STUDY OF THE FUSION CRUST IN CHELYABINSK LL5 FRAGMENTS USING X-RAY DIFFRACTION AND MÖSSBAUER SPECTROSCOPY.

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Introduction: The fusion crust formation after meteorite entrance into the Earth atmosphere shows how the internal matter combustion can occur. It is possible that different time of meteorite fragments fall can be a reason of some variations in the fusion crust. Therefore, we studied two fragments of Chelyabinsk LL5 meteorite which have the fusion crust by means of X-ray diffraction (XRD) and Mössbauer spectroscopy in comparison with those studies of their internal matter.

Materials and Methods: The powdered samples of the fusion crust and internal matter from two fragments of Chelyabinsk LL5 meteorite with different lithologies (fragment No 1a with light lithology and fragment No 2a with mixed light and dark lithologies) were prepared for XRD and Mössbauer studies. The XRD patterns were measured with the XRD–7000 powder diffractometer (Shimadzu). The ^{57}Fe Mössbauer spectra were measured at 295 K using SM-2201 spectrometer with a high velocity resolution.

Results and Discussion: The results of the fusion crust XRD patterns analysis showed the presence of the main phases such as olivine, orthopyroxene, troilite and magnesioferrite ($MgFe_2O_4$) as the ferric compound. However, the content of these phases in fragments No 1a and No 2a was slightly different: ~56 wt.% (olivine), ~22 wt.% (orthopyroxene), ~8 wt.% (troilite) and ~8 wt.% (magnesioferrite) in fragment No 1a and ~62 wt.% (olivine), ~20 wt.% (orthopyroxene), ~7.5 wt.% (troilite) and ~3 wt.% (magnesioferrite) in fragment No 2a. Earlier, the presence of magnesioferrite in the fusion crust was found in one meteorite only [1]. Mössbauer spectra of the fusion crust demonstrate also the presence of magnesioferrite (this spinel has a formula $(Mg_{1-x}Fe_x)_A[Mg_yFe_{2-y}]_BO_4$ with 8 metal cations occupied tetrahedral A sites and 16 metal cations occupied octahedral B sites). Other spectral components were related to the M1 and M2 sites in olivine and orthopyroxene, troilite, chromite, residual Fe-Ni-Co alloy and unknown ferrous compound. The relative areas of these spectral components, which can roughly correspond to the relative iron content in these phases, were: (i) ~42 % (olivine), ~9 % (orthopyroxene), ~5 % (troilite), ~4 % (Fe-Ni-Co alloy), ~4 % (chromite), ~3 % (ferrous compound) and ~33 % (magnesioferrite) in fragment No 1a; (ii) ~53 % (olivine), ~9 % (orthopyroxene), ~6 % (troilite), ~3 % (Fe-Ni-Co alloy), ~1 % (chromite), ~6 % (ferrous compound) and ~22 % (magnesioferrite) in fragment No 2a. These results showed a smaller content of magnesioferrite in the fusion crust from fragment No 2a in comparison with fragment No 1a. Further, these results were compared with those of Mössbauer spectroscopy of the internal matter from these fragments. It was found that formation of the fusion crust led to different decrease in the initial content of the same phases in fragments No 1a and No 2a: ~74 % and ~45 % for troilite, ~25 % and ~14 % for olivine and ~39 % and ~52 % for orthopyroxene, respectively (Fig. 1). These differences and different content of magnesioferrite in fragments No 1a and No 2a can be explained as a result of different time of fragments fall in the atmosphere and combustion. We can suppose that fragment No 1a with light lithology was close to the suface of Chelyabinsk meteoroid while fragment No 2a with mixed light and dark lithologies was deeper inside meteoroid and released later than fragment No 1a. Therefore, the latter fragment fell relatively longer time with formation of a larger amount of magnesioferrite than fragment No 2a (see details in [2]).

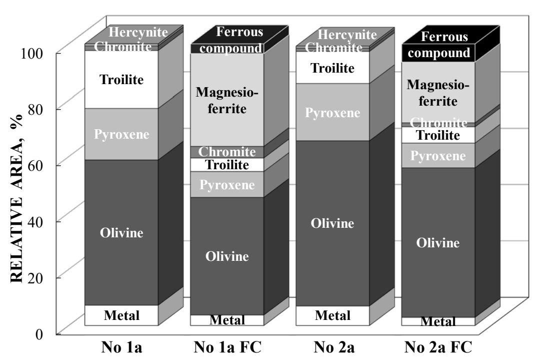

Fig. 1. Comparison of the differences in the total relative areas for the Mössbauer spectral components corresponding to the iron-bearing phases (roughly equivalent to the relative iron content in these phases) in the internal matter and in the fusion crust (FC) in Chelyabinsk LL5 meteorite fragments No 1a with light lithology and No 2a with mixed light and dark lithologies.

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References:

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