COSMIC DUST IN PERMIAN EVAPORITES

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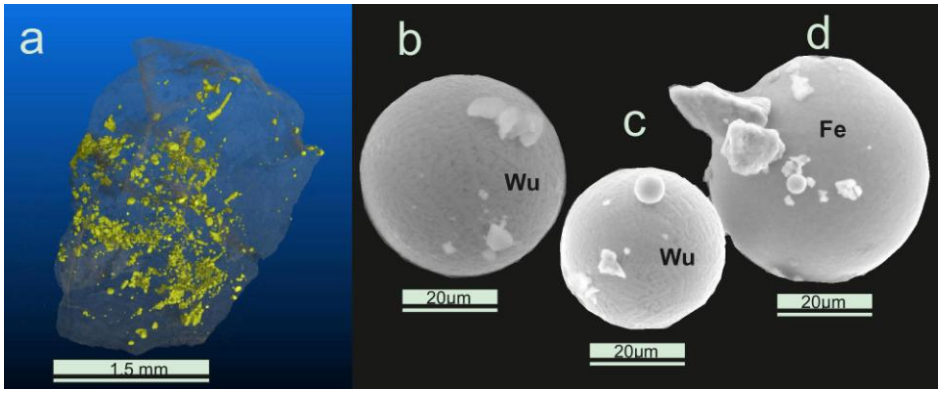
Introduction: Saliferous basins are good objects for the accumulation of cosmic dust [4]. Among the microparticles of cosmic dust there are microspheres with magnetic properties. However, their origin is controversial. The hypotheses of natural (terrestrial), cosmic and technogenic origin are considered [1-5]. Therefore, the study of magnetic microspheres can help to understand information about mineral formation .

Our research is devoted to the study of magnetic microspheres from the Permian evaporites of the East European Platform and the Urals foredeep. We studied structure, chemical and mineral composition of 30 microspheres from the gypsum of the Kamsko-Ustinskoe deposit (~ 265 million years, Guadalupian epoch of the Permian system) and 13 microspheres from the potassium-magnesium salts of the Verkhnekamskoe deposit (~ 280 million years, Cisuralian epoch of the Permian system).

Methods: Before crushing the gypsum samples (1.5 x 2 x 2.5 cm), we studied them using an X-ray microtomography (Phoenix V | tome | XS 240) with a nanofocus X-ray tube with a maximum accelerating voltage of 180 kV and a power of 15 W. Measurements were conducted for detection objects with high density in the rocks (iron oxide magnetic microspheres). After rocks were crushed and carried out magnetic separation with a neodymium magnet; then microspheres were taken from magnetic separat. Microspheres were studied using a Phillips XL-30 electron microscope equipped with an energy dispersive spectrometer with an accelerating voltage of 20 kV and a working interval of 8.9–15 mm. The probing depth was 1.0–1.5 μm, the measurement accuracy was 0.1–1%.

Results: On the microtomographic images of gypsum there are inclusions of X-ray dense minerals (Fig. 1a), which allows us to disprove their technogenic origin. All microspheres have a diameter of 5-150 μm, ideal spherical shape (Fig. 1b, c) and a strong metallic luster. Microspheres have a diverse texture surface with a predominance of dendritic. The main elements of the microspheres are Fe and O, according to the ratio of which the surface of most microspheres consists of wustite and, more rarely, native iron (Fig. 1b-c).

Fig. 1. Cosmic dust in Permian evaporites (a – tomographic image of the gypsum sample from Kamsko-Ustinskoe deposit (yellow - X-ray dense minerals, b – microsphere from the potassium-magnesium salts of the Verkhnekamskoe deposit, c, d - microspheres from the gypsum of the Kamsko-Ustinskoe deposit.



Discussion: In terms of chemical composition, the objects we investigated are close to microspheres that arose during the ablation of meteorites and falling out of cosmic dust [3]. The texture of pattern of the surface of microspheres depends on the amount of iron: with increasing of iron, the surface of the microsphere becomes smoother with the complete disappearance of the texture, which is typical for the surface of native iron microspheres.

Conclusions: Microspheres from different evaporites (gypsum, potassium-magnesium salts) have a great similarity, which may testify in favor of a single (cosmic) process of their formation. Findings of microspheres in evaporites can be additional tool for stratigraphic correlation of terrestrial rocks.

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