THE CHELYABINSK METEOROID – WHAT DO WE LEARN FROM THE RECOVERED METEORITE FRAGMENTS?

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Introduction: On February 15, 2013, a brilliant fireball was observed over the southern Ural region (Russia), followed by an explosion and shock wave that damaged several buildings and injured more than a thousand people in the region. Thousands of relatively small stones fell and were rapidly recovered, bringing some extremely fresh material for scientific investigations.

Here we report on a multi-disciplinary study of a dozen stones of the Chelyabinsk meteorite that allowed us to confirm its classification and to characterize the initial meteoroid.

Petrographic and Microprobe Investigations: Our petrographic observations, as well as the mineral compositions, are in very good agreement with the classification of the Chelyabinsk meteorite as an LL5 chondrite. In addition to the phases already described, we found and analyzed a few grains of the minerals whitlockite and pentlandite. Averaged compositions of the major silicates olivine and orthopyroxene are ($Fa_{28.1+0.2}$, N=14) and ($Fs_{23.2+0.2}Wo_{1.4+0.2}$, N=21), respectively. Ca-rich clinopyroxene is diopsidic in composition, $Fs_{8.9+0.4}Wo_{44.3+0.3}$ (N=13). Spinel is typical chromite with mean (N=10) atomic ratios Cr/(Cr+Al)=0.86 and Fe/(Fe+Mg)=0.90. Averaged contents of Ni (5.1 wt.%) and Co (1.86 wt.%) in kamacite are within the compositional range for equilibrated LL chondrites [1].

Magnetic properties: SM30 probe magnetic susceptibility measurements were acquired for our stones, and, interestingly, the Log χ values range between 4.50 and 4.60, when typical Log χ values of LL meteorites (falls) are of 4.10 ± 0.30 [2]; The surprisingly high values obtained deserve additional investigation.

Cosmogenic Radionuclides: So far five small stones (~2-10 g) of Chelyabinsk have been analyzed by non-destructive gamma-ray spectrometry using high purity Germanium detectors (HPGe) placed in the Gran Sasso [3] and Bratislava [4] low background laboratories. Averaged radionuclide activities were 0.8, 0.4, 1.1, and 0.2 mBq/g for ^{54}Mn ($T_{1/2}$ = 312 d), ^{22}Na ($T_{1/2}$ = 2.60 y), ^{60}Co ($T_{1/2}$ = 5.27 y), and ^{26}Al ($T_{1/2}$ = $7x10^5$ y), respectively. The high activity levels for ^{60}Co, but lower ones for ^{22}Na and ^{26}Al, indicate that the samples studied originated from the interior of the meteoroid. A preliminary comparison of measured and calculated activities suggests a meteoroid diameter of 14 to 20 m.

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