MINERALOGY OF OLIVINE-HOSTED INCLUSIONS FROM THE OMOLON PALLASITE. V. V. Sharygin[1], S. V. Kovyazin[1] and N. M. Podgornykh[2], [1]Institute of Mineralogy and Petrography, Koptyuga prospect 3, 630090 Novosibirsk, Russia (sharygin@uiggm.nsc.ru), [2]Siberian Geological Museum of UIGGM SD RAS, Koptyuga prospect 3, 630090 Novosibirsk, Russia.

Introduction: The Omolon meteorite (250 kg) was found in 1982 (it fell in 1981) near the Omolon river (Magadan district, Russia). This meteorite belongs to the main group of the pallasite family. It contains rounded olivine grains (about 60 vol. %, sizes – up to 3 cm, Fa content – 12.3 mole %) in nickeloan iron matrix consisting of kamacite, taenite and plessite [1-2]. In addition, troilite, chromite, schreibersite, nikelphosphide (former rhabdite) and stanfieldite were found in the meteorite [1-3]. The irradiation time of this meteorite was determined to at 78±7 Ma (by noble gases); the K-Ar age for olivine crystallization was assessed as 4.6 Ga, i.e., close to the starting time for formation of protoplanetary system [4]. The calculation of atmospheric trajectory and orbit showed that the Omolon meteorite was probably a fragment of an Apollo M-type asteroid and its preatmospheric mass was approximately 390-490 kg [5]. According to fossil track studies the depth of ablation for the Omolon pallasite does not exceed 8.2±2.1 cm out of the preatmospheric surface [3]. It is suggested that glass of the forsteritic composition is present in melting rim of the meteorite [6]. Preliminary data on olivine-hosted inclusions are given in [7].

Mineralogy of inclusions in olivine: We studied individual olivine grains from the outer zones of the Omolon pallasite. In general, inclusions form planar arrays associated with fractures in the host olivine (Fig. 1). Coexisting metal-sulfide blebs, fluid and crystal inclusions and their combinations were found in some arrays.

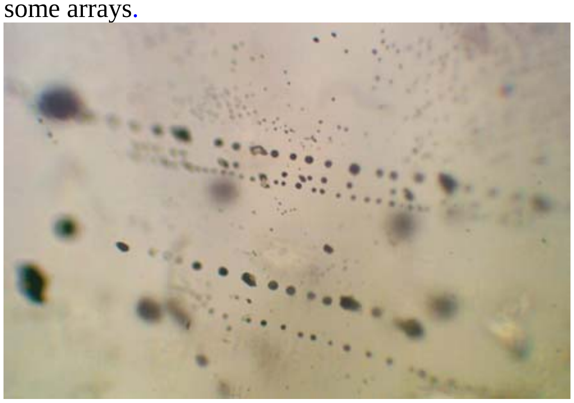

Fig.1. Planar arrays of metal-sulfide inclusions in olivine.

The sizes of individual inclusions range from 5 to 200 µm. In addition, olivine hosts large metal-sulfide blebs and oriented needle-like isolations of Cr-spinel, unrelated to the arrays described above (Fig. 1 A-B). Metal-sulfide and fluid inclusions are most common. Typical phase composition of large metal-sulfide blebs is troilite + kamacite. Nickelphosphide, taenite, stanfieldite, and chromite are minor. Whitlockite, eskolaite and unidentified Si-O-rich phase occur very rarely. Fluid inclusions contain low-density fluid and sometimes metal-sulfide isolations (Fig. 1 C). Colorless transparent phase (phosphate?) rarely occurs in large fluid inclusions (>100 µm). Some mineral associations from the arrays resemble the silicate melt inclusions; however, microprobe analysis has demonstrated, that they are assemblages of stanfieldite, metal-sulfide bleb, and gas bubble (Fig. 1 D). The individual euhedral chromite (up 20 µm) with adhered metal-sulfide bleb and Si-O-rich phase occurs rarely (Fig. 1 C).

