IDENTIFICATION OF THE COSMIC SPHERULES IN THE MODERN URBAN SEDIMENTS

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Introduction: When meteoric bodies enter the Earth's atmosphere as a result of ablation processes, the mass of meteoroids decreases significantly. Due to resistance to the incoming air flow, the surface layer of a meteorite melts and blown away from the surface of meteoroid body. As a result, particles of extraterrestrial origin, such as ablation spheres and dust particles remain in the atmosphere and then precipitate on the Earth's surface [1-3]. It is easier to collect the cosmic spherules in a clean area as Antarctica [2, 3]. However, we suppose it is possible even in an industrial center like Ekaterinburg.

This study describes an attempt to check whether there are particles of extraterrestrial origin in the sediment of the city. Ekaterinburg is the fourth-largest city in Russia located in Middle Ural on the eastern side of the Ural Mountains (N56.5°, E60.4°). The snow winter period lasts for about six months—from October until the middle of April. Summer in the Urals is short, only 65–70 days with average temperature of +18°C. Ekaterinburg is an important transport and logistics hub on the Trans-Siberian Railway, a large industrial center of machinery, metal processing, and ferrous and non-ferrous metallurgy. The city's public transit network includes many trams, buses, trolleybuses, and underground.

Experimental: The specimens for urban sediment study were collected within a residential area in Ekaterinburg in 2017. The experiment was composed of two periods: I period in March (snow, snow-dust pulp), II – in July (soil, road dust, urban mud). Mud is a liquid or semi-liquid mixture of water and any combination of different kinds of soil (loam, silt, and clay).

Preparation of the urban specimens and subsequent granulometric (particle size distribution) analysis were conducted in compliance with the standard requirements of the Russian Federal Certification System. Previously, the organic component (twigs, leaves, needles) was removed from the specimens. Preparation steps included separating the liquid (meltwater) and the solid phase under laboratory conditions at room temperature for I period and drying, sieving using a sieve with 1 mm diameter for II period. The resulting solid insoluble phase was divided into six fractions: less than 1 mm, 0.25-1 mm, 0.1-0.25 mm, 0.05-0.1 mm, 0.01- 0.05 mm, 0.002-0.01 mm. The results of the study of technogenic particles are given in [4].

The spherical particles were detected visually in the fractions of 0.1-0.25 mm and 0.25-1 mm. These particles most likely formed during solidification from the liquid state. Therefore, for some of the spheres, an origin connected with the entry of meteoric bodies into the Earth's atmosphere was suggested.

Chosen spherules were glued on the glass plates and sequentially polished on the sanding paper and diamond pastes. Their texture was studied using optical microscope Carl Zeiss AxioVert 40 MAT and electron microscope Carl Zeiss ΣIGMA VP with the X-MAX EDS equipment.

Results and Discussion: 10 spherules were analyzed. Their sections were from 0.3 to 1.0 mm in diameter. Between them, 8 spherules contained small inclusions, which were few micrometers in size and consist of Fe, Ni, Co, S. However, one of the inclusions was 0.1 mm in diameter. Its composition was affordable for measurement: Fe – 41.40 wt.%, Ni – 32.0 wt. %, Co – 0.67 wt. %, and S – 25.92 wt. %. All the spherules with inclusions consist of the O ~ 40 wt.%, Si ~ 18%, Fe ~ from 4 to 16 wt. %, and small amount of K ~ 0.26-0.77 wt./%, Mn ~ 0.8-0.73 wt. %, Na ~ 0.65-2.47 wt. %, Al ~ 2.65 – 7.89 wt.%, Ca ~ 1.16-24.16 wt.%, Mg ~ 4.0 – 29.74 wt.%. The content is consistent with the content for cosmic spherules from the carboniferous deposits of the Usolka section [5].

Three spherules contain Ti ~ 0.58-1.38 wt.%, which is supposed to be an indicator of the industrial origin of the spherule. The titanium is used in industrial alloys. Therefore, its products could appear in the atmosphere and precipitate in close regions while alloys have been produced. Nevertheless, Ti was revealed in a small quantity in stony cosmic spherules, which provided in [3].

Conclusions: In the current study we confirm that cosmic spherules can be found in the muddy sediments of the industrial city like Ekaterinburg. However, their extraction from the probe and identification is a relatively complicated procedure.

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