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Introduction: During a Russian Antarctic expedition from Ural Federal University, two meteorites, an ordinary chondrite and an achondrite, were found by C. Malagamba and A. Pastukhovich in the Lomonosov Mountains region of Antarctica near Osechka mountains (71.549ºS, 15.489ºE) in an area of blue ice. Here we report results on petrography, mineralogy and mineral chemistry of these meteorites, classify them and compare their characteristics with those of known meteorites of the same types.

Results: Meteorite LOM 15001 (provisional), weighing 12.5 g is an ordinary chondrite with brownish-black fusion crust. It consists of chondrules (65%) embedded in fine-grained matrix (35%) (Fig. 1). Chondrules ~0.35 mm in average size are well delineated and represented by POP, PO, PP, RP, and rare CC and BO textures. The total metal content is ~9 vol% on average. The main minerals are olivine and pyroxene; minor and accessory minerals include: sulfide, chromite and iron hydroxides. LOM 15001 demonstrates minor features of terrestrial weathering, W1 [1]. Extinction of olivine is sharp; only a few grains showing undulatory extinction. Shock veins are not observed in the meteorite. These features correspond to shock stage – S2 [2].

The chemical composition of olivine in chondrules is variable, from Fa0.77 to Fa28 (mol.%), with average Fa from 29 analyses of 15.2 ± 6.1, PMD = 40 %. Zoned olivine grains have a range of compositions from Fa19 in the rim to Fa10 in the core. Pyroxene is represented by orthopyroxene (Fs13.6±7 Wo1.3±1.1), pigeonite and augite. The chondrule mesostasis is represented by glass and crystalline glass consisting of a mixture of albitic plagioclase and clinopyroxene. Fe,Ni-metal is represented by kamacite, taenite and tetrataenite. The Co content of kamacite varies in a wide range, and its average value (N=24) is 0.72 ± 0. 53 wt.% with PMD > 26.3 %.

Meteorite LOM 15002 (provisional), is an achondrite weighing 118 g. The fusion crust consists of transparent brown glass with gas vesicles up to 100 μm in diameter. The vugs are empty and have no traces of weathering products. The fusion crust is decorated by a network of tiny sulfide veinlets entering through fractures into the silicate grains and along the grain boundaries up to 50 μm from the fusion crust.

The meteorite is very fragile due to numerous fractures. It consists of rock fragments up to 1 mm in size embedded into the fine-grained recrystallized clastic main mass. The content of the rock fragments (0.2-1 mm in size) is ~50%. The main mass is comprised of grains less than 100 μm in size.

The rock fragments have poikiloophitic texture; feldspar forms anhedral and subhedral grains growing in and between the subhedral pyroxene crystals (Fig. 2). The more coarse-grained rock fragments have gabbroic texture. The grain size of pyroxene and feldspar is 100-200 μm. The pyroxene and feldspar in the rock fragments have undulatory extinction. The pyroxene contains fine lamellae (0.1-10 μm) of solid solution breakdown. Pyroxene is pigeonite En36.3±1.12 Wo5.69±1.81 (N=10), Fe/Mn=31.3 at.; augite lamellae are En30.1±0.28 Wo40.8±0.17 (N=10). Feldspar is An90.5±1.68 Ab9.04±1.67 (N=5).

Accessory phases are silica polymorph, probably tridymite, iron sulfide (troilite), ilmenite, chromite, phosphate, zircon, metallic iron, iron hydroxides. Accessories are localized in the pyroxene-feldspar interstices or as inclusions within the feldspar grains. Ilmenite forms lamellar intergrowths with chromite, and has indicated breakdown of solid solution. The size of chromite-ilmenite aggregates is 5-50 μm.

Pyroxene usually contains numerous micro-inclusions of opaque phases, mainly ilmenite and chromite, that at places are oriented along the augite lamellae. Silica occurs as rare subhedral tablets 50-100 μm in size intergrowing with the feldspar. Troilite forms xenomorphic grains associated with the feldspar, chromite-ilmenite assemblages or metal Fe, or occurs as prismatic or ovoid inclusions in the pyroxene. In large grains troilite is slightly replaced by Fe-hydroxides along thin fractures.

Several metal Fe inclusions were found in the fragments of eucritic rock: 1) as 200 μm xenomorphic aggregate of metal, minor troilite and silica in the interstices of pyroxene and feldspar grains; 2) as intergrowth of ilmenite, chromite, metal and troilite; 3) as a zigzag veinlet of 20-50 μm wide and 350 μm long. Rare small isolated grains of Fe metal were found in the main mass. The metal inclusions localized near the surface of the meteorite are partly (15-20 vol.%) replaced by iron hydroxides due to terrestrial weathering. Thin veinlets filled by iron hydroxides run from the

metal grains into the surrounding rock. The small metal grains in the central part of meteorite are less weathered (<10 vol% of Fe-hydroxides). The metal contains in average 0.18 wt% Ni and 1.2 wt% Co (Ni/Co=0.15). Single rock fragments contain thin (<5 μm) melt veinlets of impact friction origin. A troilite-silicate melt pocket and veinlet was found in the main mass of the meteorite.

