THE FUSION CRUST FROM OZERKI L6 AND KEMER L4 STUDIED BY X-RAY DIFFRACTION, MAGNETIZATION MEASUREMENTS AND MÖSSBAUER SPECTROSCOPY.

A. A. Maksimova[1,2], E. V. Petrova[1], A.V. Chukin[1], I. Felner[3] and M. I. Oshtrakh[1], [1]Department of Experimental Physics, Institute of Physics and Technology, Ural Federal University, Ekaterinburg, 620002, Russian Federation (alia55@bk.ru, evgeniya.petrova@urfu.ru, achukin@e1.ru, oshtrakh@gmail.com), [2]The Zavaritsky Institute of Geology and Geochemistry of the Ural Branch of the Russian Academy of Sciences, Ekaterinburg, 620016, Russian Federation, [3]Racah Institute of Physics, The Hebrew University, Jerusalem 91904, Israel (israel.felner@mail.huji.ac.il).

Introduction: The first study of the fusion crust from ordinary chondrites by X-ray diffraction (XRD) was done for Saratov L4 [1], then the fusion crust from Chelyabinsk LL5 was analyzed by XRD and Mössbauer spectroscopy with a high velocity resolution [2]. The presence of magnesioferrite $MgFe_2O_4$ in the fusion crust was observed in both studies. Here we compare results of fusion crust taken from Ozerki L6 [3] and Kemer L4 [4] ordinary chondrites obtained by XRD, magnetization measurements and Mössbauer spectroscopy.

Materials and methods: The fusion crusts were removed from the surfaces of Ozerki L6 and Kemer L4 fragments and then powdered. XRD measurements were carried out using the XRD-7000 powder diffractometer (Shimadzu) operated at 40 kV and 30 mA with CuK_α radiation. Magnetization measurements were done using commercial SQUID MPMS-5S magnetometer (Quantum Design) in the temperature range of 5–295 K. ^{57}Fe Mössbauer spectra were measured at 295 K using an automated precision Mössbauer spectrometric system based on the SM-2201 spectrometer with a high velocity resolution using a saw-tooth velocity reference signal and moving absorber.

Results: The Rietveld full profile analysis of XRD deduced the following composition of the fusion crust: olivine (58.8 wt% and 59.8 wt%), orthopyroxene (14.8 wt% and 13.2 wt%), magnesioferrite (13.1 wt% and 12.3 wt%), anorthite (7.6 wt% and 4.6 wt%), troilite (2.0 wt% and 1.3 wt%), Ca-rich clinopyroxene (1.6 wt% and 4.9 wt%), the α-Fe(Ni, Co) phase (1.0 wt% and 2.8 wt%), chromite (0.5 wt% and 0.4 wt%), hercynite (0.4 wt% and 0.2 wt%) in Ozerki L6 and Kemer L4, respectively. Additionally, 0.2 wt% of the γ-Fe(Ni, Co) phase was found in Ozerki L6 and 0.4 wt% of ferrihydrite was detected in Kemer L4.

Magnetization measurements of the fusion crust from Ozerki L6 demonstrated two magnetic phase transitions in the zero-field-cooled (ZFC) curve at 21 K and 48–50 K, which were attributed to the phase transitions in hercynite and chromite, respectively, and the saturation magnetic moment M_S of 26 emu/g (5 K) and 22 emu/g (295 K). Magnetization measurements of the fusion crust from Kemer L4 showed one magnetic phase transition in the ZFC curve at 41 K related to chromite and M_S values of 21.5 emu/g (5 K) and 16.2 emu/g (300 K).

The Mössbauer spectra of the fusion crust from Ozerki L6 and Kemer L4 demonstrate the presence of different number of spectral components. The spectrum of Ozerki L6 fusion crust consists of 5 magnetic sextets associated with the tetrahedral (A) and octahedral [B] positions in magnesioferrite (2 and 3 sextets, respectively), 2 magnetic sextets related to the α-Fe(Ni, Co) phase and troilite, 2 pairs of quadrupole doublets assigned to the M1 and M2 sites in olivine and orthopyroxene, 2 quadrupole doublets corresponding to unknown ferrous and ferric compounds and 1 paramagnetic singlet attributed to chromite. The spectrum of Kemer L4 fusion crust was decomposed into the following components: 2 pairs of magnetic sextets assigned to the (A) and [B] sites in magnesioferrite, respectively, 2 magnetic sextets related to the α-Fe(Ni, Co) phase and 1 sextet associated with troilite, 2 pairs of quadrupole doublets assigned to the M1 and M2 sites in olivine and orthopyroxene, 2 quadrupole doublets associated with ferrous (hercynite?) and ferric (ferrihydrite?) compounds and 1 paramagnetic singlet attributed to chromite as well as a large magnetic sextet associated with maghemite (Kemer L4 was weathered in contrast to Ozerki L6 which was fresh). Evaluation of the Fe^{2+} and Mg^{2+} cations distribution in olivine and orthopyroxene from XRD and Mössbauer data (see [5]) yield the ratios of Fe^{2+} occupancies among the M1 and M2 sites as follows: (**i**) 1.19 and 1.22 for olivine and 0.22 and 0.21 for orthopyroxene (Ozerki L6) and (**ii**) 1.47 and 1.53 for olivine and 0.19 and 0.14 for orthopyroxene (Kemer L4). Further, the fast cooling temperatures starting were estimated from XRD and Mössbauer data: (**i**) 1113 K and 927 K for olivine and 978 K and 962 K for orthopyroxene (Ozerki L6) and (**ii**) 498 K and 451 K for olivine and 901 K and 803 K for orthopyroxene (Kemer L4).

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