ALTERED MATERIAL IN CH/CB CHONDRITE ISHEYEVO. M. A. Ivanova[1], L. V. Moroz[2,3], N. N. Kononkova[1] [1]Vernadsky Institute of Geochemistry, Kosygin, 19, Moscow 119991, Russia, e-mail:meteorite2000@mail.ru; [2]Institute of Planetology, University of Münster, Wilhelm-Klemm Str. 10, D-48149, Münster, Germany.[3]Institute of Planetary Research, German Aerospace Center, Rutherford Str. 2, 12489, Berlin, Germany.

Introduction: Isheyevo is a metal-rich carbonaceous chondrite, consisting of metal-rich and metal-poor lithologies that show mineralogical, chemical and isotopic similarities to both CH and CBb chondrites [1]. Isheyevo contains coexisting mineralogically primitive high-temperature components (Fe-Ni metal grains, chondrules, refractory inclusions (CAIs and AOAs) and heavily hydrated, low-temperature, material. The heavily hydrated materials include lithic clasts and layered chondrules [1]. The former most likely experienced aqueous alteration in an asteroidal setting and later accreted together with other chondritic components, the latter probably, as we concluded in [1], might have formed in the nebula. IR-microspectroscopy [2] and oxygen isotopes [3] have revealed a high diversity among the lithic clasts of Isheyevo. The lithic clasts are not clearly affiliated with known CI and CM chondrites, and probably represent distinct, previously unsampled parent bodies. Here we report results on mineralogical and IR-microspectroscopic studies of several lithic clasts and layered chondrules with rim of altered materials from Isheyevo meteorite to understand their origins and genetic relationships.

Results and discussion.

Layered chondrules. We analyzed several chondrules, 40-90 µm in diameter, found in the metal-rich lithology of Isheyevo. They are mineralogically zoned and have a magnesian core composed of low-Ca pyroxene or olivine, that is surrounded by a thin (3-15 µm) rim of ferrous olivine (Fa60-72) or phyllosilicates. Some of the zoned chondrules have cryptocrystalline textures and contain tiny inclusions of Fi,Ni-metal. No traces of reactions between phyllosilicate rims and surrounding materials were observed. Bulk chemical compositions of the rims are more Fe-rich than those of lithic clasts. One of these chondrules (# 11), 35 µm in size, consists of Mg-rich pyroxene core (Fs7, Wo0.3) and surrounded by phyllosilicate rim, 10 µm thick. We used this rim for investigation of its hydration state.

Lithic clasts. All lithic clasts demonstrate a high diversity of their mineral assemblages. They consist of lath-shaped Fe,Ni-sulfides, Ca- and Mg-rich carbonates, magnetite, rare tiny olivine and pyroxene grains embedded in altered materials. Sometimes chondrules and Fe,Ni-metal grains were incorporated into lithic clasts. Magnetite has platy and framboidal morphologies. Bulk chemical compositions of the fine-grained matrices of all clasts are similar to those of matrices in CM2 chondrites (Fig. 1). Phyllosilicates in the clasts are less Fe-rich in composition than those in rims around layered chondrules (Fig. 1). We chose three lithic clasts (#18, #20 and #21a) to analyze their hydration states and compare them with matrices of CI, CM, and metamorphosed carbonaceous chondrites (MCCs). All clasts contain phyllosilicates, magnetite, sulfides and carbonates, but beside that, the clast #18 contains small grains of olivine, the clast #20 does not contain any anhydrous silicates, and the clast #21a contains rare grains clinopyroxene and olivine.

IR microspectroscopy. We used synchrotron-based IR microspectroscopy (SIRM) in reflectance mode [4] to characterize hydration states of three lithic clasts (#18, #20 and #21a) and a rim of the layered chondrule #11.

Although all lithic clasts in Isheyevo have nearly identical chemical compositions close to those of CM2 matrices (Fig. 1), we found that all three clasts analyzed with SIRM show different IR spectral characteristics. All three clasts show O-H stretching signatures near 2.7 µm, clearly indicating the presence of hydrated phases. However, the 2.7-µm hydroxyl band in the IR spectrum of the clast #21a is less intense compared to those of the clasts #18 and #20. The spectral range between 9 and 14 µm, dominated by Si-O signatures of silicates, provides additional indication that the clast #21a is depleted in hydrated silicates compared to the latter two clasts. The IR spectrum of the clast #21a (Fig. 2) is dominated by Si-O bands at 11.4 and 12 µm typical of fine-grained olivines. It is possible that the fine-grained olivine in the clast #21a formed by dehydration of phyllosilicates. Hydrated silicates appear to be less abundant than olivine. In this respect the clast strongly resembles matrix IR spectra of metamorphosed CM carbonaceous chondrites (MCCs) (Fig. 2), [4, 5]. However, unlike the spectra of MCCs, the spectrum of the lithic clast #21a shows some spectral contribution from pyroxene. The spectra of the lumps #18 and #20 are strongly dominated by Si-O signatures of hydrated silicates. Although all matrix lumps of Isheyevo chemically resemble matrices of CM2 chondrites (Fig. 1), the spectra of strongly hydrated lumps #18 and #20 are much more similar to the spectra of Orgueil CI phyllosilicates (with rather sharp Si-O signatures centered at 9.9 µm) than to IR spectra of CM2 matrices (Fig. 2). The CM2 chondrite matrix spectra show smooth broad Si-O features consistent with a wide variety of hydrated silicates in these meteorites [4]. The clast #18 spectra are Orgueil-like but show carbonate features at 7 µm (red arrow in Fig. 2) absent in the spectra the clast #20 and Orgueil. It appears that the clast #18 is enriched in fine-grained carbonates intimately mixed with matrix phyllosilicates. Thus, all three matrix lumps analyzed by SIRM show different spectral characteristics.