Discussion: Our preliminary results showed that meteorite LOM 15001 is an unequilibrated ordinary chondrite with shock stage 2 and weathering grade W1. Based on the texture, chondrule sizes, metal content, presence of glass in chondrules, and zoned olivine grains it belongs to the H group chondrites of petrological type 3. However, the average Fa of olivine and Fs of orthopyroxene are the lower than those of H chondrites and correspond to HH chondrites like the Burnwell chondrite [3]. PMD of olivine corresponds to 3.6 petrological type. The average Co content in kamacite is in the wide range of groups H and L composition with very high PMD in comparison with other chondrites of 3.6 petrologic type. Based on our observation we can conclude that the meteorite preserved its primary features and was not disturbed much by thermal and shock events during its history.

Meteorite LOM 15002 is classified as genomictic eucrite breccia (monomict eucrite) based on the Fe/Mn ratio in low-Ca pyroxene, rock structure and mineralogy. Average MG# volume in the pyroxenes is ~45. We suppose that bulk Ti content should be relatively low due to the small modal content of ilmenite. Based on that, the source rocks of LOM 15002 should be members of the main group of eucrites. The meteorite is moderately weathered, weathering index is B [4].

The maximum size of feldspar grains could indicate a crystallization cooling rate of eucritic rocks on the order of several degrees per hour [5]. Coexisting pyroxene pairs correspond to equilibrium temperatures in the range of 700-800°C [6] indicating sub-solidus annealing of the rocks.

LOM 15002 is a piece of well lithified equilibrated eucrite breccia that underwent at least three impact events. During the first, the breccia was formed, heated, and subsequently thermally metamorphosed. A second impact event formed the melt pockets and veinlets in the lithified breccia. The third impact ejected the meteorite from the parent body and could have led to the fracturing of the breccia.

The metal of LOM 15002 is Ni-poor, similar to that of Camel Donga [7], NWA 4269 [8] and NWA 5738 [9] in contrast to that of DHO 007 and ALHA 12073 [10, 11]. However, in contrast to the finely dispersed metal in Camel Donga and NWA 4269, the low-Ni metal of LOM 15002 forms large metal inclusions in the eucrite rock and veins like that observed in NWA 5738 [9]. Low Ni content of the metal and its close igneous association with all minerals in the eucrite rock fragments indicate it igneous, indigenous origin and should be a result of decreasing of fO_2 during crystallization of the parent magma. However, vein-like morphology of one of the observed metal inclusions should indicate a mobilization of the metal Fe from some igneous source, its transport and deposition, which could be result of reducing fluid activity in the HED parent body interior.

References: [1] Wlotzka F. (1993) *Meteoritics 28*, 460] [2] Stoffler D. et al. (1991) *Geochim. et Cosmochim. Acta 55*, 3845-3867. [3] Russel S. S. et al. (1998) Meteoritics & Planetary Sci 33, 853-856. [4] Gooding J. (1989) *Smithsonian Contrib. Earth Sci., 28*, 93–98. [5] Yamaguchi A. et al. (1996) *Icarus, 124,* 97–112. [6] Lindsley D., Andersen, D. (1983) JGR 88, A887–A906. [7] Palme H. et al. (1988) *Meteoritics, 23,* 49-57. [8] Moine B. et al., (2006) *Meteoritics & Planet. Sci., 41,* Supplement, Abstract #5390. [9] Warren P. H. et al. (2014) *GCA 141,* 199-227. [10] Yamaguchi A. et al. (2006) *Meteoritics & Planet. Sci., 41*, 863–874. [11] Di Rocco et al. (2016) *LPI Contrib. 1921*, id.6326.

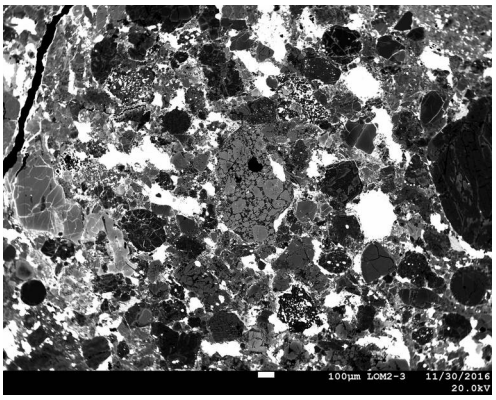

Fig. 1. BSE image of the LOM 15001 unequilibrated chondrite.

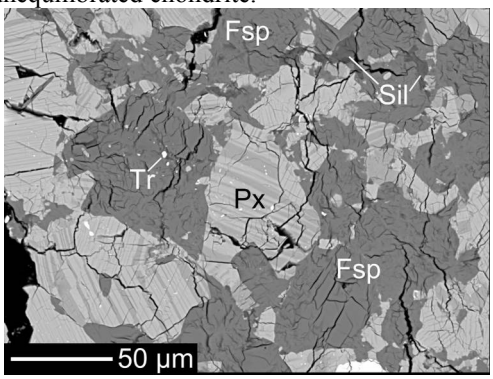

Fig. 2. BSE of the eucrite rock fragment from the LOM 15002; Px -pyroxenes, Fsp – feldspar, Sil – silica, Tr – troilite.