, Austria, (gyildi@gmail.com), [2]Eötvös University, Institute of Physics, Department of Materials Physics, Cosmic Materials Space Research Group, H-1117 Budapest, Pázmány Péter sétány 1/A Hungary, (bercziszani@ludens.elte.hu), [3]Szeged University, Dept. Mineralogy and Petrology, H-6722, Szeged, Egyetem u. 2-6., Hungary (ringwoodite@gmail.com),

Introduction: As it is known, the shock-wave related fracturing starts at already at S3 stage according to Stöffler scale [1]. In the less shocked meteorites, dynamical fracturing, cataclastic texture occure, where the shock veins are filled by chondrules and mineral fragments. If the temperature is high, but shock loading is short, glassy, vitrified texture occurs in the veins, where the original melted pyroxene recrystallized as microgranular textural assemblages. High pressure minerals occur in those veins, where both of postshock temperature and shock-loading is high. The shock veins can be formed by a single impact and multiple impacts on little planetary body: (1) the thin veins could be formed by single impact, (2) the thick veins, in which the high pressure minerals (ringwoodite, majorite, perovskite) have more crystallization rim probably have been formed by multiple impact events. Our study gives an overview of the shock vein formation by comparing different types of shock veins.

The shock veins were studied by optical microscopy, micro-Raman spectroscopy, and electron microprobe to distinguish the presence of high pressure minerals and element fractionation due to shock melting.

One of the causes of shock pressure heterogenity (presence of peak shock pressure) is the interaction of shock wave with pores and cracks. Hence, after the shock wave transit the former cracks could become large shock veins. But, planar melt veins can be produced by enhanced shock-wave propagation through grain-scale heterogenities. Each mineral types have different acoustic impedance drive reaching peak shock pressure via shock pressure reflection. Shock melt vein crystallization proceeds from rim to core, hence melt vein forming mineralogy provides important sequences of shock loading histories [2]. The presence of high pressure transformation mineral fragments in chondritic melt of shock vein in unmelted chondritic meteorite is induced by shear friction stress, which might have been caused by collision of planetary bodies [3].

Observations:

(1) *dynamical fracturing in short-duration shock pressure*. Both of Mócs (L6) and NWA-4353 (L4) meteorites contain veins which made up of mineral fragments of pyroxene and olivine, but groundmass is made up of opaque material, mainly iron oxide. However, some olivines of Mócs meteorite have strong mosaicism and deformation microstructure, which might have been caused by shock wave propagation related dislocations. The minerals in shock vein of NWA-4353 has been dynamically recrystallized due to high shock pressure but the loading time in this case was very short, therefore the post-shock temperature was not enough to form high pressure minerals. In the shock veins of highly shocked meteorites (S6) K-Na fractionations can be observed.

(2) *melt vein formation and vitrified crystal needles*. The ALH-77005 meteorite contains pyroxenes with deformation microstructures and anorthites with strong mosaicism. These large grains are crossed by dark veins, which contain vitrified mineral laths. The presence of melt vein and maskelynite predict high postshock temperature, but lack of high pressure minerals (majorite, ringwoodite, hollandite) reveal lower postshock temperature and shock loading pulse.

(3) *high pressure minerals in shock vein*. Both of Tenham (L6) and NWA-5011 (L6) chondrites contain high-pressure minerals in shock veins: ringwoodite, majorite, perovskite, hollandite. The Tenham meteorite have thin veins with a few ringwoodite in melt matrix, while NWA-5011 meteorite is crossed by a large, 6 mm thick vein, which contains porphyritic chondrule fragments, where original olivine grains transformed to ringwoodite at high postshock pressure and temperature. At the rim of the vein akimotoite crystals has been recrystallized providing a double rim at the large melt vein. These phenomena suggest the possibility for multiple impact event on small L-type chondritic planetary body. Silicate melt inclusions occur in olivine grains (parallel to grain boundaries and fractures of minerals) outside of shock vein indicating the effect of postshock melting outsite of veins. Slide faulting of chondrules is the signature of cataclastic texture in veins. However, large remnant chondrule-textures outside of shock veins (especially glassy and radial chondrules) are signatures of L5 petrological type.

Conclusion: The shock wave propagation may occur in various ways in the little planetary body depending on the rock forming mineral assemblage and the existence of previous fractures (due to earlier impact event or space weathering). Hence, those remnant textures might have been preserved, which were not overprinted by the later impact event. Such regions in the rock may preserve the original petrologic type of the chondritic meteorite. Appearance of shock veins depends on loading of post-shock pressure and temperature: 1) cataclastic texture without phase transition is common for shock pressure around 10 GPa and shock temperature below 700 °C, and short pressure pulse (few nanoseconds) shock regime, 2) post-shock temperature above 1000 °C shock pressure between 10-35 GPa indicate shock melting, 3) phase transitions with occurrence of both of shock melting and cataclasitic fracturing indicate post-shock pressure above 35 GPa, and postshock annealing temperature at 2700 °C, and pressure pulse time of 6-8 seconds.

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