METEORITE OCHANSK: GENESIS AND COMPOSITION PECULIARITIES

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Introduction: Meteorite Ochansk fell to Earth on August 18, 1887, near the city of Ochansk, Perm province in Russia and he weighed 186.5 kg. Earlier, the meteorite Ochansk was studied in [1,2]. Meteorite was assigned to the group of olivine-bronzite H-chondrites of the family of ordinary chondrites of the class of stony meteorites. It is intensively brecciated and is represented by a disorderly mixture of silicate chondrules, their breaks and their fine-grained matrix enclosed by silicate minerals, interstitial silicate glass, which is the same as chondra. Ore minerals are nickel-iron (kamacite) and troilite. A.A. Marakushev [1] connects the formation of the meteorite Ochansk with volcanic processes in the mother protoplanetary body. However, most researchers connect the origin of chondrites with the accretion processes of matter in the Protosolar nebula. Therefore, we undertook an additional study of the meteorite Ochansk in order to clarify its genesis.

Methods: In the study of the meteorite Ochansk, we used the following methods and instruments: 1) microprobe analysis on a scanning scanning electron microscope XL-30 from Philips with an EDAX; 2) X-ray fluorescence analysis on the Bruker S8 Tiger analyzer; 3) X-ray diffraction analysis on a P2 Phaser diffractometer from Bruker; 4) crystal-optical study of petrographic sections on a microscope from Zeiss.

Results: According to the content of the main elements (Si, Mg, Ca, Al, Na, K), the Ochansk meteorite is close to the group of H-chondrites, and by the content of total iron approaches the group of L-chondrites. The average mineral composition of the meteorite, calculated by X-ray fluorescence analysis, corresponds to the class of chondrites. Under a microscope in petrographic sections, it can be seen that the meteorite is composed of chondrules up to 2 mm and containing a matrix. The main minerals of the meteorite in order of decreasing prevalence are olivine, bronzite, plagioclase, diopside. Sometimes there is a silicate glass. The iron index of olivine and orthopyroxene varies between 0.15 and 0.20, averaging 0.17 in the chondrules and 0.18 in the matrix, which is characteristic of H chondrites. The following types of chondrules are distinguished in terms of quantitative ratios of minerals in order of decreasing from the occurrence: olivine-bronzite, bronzite-olivine-new, olivine-plagioclase, vitreous, composed of silicate glass with microliters of bronzite, plagioclase. The structure is dominated by granular chondrules. Less often there are radiant bronzite chondrules and glassy fringes. Sometimes olivine-pyroxene chondrules with a grate and symplectite structure are noted [1]. The matrix is composed of small grains of the same silicate minerals as chondrules with fragments of chondrules, their minerals and silicate glass. The microscopic examination in reflected light, as well as microprobe analyses, show that the ore minerals in the meteorite are basically kamacite (less often taenite) and troilite, in chondrule much smaller and smaller than in the matrix. In chondrules, troilite predominates over kamacite. In the matrix, on the contrary, kamacite predominates on the troilite. The accessory minerals in the meteorite are more often characterized by a chromite, less often there is a whitlockite, ilmenite, apatite, spinel, and schreibersite. Plagioclase and diopside in chondrules occur almost twice as often as in the matrix. The number of plagioclase varies in the range 0-34 and on the average has the value N = 10. Diopside in the meteorite is a secondary mineral replacing the orthopyroxene as a result of its interaction with the residual silicate glass.

Discussion: In petrographic sections, under a microscope, the matrix structure resembles an uneven-grained polymineral sandstone with porous cement, which develops spotted and is represented by ore minerals (kamacite, troilite) and silicate glass. The matrix material does not show recrystallization and has an increased porosity. The specific gravity of the meteorite calculated by Archimedes' method was 2.86 g/cm^3. The theoretical density of the meteorite, calculated from the density of its mineral constituents, was 3.89 g/cm^3. Hence the calculated porosity of the meteorite Ochansk was found to be 26%, the value of which corresponds to weakly cemented clastic rocks [3]. Ore minerals in the matrix form larger irregularities than in the chondrules, cementing the matrix grains with each other and a matrix with chondrules. The irregular shape of the ore precipitates and their location in the intergranular pores of the matrix indicate that the ore matter aspired to separate from the silicate melt even in the melt and entered the already consolidated matrix while still in a liquid state. This indicates a high accretion temperature, possibly exceeding 15000°C.

Conclusions: The absence of traces of recrystallization of the meteorite Ochansk substance and its high porosity indicate that the substance of this meteorite did not sink deep into the bowels of the maternal body and was not exposed to elevated temperatures and pressures and, therefore, preserved information about the earliest stages of accretion of the protoplanetary substance of the Solar System.

References: [1]Marakushev A.A. et al. 1992. Space Petrology, M.MGU.325p. [2]Kaushal S.K., Wetherill G. W. 2016. J.Geophys.Res.158:569-582. [3] Kuznetsov V.G. 2007. Sedimentary rocks and their study. M. Nedra. 511 p.