THE OZERKI METEORITE: PETROLOGY AND THE FIRST DATA ON NOBLE GASES AND NITROGEN RELEASED BY STEPWISE COMBUSTION AND CRUSHING METHODS.

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Introduction: The Ozerki meteorite shower fell on June 21, 2018 in Russia. More than 100 individual stones were found. The total recovered mass of the meteorite rain is >10 kg. Ozerki is classified as ordinary chondrite (L6, W0, S5) [1]. Preliminary study of the chondrite indicates absence of heavy particle tracks in olivine (Ol) grains presumably due to the low cosmic-ray exposure (CRE) age of this meteorite and the deep location of the studied sample (≥ 30 cm) in the pre-atmospheric body with radius ≥ 50 cm [2]. We report petrological information on this meteorite and preliminary data on noble gases and nitrogen extracted by stepped combustion and crushing methods.

Results and discussion: Ozerki has a brecciated texture. Some individual samples are completely chondritic, while others represent fragments of melt matrix breccia. These two lithologies have different degrees of shock metamorphism. In thin sections the completely chondritic species of the meteorite show recrystallized texture with rare relics of large (up to 1.5 mm) chondrules. Ol is only weakly and irregularly fractured and has mostly sharp optical extinction corresponding to shock stage S1 by [3]. The melt matrix of the breccia consists of rounded chondritic fragments from tens of μm to several cm in size joined together by shock melt (matrix). The fragments demonstrate different degrees of shock darkening. Ol in the fragments has weak wavy extinction and some planar fractures. Feldspar has also wavy extinction. These impact features correspond to shock stage S3 [3]. Large troilite (Tr) inclusions are polycrystalline. The veins of Tr and FeNi metal (Met) are abundant in the chondritic fragments. The melt matrix varies in texture from emulsion aggregate of submicron-sized Met, Tr and silicate phases to devitrified crypto- to microcrystalline (1-2 μm) silicate melt with Met-Tr globules of 5-200 μm in size. Some Met-Tr veins cross both chondritic fragments and melt matrix of the breccia and are associated with the fragmentation zones composed of chondritic and shock melt fragments cemented by troilite. Obviously these objects were formed after the impact breccia formation during a subsequent shock event on the L-chondrite parent body.

The samples of chondritic material (5.059 mg) and fine-grained melt matrix breccia (3.006 mg) have been studied by stepped combustion method. The specimens were stepwise heated in oxygen from 200 °C to 1500 °C (12-14 temperature steps). Chondritic material contains ^{4}He = 191, ^{20}Ne = 5.71, ^{36}Ar = 1.07 and ^{40}Ar = 1171 ($\times10^{-7}$ cm^3 STP/g). The contents of these isotopes in melt matrix breccia are 104, 1.21, 1.28 and 649 ($\times10^{-7}$ cm^3 STP/g), respectively. ^{20}Ne/^{22}Ne ratios in the samples are < 10. Ozerki experienced a significant shock event, and ^{36}Ar amounts in both samples are comparable to these in highly shocked meteorites that trapped gases during impact events: e.g., dark chondritic lithology of Chelyabinsk (LL5) contains $^{36}Ar_{trapped}$ = 1.86 × 10^{-8} cm^3 STP/g accounting for ~95 % of the total ^{36}Ar release [4]; (7-33) and (15-43) × 10^{-8} cm^3 STP/g were released from the Gubara chondrite (L5) during stepwise combustion and crushing, respectively [5]. Hence, it could be expected that Ozerki also contains gases redistributed and trapped during a shock event. We conducted noble gas and nitrogen stepwise crushing of the sample of chondritic material (86 mg) with cumulative number of strokes of 6000. The data of the first two factions were lost due to technical problems. In the next four crushing steps 9.06 × 10^{-9} of ^{36}Ar and 1.68 × 10^{-5} of ^{40}Ar (in cm^3 of STP/g) were extracted. ^{40}Ar/^{36}Ar ratios in all extraction steps are ~2000 (varying from 1831 to 2120). A similar isotopic composition of trapped argon was previously determined in the high temperature steps of the dark chondritic lithology of Chelyabinsk: $(^{40}Ar/^{36}Ar)_{trapped}$ = 1869 ± 214 [4]. N abundance released by crushing is only12 ng/g (a significant part of nitrogen could be released in the first two lost steps). It is not possible to calculate correctly nitrogen isotopic composition because of its very low content in steps. We intend to repeat crushing experiment on a sample of chondritic material of Ozerki, significantly increasing the sample weight as well as to perform crushing analyses on a sample of the fine-grained melt matrix breccia of this meteorite.

The amount of $^{21}Ne_{cos}$ in the sample of chondritic material studied by stepped combustion is 0.47×10^{-8} cm^3 STP/g calculated using the endmember compositions of Ne_{SW} with ^{20}Ne/^{22}Ne=13.78 and ^{21}Ne/^{22}Ne=0.0329 [6] and Ne_{cos} with ^{20}Ne/^{22}Ne=0.8 [7] and ^{21}Ne/^{22}Ne = 0.86 (the average value for the $(^{21}Ne/^{22}Ne)_{cos}$ range, see [5]). The CRE age is ~1.3-1.5 Ma calculated using the model by [8] and the assumption of the pre-atmospheric meteoroid radius of Ozerki to be 65-85 cm (taking into account radius evaluation by [2]).

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