PALLASITE METEORITE BRAHIN: COMPOSITION AND GENESIS

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Introduction: Meteorite Brahin belongs to the class of pallasites. We studied a polished plate of this meteorite weighing 19.6 g. From the collection of the Geological Museum of Kazan Federal University. In the literature, the genesis of pallasites remains controversial, and the Brahin meteorite is poorly understood [1,2]. The meteorite has a loop-porphyry structure. The loop part is composed of kamacite-taenite, and porphyry - by large crystals of olivine.

Methods: A polished plate 4 x 5 cm in Brahin meteorite was examined using an XL-30 electron microscope from Phillips, equipped with an EDAX. We performed sixty microprobe analyzes, which were the basis for the characteristics of the composition and genesis of this meteorite.

Results: In the meteorite, fifteen minerals and aluminosilicate glass of complex composition were detected. In addition to olivine and kamacite-taenite, composing 95% of the area of the plate, chromite, graphite, cogenite, mackinawite, wustite, silicate glass, lawrencite, K-Na feldspar, hexonite, heazlewoodite, algamite, panetite have been found (in decreasing order of occurrence). At some sites in the Brahin meteorite, olivine contains metasomatic inclusions of graphite. The form of graphite precipitation is incorrect with numerous rectilinear constraints, indicating the penetration of graphite-forming fluid through cracks, crystallographical oriented and weakened zone.

Discussions: The formation of graphite inclusions in olivine of the Brahin meteorite can be explained by the penetration of a gas fluid containing CO, CO_2, and can be expressed by the reaction 2 CO = C (graphite) + CO_2. Graphite in olivine replaces a significant volume of the host mineral. The question arises, where did the mineral forming elements of olivine Mg, Fe, Si disappear? Obviously, they were carried out by fluid melts FeO, which are due to the molecular decomposition of olivine under the influence of high temperatures of graphite-forming gas fluids CO, CO2, according to the reaction $(Mg, Fe)_2 SiO_4 \rightarrow f \cdot FeO$ (melt) + (2 - f) MgO^0 + SiO_2^0, where f is the ferruginous index of olivine f = Fe/(Fe + Mg). The resulting wustite melt produced the removal from the decomposing olivine of periclase MgO^0 molecules and tridymite SiO_2^0 compounds. This process was most intensive in areas of more active migration of high-temperature reducing gas fluids. Here a melt of wustite-silicate glass appeared and small olivine relics remained. The wustite melt that originated could generate in the areas enriched with CO fluids the formation of: 1) metallic iron FeO + CO = Fe (metal) + CO_2; 2) iron carbide 3FeO + 5CO = Fe_3C + $4CO_2$; 3) troilite FeO + H_2S + CO = FeS + CO_2 + H_2 in areas additionally enriched with H_2S. Therefore, in the areas of the most intensive migration of deep reducing fluids, the metal phase of pallasites (mainly kamacite, taenite) accumulated, creating a loop pattern of the meteorite structure. These sites correspond to the geochemical buffer IW. Areas of the meteorite, composed of porphyry-like olivine crystals, signify a weakly oxidizing environment corresponding to the stability of the fayalite of the geochemical buffer QFM. Therefore, local oxidation-reduction zonation appears in the pallasites. From the sections of the loop structure in the direction toward the large crystals of olivine, the reduction and reduction of the oxidative potential of the medium occurs. Olivine here no longer decomposes, but grows, increasing its size and using the molecules MgO^0, SiO_2^0, brought here by wustite fluid from the buffer zones of IW. In contact with olivine, the newly formed spinel-chromium is often found, emphasizing the increasing oxidative potential of the medium.

Conclusions: The metallic phase composing the sections of the bent structure of the Brahin meteorite signifies a strongly reducing environment corresponding to the geochemical buffer IW. This environment was created by a more active migration of deep-lying reducing fluids H_2, CO, H_2S. Areas of the meteorite, composed of porphyry olivine crystals, signify a less restorative environment adjacent to the geochemical buffer QFM. In the most permeable areas of the loop structure, kamacite, taenite, and cogenite are widely developed, and olivine here is unstable and decomposes to form a melt of FeO and molecules MgO^0, SiO_2^0. The latter are carried out by wustite melt in the direction of large porphyry-like olivine crystals, ensuring their further growth and enlargement. Therefore, we associate the formation of the composition and structure of Brahin pallasite with the fluid-metasomatic transformation of the initially chondritic substance under the influence of deep reducing gas fluids H_2, CO, CO_2, H_2S, and others. The flow of these fluids occurred in stages and was initiated, apparently, by impact collisions of planetesimals and processes of differentiation of matter in their interior.

References: [1] Bussek P.R. 1977. *Geochim. Cosmochim Acta*, 41: 711-740. [2] Lavrent'eva Z.A. et al. 2012. *Geochemistry*, 1: 38-47.