The rim #11 is only 8-µm thick, so it was impossible to acquire any good-quality spectra in the most informative spectral region between 9 and 14 µm. The spectrum shown in Fig. 2 is taken from an area of 12 x 12 µm, which includes the rim itself and the surrounding metal. The spectrum is dominated by Si-O features of low-Ca pyroxene overlapping with some other features (probably phyllosilicates). It is impossible to define whether the pyroxene belongs to the rim itself. The rim is mantled by tiny silicate and metal inclusions, so that these silicate inclusions may be responsible for the pyroxene signatures in the IR spectra we acquired. The rim is definitely hydrated, because all its spectra show well-detectable O-H bands at 2.7 µm, while the spectra of adjacent areas do not exhibit this band.

Conclusions. The lithic clasts are different in mineral compositions and hydration states. Their main mineral assemblages are not correlated with hydration states of altered materials. They have different spectral characteristics that resemble those of CI and metamorphosed carbonaceous chondrites (MCCs). Genetic relationship between altered material of lithic clasts and rims around layered chondrules is still unclear. Probably layered chondrules previously were incorporated into lithic clasts and preserved their phyllosilicate rims during accretion of Isheyevo parent asteroid.

References. [1] Ivanova et al. (2008) *Meteoritics and Planet. Sci* 43, 915-940. [2] Moroz et al. (2008) *EPSC*, Abstract #A-00506. [3] Bonal et al. (2008) *LPS XXXIX*, Abstract #1506. [4] Moroz et al. (2006) *Meteoritics and Planet. Sci.* 41: 1219-1230. [5] Ivanova et al. (2008) *Meteoritics and Planet. Sci.* (submitted) .

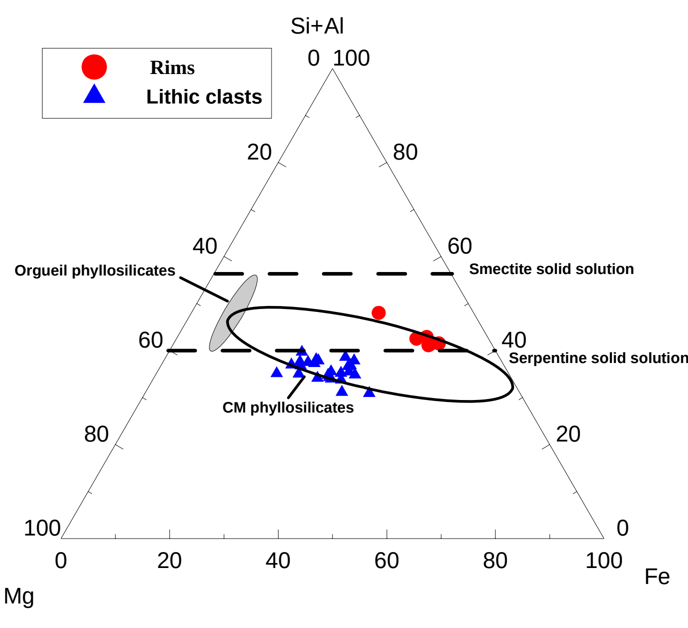

Fig. 1. Chemical composition of phyllosilicate in lithic clasts and rims of layered chondrules.

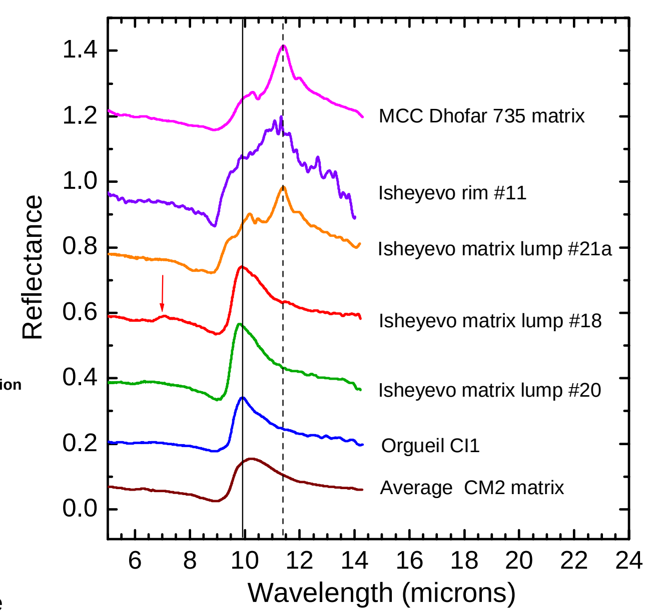

Fig. 2. Average IR spectra of a hydrated rim and three matrix lumps from Isheyevo meteorite in comparison with IR reflectance spectra of CM2 matrices and CI1 chondrite Orgueil. Each spectrum is offset for clarity from the previous one.