THE CLOUDY ZONE STRUCTURE AS AN INDICATOR OF SHOCK AND THERMAL EFFECTS.

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Introduction: The study of the impact of shock and thermal effects on the structure of meteorites in space conditions is a difficult task since the distribution of temperatures and pressures in meteorite matter is very chaotic. For example, it was shown in [1] that in ordinary chondrites with a grain size of about a millimeter, the pressure reaches equilibrium within microseconds after the impact, and it will take several seconds to reach the equilibrium temperature.

In space conditions, a unique structure of meteorite metal is formed, which consists of a Fe-Ni alloy. Using the double phase diagram of Fe-Ni it is possible to estimate the temperature at which the substance was heated before falling to the Earth. The main difference from artificial alloys is extremely slow cooling (about 1K / million years), leading to the formation of zonal taenite. It consists of tetrataenite, an ordered γ'-phase of FeNi, and cloudy taenite or cloudy zone. This zone is formed as a result of spinodal decomposition and consists of two phases: tetrataenite in a kamacite matrix (γ '+ α) [2].

Samples and Methods: In this work, we studied a sample from the pallasite part of Seymchan meteorite, which was a part of the experiment with spherically converging shock waves. The experiment was carried out at the Russian Federal Nuclear Center (RFNC) – Zababakhin All-Russia Research Institute of Technical Physics in Snezhinsk according to the method described in [3]. On the outermost part of the spherical sample after the impact, particles of taenite with a zonal structure were found using a scanning electron microscope Zeiss ∑IGMA VP. It contains high-nickel nanosized rounded islands of tetrataenite surrounded by kamacite. It can be assumed that the preserved structure of cloudy taenite is possibly related to the peculiarity of heat removal at the metal/silicate boundaries. The traces of the cloudy zone are not observed in the center of the sphere.

Results and Discussion: A local increase in pressure entails generally a local increase in temperature in such heterogeneous multicomponent materials as the material of meteorites. However, the converse is also true. Cloudy taenite structure is observed in meteorites which underwent impact event (> 13 GPa). It can be argued that there are threshold values of pressures and temperatures, after which the structure of cloudy taenite disappears. Analysis of the literature has shown that there are no studies of changes in the structure of the cloudy taenite itself before and after shock loading. Earlier in work [4], it was found that the structure of cloudy taenite completely decomposes During heating to 700 °C and holding for 6 hours, but it turns out to be stable when heated to 400°C and the same holding time. Thus, we can conclude that this area did not heat up above 700°C, and the structure itself can serve as an indicator of shock and heating of extraterrestrial matter. In the future, it is planned to establish the structural parameters of the zoned taenite in the shocked sample, which will make it possible to more accurately assess the changes in cloudy taenite and tetrataenite.

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