**Ordinary chondrites of Chelyabinsk meteorite and comparison with asteroid 25143 (Itokawa)**

S. Voropaev[1], A. Korochantsev[1], D. Petukhov[2], A. Kocherov[3], D. Kaeter[4], M. A. Ziemann[4], U. Böttger[5]

[1]GEOKHI RAS, Str. Kosygina 19, Moscow, 119991, Russia, voropaev@geokhi.ru
[2] Lomonosov Moscow State University, Moscow, 119991, Russia
[3]Chelyabinsk State University, Chelyabinsk, 454001, Russia
[4]University of Potsdam, 14476 Potsdam, Germany
[5]German Aerospace Center (DLR), 12489 Berlin, Germany

On 15 February 2013, a piece of asteroid entered Earth's atmosphere over Russia at about 09:20 YEKT (03:20 UTC) [1] with an estimated speed of 20 km/s (42,500 mph); it became a superbolide meteor over the southern Ural region. With an estimated initial mass of 13,000 t and a diameter of approximately 18–22 m, the Chelyabinsk meteor is the largest object to have entered Earth's atmosphere since the 1908 Tunguska event and the 1930 Brazilian event. It is the only meteor known to have resulted in a large number of injuries. About 3.5 kg of the meteorite fragments were first found by the group of GEOKHI RAS and mineralogical, chemical and isotopic compositions were analyzed. The main result is that Chelyabinsk meteorite is an ordinary chondrite, type LL5 S4 W0, according to international classification [1].

The Haybusa spacecraft arrived at S (IV)-type asteroid 25143 (Itokawa) in September 2005. Already the first remote measurements have shown that the surface is composed of rocks close to LL5 and LL6 ordinary chondrites. After contact at November 2005, the spacecraft captured dust particles from the MUSES-C region and the sample capsule successfully landed in South Australia on 13 June 2010. Most of the rocky particles harvested by the Hayabusa spacecraft are < 10 μm in size and the largest one being 180 μm. As described in the paper [2], the dominant mineral found on the spatula was olivine, with significant quantities of low-Ca pyroxene, high-Ca pyroxene, feldspar, and troilite, and rare chromite, merillite, and FeNi metal. For the Itokawa grains, the average and one sigma variations of the major minerals were: Fa for olivine (28±4), Fs for low-Ca pyroxene (23±6), Fs and Wo for high-Ca pyroxene (12±9 and 38±6, respectively), and Ab for plagioclase (86±7).

As typical Near-Earth Objects (NEO), Itokawa and Chelyabinsk present unique scientific opportunities for both, direct geochemical and astronomical investigation of LL chondrites genesis and dynamical evolution. We compared data concerning major, minor and trace mineral phases in rock particles from Chelyabinsk meteorite and Itokawa dust grains by means of Raman and SEM-EDX facilities, mainly. General geochemical compositions of olivine, (Mg, Fe, Ca)-pyroxenes, feldspar and Fe-Ti-Cr oxides in both asteroids are very similar. In some cases, Chelyabinsk provides more opportunities for understanding paragenesis of minerals due to the large amount of the substance. For instance, phosphates grains are very few in the Itokawa samples. On the contrary, we find enough phosphate minerals in Chelyabinsk for detailed analysis of typical conditions of its formation in LL chondrites. So, the xenomorph grains were in the paragenesis of both silicates as well as metal sulfides, wherein all of the analyzed apatite occur together with plagioclase. Merrillite is also found frequently in the paragenesis with plagioclase in melt pockets, where it is rounded and shows signs of melting. It is also observable as a secondary phase in association with impact melt, residual (Cl)-apatite and pore, where it shows a bladed habitus as it crystallized from a undercooled melt made of apatite+plagioclase. In additon plagioclase in Chelyabinsk seems to be mainly of secondary origin due to melting or transformation after shock events, as no metal-sulphide shock veins and fractures are observed in plagioclase or feldspathic glass [3]. The results obtained will further help in better understanding of transformation processes on the parent bodies of LL chondrites.

[1] E. M. Galimov et al. 2013 *Geochemistry International* 51(7): 522-539. [2] T. Nakamura et al. 2011. *Science* 333: 1113 -1116. [3] D. Kaeter 2015. MSc thesis, University of Potsdam, Germany.