VARIATIONS IN OLIVINE EXTRACTED FROM TWO DIFFERENT FRAGMENTS OF SEYMCHAN MAIN GROUP PALLASITE.

E. V. Petrova, A. A. Maksimova, A. V. Chukin and M. I. Oshtrakh, Institute of Physics and Technology, Ural Federal University, Ekaterinburg, 620002, Russian Federation (zhulicki@gmail.com; oshtrakh@gmail.com).

Introduction: Seymchan main group pallasite (PMG) is stony-iron meteorite consisting of Fe-Ni-Co alloy as metallic matrix with stony pieces embedded into the matrix. Pallasites could be formed as a result of slow cooling mixture of solid silicates (stony) fragments in molten Fe-Ni-Co alloy [1]. The stony part contains olivine $(Fe, Mg)_2SiO_4$ as the main mineral with some troilite FeS and chromite $FeCr_2O_4$ inclusions or associates. It was shown that olivine in Seymchan PMG demonstrates two different morphology [1] as well as olivine in different slices contained or did not contain chromite [2]. Therefore, we decided to compare olivine in the stony parts obtained from two different fragments of Seymchan PMG using X-ray diffraction (XRD) and Mössbauer spectroscopy.

Materials and Methods: Stony part was mechanically extracted from two fragments of Seymchan PMG: one was donated by the Committee on Meteorites of the Russian Academy of Sciences, Moscow (No 1) while another one was found by the Meteoritical Expedition of the Ural Federal University (No 2). Powdered stony samples No 1 and No 2 were studied using X'Pert PRO MPD diffractometer (PANalytical, The Netherlands) and Mössbauer spectrometer SM-2201 with a high velocity resolution. Additionally, polished sections of these two fragments were analized using scanning electron microscopy (SEM) with energy dispersion spectroscopy (EDS) by means of ΣIGMA VP (Carl Zeiss) scanning electron microscope with an X-max 80 EDS device (Oxford Instruments).

Results and Discussions: SEM with EDS demonstrated that the stony part in the section of Seymchan PMG fragment No 2 contains olivine, troilite and chromite. XRD patterns demonstrated the presence of ~97 wt.% of olivine and ~3 wt.% of SiO_2 in the sample No 1 [3] and ~95.5 wt.% of olivine, ~2.3 wt.% of Ca-rich clinopyroxene, ~1.1 wt.% of chromite and ~0.3 wt.% of troilite in the sample No 2. The unit cell parameters appeared to be different for olivine crystals from two Seymchan PMG fragments: a = 10.2267(7) Å, b = 5.9939(4) Å, and c = 4.7623(3) Å (No 1) and a = 10.2317(8) Å, b = 5.9965(7) Å, and c = 4.7636(5) Å (No 2). Mössbauer hyperfine parameters obtained for olivine from two fragments appeared to be slightly different also. For example, the values of quadrupole splitting ΔE_Q for the M1 and M2 sites were as follows: ΔE_Q = 3.058 ± 0.002 mm/s (M1), ΔE_Q = 2.876 ± 0.002 mm/s (M2) for No 1 and ΔE_Q = 3.024±0.008 mm/s (M1), ΔE_Q = 2.955±0.008 mm/s (M2) for No 2. These results indicate some differences in the local iron microenvironments in both M1 and M2 sites. These structural differences may be related to diferent thermal history and Fe^{2+}–Mg^{2+} partitioning in two olivines. Using the Rietveld full profile analysis the cation occupations for both olivines were estimated: X_{Fe}^{M1} = 0.126, X_{Mg}^{M1} = 0.874 and X_{Fe}^{M2} = 0.098, X_{Mg}^{M2} = 0.902 for No 1 and X_{Fe}^{M1} = 0.145, X_{Mg}^{M1} = 0.855 and X_{Fe}^{M2} = 0.105, X_{Mg}^{M2} = 0.895 for No 2. The ratios of Fe^{2+} occupations of the M1 and M2 sites in olivine were estimated using two independent techniques: XRD and Mössbauer spectroscopy (in the latter case we can use relative areas of spectral components associated with the ^{57}Fe in the M1 and M2 sites: A_{M1} and A_{M2}, respectively). The results obtained by two techniques demonstrate agreement for each olivine sample: X_{Fe}^{M1}/X_{Fe}^{M2} = 1.25 and A_{M1}/A_{M2} = 1.22 (No 1) and X_{Fe}^{M1}/X_{Fe}^{M2} = 1.38 and A_{M1}/A_{M2} = 1.35 (No 2). However, these results indicate some differences in the Fe^{2+} and Mg^{2+} content as well as in Fe^{2+}–Mg^{2+} partitioning in two olivines. Further, using XRD data and the method described in [4] for Mössbauer data we can estimate temperatures of equilibrium Fe^{2+} and Mg^{2+} cations distribution T_{eq} in olivines from two Seymchan PMG fragments. The values of T_{eq} obtained using two techniques are as follows: 1002 K (XRD) and 1118 K (Mössbauer spectroscopy) for fragment No 1 and 684 K (XRD) and 744 K (Mössbauer spectroscopy) for fragment No 2. These estimations of T_{eq} demonstrate different thermal history of olivines in Seymchan PMG fragments No 1 and No 2 that may be a reason of some structural differences in these silicates.

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