APPLICATION OF IMAGE ANALYSIS IN OPTICAL MICROSCOPY OF ORDINARY CHONDRITES.

E. V. Petrova, M. S. Petrov, and V.I. Grokhovsky, Institute of Physics and Technology, Ural Federal University, Ekaterinburg, 620002, Russian Federation. E-Mail: evgeniya.petrova@urfu.ru.

Most of meteorite collections contain sections/thin sections and slices of meteoritic material, which are avaliable for the microscopic study. Ordinary chondrites consist of various mineral phases such as olivine, orthopyroxene, clinopyroxene, plagioclase, kamasite, taenite, troilite, chromite, ilmenite. Most of the phases can be determined using optical microscopy with transmitted light (TL) and reflected light (RL). Optical microscopy is a useful non-destructive method, which give information about as phase composition as distribution of grains of different phases within the sample.

Application of image analysis systems give additional possibilities for estimation, calculation and comparison of microscopic images. It allows to provide measurements on a large area of the section with a high spatial resolution, up to the scanning of the whole polished surface of the fragment at once (see, for example [1]). It demands less complicated sample preparation for the study than, for instance, electron microscopy. Moreover, image analysis of optical microscopy images can be easily applied using equipment that most of laboratories already have. This is method for direct observations. Phase composition can be obtained using indirect methods, while phase distribution – using computer tomography or optical microscopy image analysis.

Different integral parameters can be measured for the troilite, metal or chromite phase inclusions in the section, for instance:

- Spatial phase distribution and its size distribution;
- Shape and relative situations of the grains;
- Intergrowings or distinctive inclusions parameters.

Different stereological and morphological characteristics can be measured for individual grain as well as for every grain in the section (see [2]). On the basis of these data several assumptions concerning phase transformations, thermal history or shock metamorphism in the meteoritic material can be developed. For instance, it was noted that amount of large metal grains in the thin sections increases with the petrologic type of ordinary chondrite from 3 to 6 [3]. Besides, increasing of the roughness factor value (FR) for both H and L chondrites with the petrologic type was revealed [3].

Other textural features of the meteorite fragment, such as porosity and jointing can be measured by image analysis. It can realize quantitative description of the sample texture instead of traditional qualitative description. Moreover, these characteristics depend on the of the processes that took place within the sample (flowing of the melt, cooling, shock etc.).

As far as optical microscopy images, in contrast to electron microscopy images, provides color information, additional analysis parameter can be used. In the case of the same image-capture conditions provided, images of the different zones in monomict breccia can be compared to each other; as images of the heated/shocked samples can be compared to the initial samples texture. It is important, because different phase positioning causes different strength properties of the meteoritic material, which means strength properties of the asteroid/meteoroid material.

In our laboratory we recently studied samples of several ordinary chondrite fragments (Chelyabinsk LL5, Annama H5 and Tsarev L5). Optical images were obtained using Axiovert 40MAT (Carl Zeiss, RL), Laboval 2 (Carl Zeiss Jena, TL), Meiji MX 8530 (TL). Further image analysis was performed with SIMAGIS software and Panoramic Microscopy System SIAMS MT.

Application of image analysis in optical microscopy of ordinary chondrites permitted us:

- to investigate phase distribution in the sample volume (from the one side of the sample to another);
- to measure and compare the texture of the different meteorite zones;
- to measure the porosity and jointing of the sample texture;
- to measure the color differences between comparable meteoritic material;

Therefore, image analysis provides additional numerical information about texture, and processes that meteorite fragment experienced.

Acknowledgements: This work was supported by the Ministry of Education and Science of the Russian Federation (the Project # 3451, 4825) and by Act 211 Government of the Russian Federation, contract № 02.A03.21.0006.

References: [1] Kohout T. et al. (2017) *Meteoritics & Planetary Science 52, Nr 8,* 1535-1541. [2] Negashev V. S. and Grokhovsky V. I. 2000. *Meteoritics & Planetary Science 35, No 5,* A117-118 [3] Zhiganova E.V. and Grokhovsky V. I. (2003) *Meteoritics & Planetary Science 38, Nr 7,* A58.