THE HEATING INFLUENCE ON THE CLOUDY ZONE STRUCTURE IN THE SEYMCHAN METEORITE (PMG).

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Introduction: The structure of the metal in meteorites is formed as result very long holding time at low temperatures. The main transformations in iron-nickel extraterrestrial alloys are given in a phase diagram [1]. The structure of zoned taenite is formed due to very low cooling rates (about several 1 K/Myr) [1]. Tetrataenite and cloudy zones belong to this structure. Tetrataenite is γ' ordered phase FeNi with variable composition (48 …50 % Ni). This area is situated next to the cloudy zone (γ' + α), which consists of high-nickel particles of the γ'-phase (tetrataenite) with a size of several hundred nm. Nickel content decreases with distance from the edge of tetrataenite from 48 to 30%. This structure is a result of spinodal decomposition in the temperature range of 400-450 °C. This area depends on the low-temperature cooling rates of the parent bodies of meteorites and it can be used as an indicator of the maximum heating temperature in thermal history of a meteoroid before falling to the Earth. In the present work, we studied the heating influence on the cloudy zone structure.

Experimental: Seymchan pallasite has two components: pallasite and octahedrite. Two fragments from each part were selected for the study. Pallasite and octahedrite fragments were heated to 400 °C and 500 °C.

Samples preparation included the following steps: cutting, grinding, and polishing using a diamond suspension and colloidal silica, etching with a 3 wt. % solution of nitric acid in 98% ethanol. The optical microscope Axiovert 40 MAT, scanning electron microscopes ZEISS ΣIGMA VP were used to study the microstructure. The chemical composition was determined using the EDS unit before and after annealing in each specimen. The average size of high-nickel particles in the cloudy zone was also measured in samples before and after heating to 500 °C by the method described in [2]. Nickel content was measured in the kamacite, tetrataenite and cloudy taenite before and after heating to 500 °C in both samples.

One sample from pallasite component and one sample from octahedrite component were heated in a vacuum furnace to 400 °C under vacuum (190 Pa). Also, two more samples (one from each components) were heated in a vacuum furnace up to 500 °C under the same vacuum The holding time was 6 hours. Samples were cooled with cooling the furnace.

Results and Discussion: The structure of metal from pallasite and octahedrite fragments has not changed after heating to 400 °C. Also, cloudy zone structure has been preserved both in pallasite and octahedrite samples after annealing.

The holding for 6 hours with T = 500 °C showed more interesting results. The beginning of the phase transformation in the cloudy zone of the pallasite and octahedrite samples was detected. The growth of a new α-phase is observed at the kamacite /tetrataenite interface. The structure of the cloudy zone has been preserved in many areas. There are areas with a modified structure of high-nickel particles. We observe disappearing of the kamacite matrix and start of high nickel particles association. So, the start of the phase transformation in the Seymchan meteorite cloudy zone has been found. Also, the average size of high-nickel nonmodified particles was measured before and after heating to500 °C for pallasite and octahedrite samples. These value were 128 nm and 130 nm before and after annealing correspondingly for pallasite sample; 137 nm and 140 nm before and after annealing correspondingly for octahedrite sample. Thus, heating does not affect the average size of high-nickel particles in the cloudy zone. Nickel content did not change after heating in all areas in both samples. This suggests that the grain boundary diffusion of nickel in iron does not begin at 500 °C.

Conclusions: As a result of the Seymchan meteorite annealing at 400 °C and holding for 6 hours, it was found that the cloudy zone didn't change both in pallasite and octahedrite components of the meteorite. Probably it needs more holding time. After annealing at 500 °C for 6 hours, the start of the phase transformation was revealed in the cloudy zone in pallasite and octahedrite fragments of Seymchan meteorite. The transformation mechanism has not yet been established. Further experiments make it possible to establish the nature of the phenomenon.

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