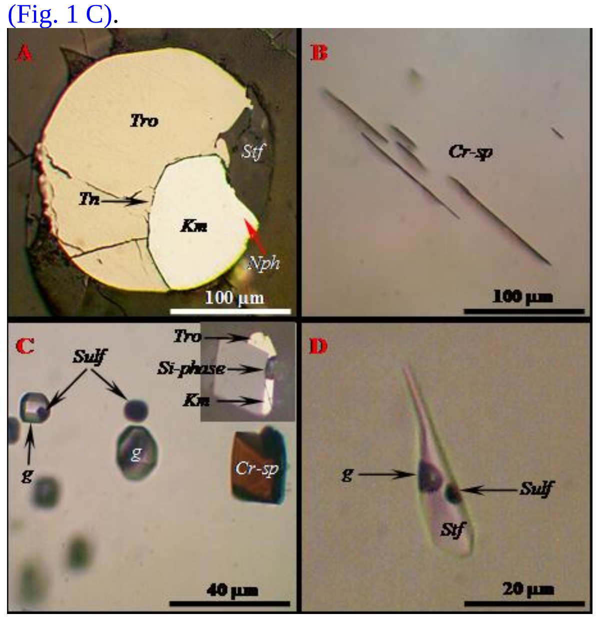

Fig. 2. Different types of olivine-hosted inclusions in the Omolon pallasite. *Tro* - troilite; *Km*- kamacite; *Nph* - nickelphosphide; *Stf* - stanfieldite; *Sulf* - metal-sulfide bleb; *Cr-sp* - chromite; *Si-phase* - Si-O-bearing phase; *g* - gas.

Chemistry of minerals from inclusions: *Troilite* is the major phase of metal-sulfide blebs. Its composition is uniform (in wt. %): Fe – 63.3-63.5; S – 36.4-36.7 and similar to sulfide from metallic part of the pallasite [1]. *Kamacite* is somewhat variable: Fe – 90.3-94.9; Ni – 4.2-8.9; Co – 0.3-0.8, Si, P and S - <0.02. Compositions of *taenite* are highly variable: Fe – 85.9-59.6; Ni – 13.1-40.1; Co – 0.05-0.6. The similar variations are also typical of taenite from metallic part of the meteorite [1]. *Nickelphosphide* $(Ni,Fe)_3P$ (re-

cently approved as a new mineral [8]) occurs rarely in metal-sulfide blebs in olivine. Its composition is: Fe – 31.9-32.8; Ni – 52.1-53.4; Co – 0-0.03; P – 14.3-14.8; Cu, S and Si - <0.15. This mineral is strongly different from schreibersite $(Fe,Ni)_3P$ and similar to nickel-phosphide from metallic part of the meteorite [1]. *Chromite* is virtually free in TiO_2 (<0.05 wt.%) that is typical of Cr-spinels from other pallassites [9]. Compositions of individual chromite crystals in olivine are homogeneous: Cr_2O_3 – 53.5-61.8; Al_2O_3 – 5.6-8.8; FeO – 25.3-32.6; MgO – 3.9-5.5; MnO – 0.6-0.8. Two phosphates were found in olivine: *stanfieldite* $Ca_4(Mg,Fe^{2+},Mn)_5(PO_4)_6$ and *whitlockite* $(Ca,Mg,Fe^{2+})_3(PO_4)_2$. Stanfieldite is a common phosphate mineral, while whitlockite is rare. Chemical composition of stanfieldite: P_2O_5 – 46.2-49.2; SiO_2 – 0-1.45; FeO – 2.8-7.8; MnO – 0.35-0.55; MgO –19.9-21.2; CaO – 23.5-28; Na_2O – 0.02-0.1. Whitlockite is SiO_2-rich (n=2): P_2O_5 – 38.4; SiO_2 – 16.7; FeO – 2.95; MnO – 0; MgO – 2.7; CaO – 37.9; Na_2O – 0.95.
Unfortunately, we could not get good microprobe data for some mineral phases from inclusions because of their very small sizes. We identified them by EDS and scanning microscopy. *Eskolaite* Cr_2O_3 (<1 µm) was found in one metal-sulfide bleb (Fig. 3). This phase is virtually free in Mg, Al, Si and Fe. To our knowledge, it is first finding of this mineral in pallasites and third finding in meteorites after Orgueil and Dhofar 225 [10-11].

