SPHERICAL SHOCK EXPERIMENTS WITH CHELYABINSK METEORITE: CHARACTERIZATION OF SHOCK GRADIENT BY OPTICAL AND ELECTRON MICROSCOPY

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Introduction: Shock experiments with loading by spherically converted shock waves on the Chelyabinsk meteorite sample was performed in the Russian Federal Nuclear Center-VNIITF. The ball sample cut from the Chelyabinsk meteorite was subjected to the pressure impact. Main details and the first description of the results could be found in [1]. The shock pressure and temperature have been increased from the outer to the inner part of the shocked ball. Here we report the description of the shock effects on the meteoritic material.

Samples and Methods: After the shock loading of the ball sample it was cut in half and then gently removed from the steel container. The diametral section was polished, while another was cut for the thin section preparation. An optical observation was performed using AxioVert 40 MAT (Carl Zeiss) and Laboval 2 (Carl Zeiss Jena), electron microscopy was done by using of scanning electron microscope ΣIGMA VP (Carl Zeiss) with an X-max energy dispersive spectroscopy device (Oxford Instruments).

Experimental:

Visually distinguishable rims in the diametral section showed features of the material processing after the shock. Thus, the outer region of the circle section showed light-colored lithology material, which resembles initial material. However, there were found a number of thick impact veins in the material texture, while some of the troilite inclusions were partly melted. In the transmitted light weak mosaicism of olivine grains was noted, that corresponds to the shock stage S4. This zone spreads from the sample edge to the 0.45 of the ball sample radius (R).

The second zone is situated from the 0.45R to the 0.4R. It looks like a dark-colored ring. Moreover, its texture appears to have the same features as the dark-colored lithology of Chelyabinsk has [2]. For example, troilite melt filled in the small cracks. There was not found troilite grains in this region. Grains have smooth ages and they are almost opaque under the transmitted light microscope. Although large metal grains and chromite grains are present, this zone corresponds to the shock stage S6.

The third zone is sulfide melt-rich zone corresponds to the S5. It situated from the 0.4 R to 0.25 R. Its texture contains clasts of heated material embedded into the melt, where abundant vesicles with the small metal and troilite particles were observed. A few newly formed silicate crystals were found in this region.

The fours zone is an entirely molten phase in the sample interior, which corresponds to the shock stage S7. It appears as completely melted material in the inner region. There are presented newly grown crystals of olivine in the shape of cross-oriented bars, which intersperse with a rich of vesicles glass. New crystals show a sharp extinction in the polarized transmitted light. Several metal-troilite intergrowing were observed in the central region. Part of them was relatively large. It was noted that every metal+troitite droplet associated with a vesicle. Only a few small chromite grains were noted in melted material sample center.

Changes in reflectance spectra correlated with the shock stage on the example of shocked Chelyabinsk LL5 is presenting in the [3].

Conclusions: The four visually different zones obtained from the spherical shock experiment on the light-colored lithology of Chelyabinsk LL5 were studied by optical and electron microscopy: shock melt, dark-colored, brighter-dark-colored and light-colored material. All shock stages were revealed in the experimentally shocked sample: from the S3/4 of the initial material up to the S7, which appears as the completelly melted material.

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