Na-Fe-PHOSPHATE GLOBULES IN IMPACT METAL-TROILITE ASSOCIATIONS OF CHELYABINSK METEORITE

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Introduction: The Chebarkul fragment (the 650 kg body found in the Chebarkul lake) of the Chelyabinsk LL5 chondrite contain abundant regions related to impact-induced remelting of the initial chondrite association. In general such associations occur in variable amounts in all samples of the meteorite shower, and they are most common for large samples (> 1 kg) and fragment of the dark lithology [1, 2, 3 and references herein]. The areas of impact melting in the Chebarkul fragment contain large gas cavities (up to 0.5 cm), in which spongy aggregate of skeletal metal crystals (Ni-rich kamacite/martensite + taenite) plus troilite is present (up to 0.5-1 mm, Fig. 1) and may occupy up to 50 vol.%. Phosphate globules have been found in such aggregates [3]. They commonly occur on the metal-troilite boundary and in troilite (5-20 μm, Fig. 1), rarely – in metal (<2 μm). The metal-troilite aggregate sometimes contains Al-free chromite, pentlandite and Cr-rich magnetite. General description of silicate and metal-sulfide parts of impact associations is given in [2, 3].

Experimental: Samples of metal-troilite aggregate were putted in epoxy resin and then polished. They were examined using optical microscope Olympus BX51, scanning microscope TESCAN MIRA 3MLU SEM with EDS system, electron microprobe JEOL JXA-8100 (WDS) and LabRAM HR 800 mm spectrometer.

Results and Discussion: Phosphate globules have multiphase composition, sometimes with clear signs of rapid quenching (Fig. 1). Four phosphates were identified in the impact metal-troilite aggregates of the Chelyabinsk chondrite: galileiite $Na(Fe,Mn)_4(PO_4)_3$, sarcopside and graftonite $(Fe,Mn,Na)_3(PO_4)_2$, and Na-Fe-phosphate (NFP) $Na_2(Fe,Mn)_5(PO_4)_4$, intermediate between galileiite and xenophyllite $Na_4Fe_7(PO_4)_6$ (fillowite group). Phase composition of globules is variable: the sarcopside/graftonite + galileiite association is most common; monomineral globules (galileiite, sarcopside/graftonite, NFP) and paragenesises of galileiite + chromite, sarcopside/graftonite + galileiite + NFP and NFP + Fe-sulfate-sulfide occur rarely. Raman spectroscopy helped to distinguish sarcopside and graftonite, which have similar composition in the Chelyabinsk meteorite. Raman spectra of graftonite is very similar to those for Na-rich graftonite from the Yanzhuang H6 chondrite [4]. The spectra of galileiite and NFP generally resemble those for meteoritic and synthetic galileiite [4]. The fillowite-group minerals in association with other Fe-Mn-Mg-orthophosphates are common of the IIIAB iron meteorites. Na-Fe-phosphate globules in impact associations were previously found in some chondrites: in the Yanzhuang H6 (Na-rich graftonite, galileiite and phase $Na_2(Fe,Mn)_{17}(PO_4)_{12}$) [4] and Krymka LL3.1 (from galileiite to xenophyllite) [5], as well as in the metal-sulfide meteorite Sahara 03505 (sarcopside/graftonite, maricite/karenwebberite $Na(Fe,Mn)(PO_4)$ and NFP phase) [6]. It is suggested that phosphate globules in the above meteorites, including the Chelyabinsk chondrite, is a result of HPT impact melting of the initial chondrite material with segregation of a metal-sulfide melt, enriched in O, P and Na, and its further liquid immiscibility into metal-sulfide and phosphate components under pressure unloading [3-6].

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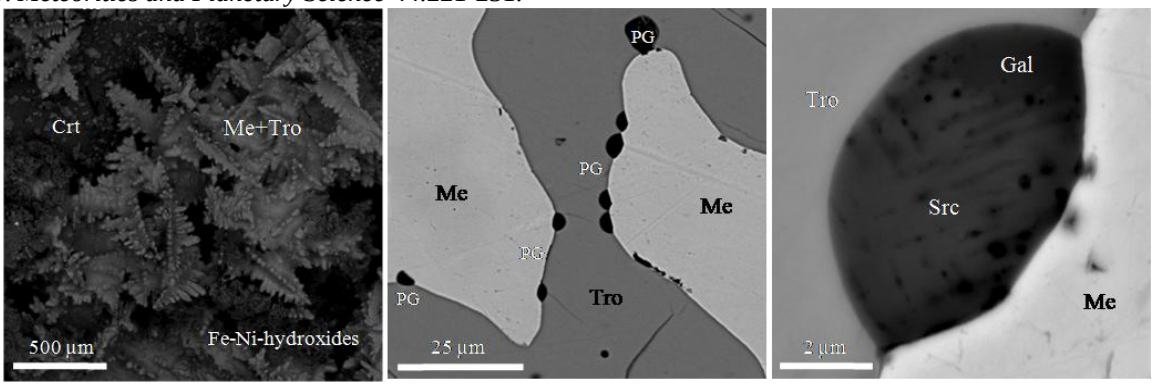

Figure 1. Aggregate of skeletal metal crystals with troilite in gas cavity, distribution of phosphate globules and their common phase composition, impact-melting region in the Chelyabinsk meteorite (BSE images). Me – Fe-Ni-metal; Tro – troilite; Crt – chromite; PG – phosphate globule; Src – sarcopside/graftonite; Gal – galileiite.