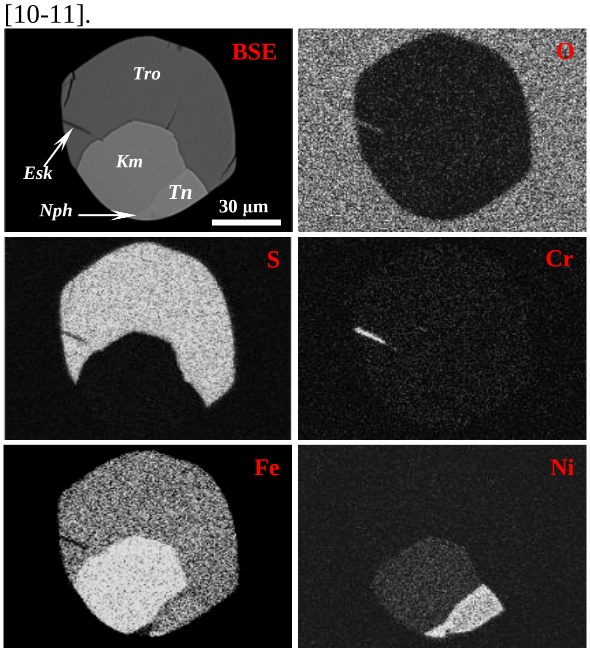

Fig. 3. Back-scattered electron image and X-ray maps for eskolaite-bearing inclusion in olivine. *Esk* - eskolaite; other symbols see Fig. 2.

Si-O-bearing phase forms 1-5 µm grains in association with chromite and metal-sulfide bleb in some arrays (Fig. 4). Scanning microscopy and EDS indicated that it contains O and Si (up to 40 wt.%), and free in other components (excepting some light elements such as N). This phase could be a SiO_2 polymorph or sinoite Si_2N_2O [12].

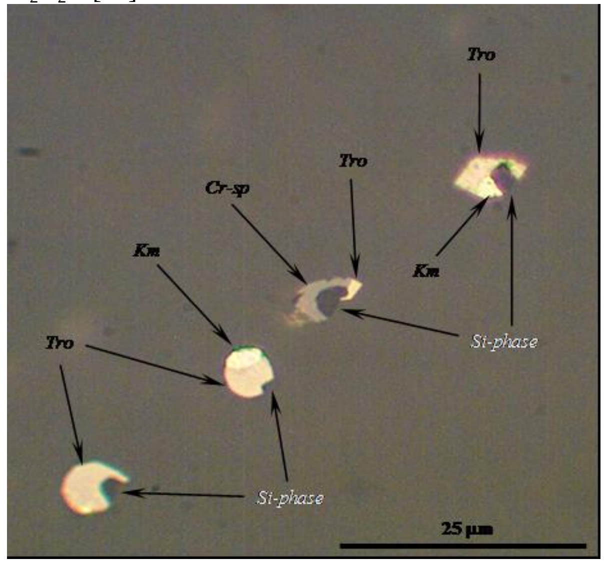

Fig. 4. Inclusions containing Si-O-rich phase.

Discussion: The petrography of the Omolon pallasite, i.e., general recrystallization kamacite, the appearance of fine-grained kamacite with boundary of migration growth, the redistribution of nickel-phosphide, kink banding in olivine, assumes that this meteorite has undergone at least two shock deformations [1]. The presence of planar arrays of inclusions in olivine seems to indicate post-deformational annealing for the meteorite [9]. Possibly, the inclusions originated in response to penetration of the meteorite into the Earth's atmosphere and subsequent impact.

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