ON THE SIMULARITY OF VOLATILE ORGANICS PATTERNS IN METEORITES AND IN IMPACT-INDUCED VAPOR PLUME.

M.A. Zaitsev[1], M.V. Gerasimov[1], A.S. Vasiljeva[1], A.V. Korochantsev[2], M.A. Ivanova[2], C.A. Lorenz[2], [1]Space Research Institute, Profsoyuznaya st. 84/32, Moscow, 117997, Russia, mgerasim@mx.iki.rssi.ru, [2]Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygina st. 19, Moscow, 119991, Russia, russian-naturalist@mail.ru

Introduction: Organic matter (OM) is an intrinsic part of meteorites and especially of carbonaceous chondrites (CCs). The main form of OM in CCs is submicron, macromolecular embeddings. The nature of OM is still not understood. Different stages of OM synthesis have been envisioned including formation in interstellar, nebular, and parent body environments. It is important here to be able to correlate structural peculiarities of the CCs OM with mechanisms of its formation. The paper considers mechanisms and peculiarities of forming pattern of OM during hypervelocity impacts.

Experiment: The aim of the experiment was to do comparative study of original OM in the meteorites and in condensed products of simulated impact-induced evaporation of these meteorites. Two carbonaceous chondrites – Murchison (CM2) and Kainsaz (CO3) – were investigated. Our simulation experiments were performed using standard laser pulse (LP) technique [1]. The chamber during laser ablation of meteorites was filled in by inert gas (helium) or by reducing gas (hydrogen) to see the response of the synthesis on change in redox conditions. Analysis of OM was done using pyrolytic gas chromatography coupled with mass spectrometry (Pyr-GC/MS) technique [2].

Results and Discussion: We found significant differences in the composition and ratios of volatile organic compounds (VOCs) between pyrolysates (at 460°C) of meteorites and their condensates obtained at different conditions. All the condensates gave lesser absolute amounts of VOCs during pyrolysis then starting meteorites. The“hydrogen” condensates gave significantly higher amounts of volatiles than the “helium” condensates.

The “helium” condensates gave volatiles which have higher relative amounts of N-, S-containing compounds and aliphatic hydrocarbons then the starting meteorites and large amounts of CO_2 and SO_2. The “hydrogen” condensates gave VOC containing higher relative amounts of aromatic and alkyl-aromatic hydrocarbons compared to the starting meteorites. At the same time, S-containing VOCs were almost absent, but there were huge amounts of H_2S.

The Murchison bulk material had higher abundance and diversity of VOCs in pyrolysates than the Kainsaz. Nevertheless, the condensates of the Kainsaz (both “hydrogen” and “helium”) were much higher in diversity and quantity of VOCs than the Murchison condensates and gave lesser amounts of CO_2 and SO_2. Processed meteorites have different metamorphic degree and volatile elements content. Nevertheless, they show rather similar VOCs pattern for the same redox conditions in the experiment.

It was peculiar that the pattern of hydrocarbons in starting meteorites and in their recondensates in helium were rather similar for both meteorites while the same produced in hydrogen atmosphere was drastically different (see Fig. 1). The circumstance that VOCs, being sensitive to redox conditions are re-synthesising with about the same pattern of hydrocarbons, speaks for about the same way of origin. That means that the origin of VOCs in CCs could be a result of synthesis during impacts in space or on parent bodies in inert vacuum-like conditions but not in dense hydrogen cloud.

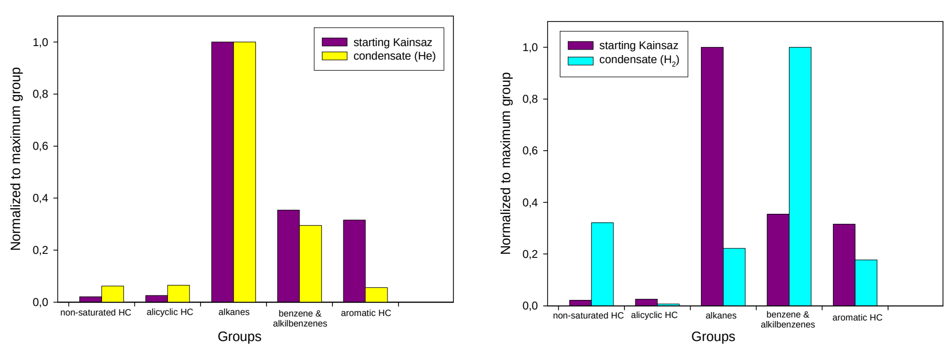

Fig.1. Relative abundances of different groups of VOCs in pyrolysates (460 °C) of bulk Kainsaz and its condensates obtained in helium and hydrogen atmospheres.

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References: [1] Gerasimov M. V. et al. (1999) Physics and Chemistry of Impacts. In: Laboratory Astrophysics and Space Research, P. Ehrenfreund et al. (eds.) KAP, 279-329. [2] Zaitsev M. A. et al. (2016) *Solar System Research* 50:113-129.