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Cosmic spherules in the land and sea sediments – can we use them in stratigraphy

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Abstract The constant influx of cosmic matter onto Earth surface is characterized by a large variety of size reaching material as well as variable spatial concentration. The dominant part in the influx takes the fine-grained matter (including cosmic spherules) which can be found in the Cenozoic sediments. Extraterrestrial spherules can be useful for the geological correlation. However this method is limited due to contaminants of the industrial origin. The author of this paper believes that contaminated area is limited to the shallow profile of Cenozoic deposits.

Key words *Extraterrestrial matter, cosmic spherules, man-made contamination.*

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INTRODUCTION

Spherules of the extraterrestrial origin are the most fascinating geological objects. They could be found in rocks and deposits of all geological periods. Their origin is connected with fall of the cosmic matter. The most spectacular is the fall of large meteoritic clods establishing craters. Fall of the smallest dust matter is almost imperceptible but more abundant. The character of dust matter varies. The biggest part of the whole dust matter takes stony matter but there is also influx of magnetic fines, relatively easy to find. Mixed (stony/iron) matter reaches the Earth in comparatively small amount.

The investigations of extraterrestrial matter can bring new data about history of solar system and the interior of our planet. Magnetic fines should be perceived as a record of violent space events such as meteoritic impact (Simons, Glass, 2004). The investigation of the fall both of the coarse-grained and fine-grained matter can lead us to preparing stratigraphic studies on the regional scale. The enrichment of different sediments in different kind of spherules could be a circumstance to correlate them upon the large area (Raukas 1996, 2000a, 2000b). It makes the studies of cosmic matter the next potential tool/marker of relative dating method.

WHERE THE COSMIC MATTER CAN BE FOUND

The cosmic matter can be found both in the higher parts of atmosphere, on the continents (rocks, glacial ice) as well as in deep ocean sediments (Taylor, Brownlee 1991). The spherules are spherical or subspherical objects (less than 1 mm; Fig. 1) which were established as a result of ablation of space matter entering and passing through the Earth atmosphere (Taylor, Brownlee 1991). From 1981 NASA lead the investigation of cosmic dust assembled in atmosphere. The samples of stratospherical dust were collected by special collectors fixed on NASA's airplanes. On the basis of the data gathered from stratosphere "The Catalogue of Cosmic Dust" was created.

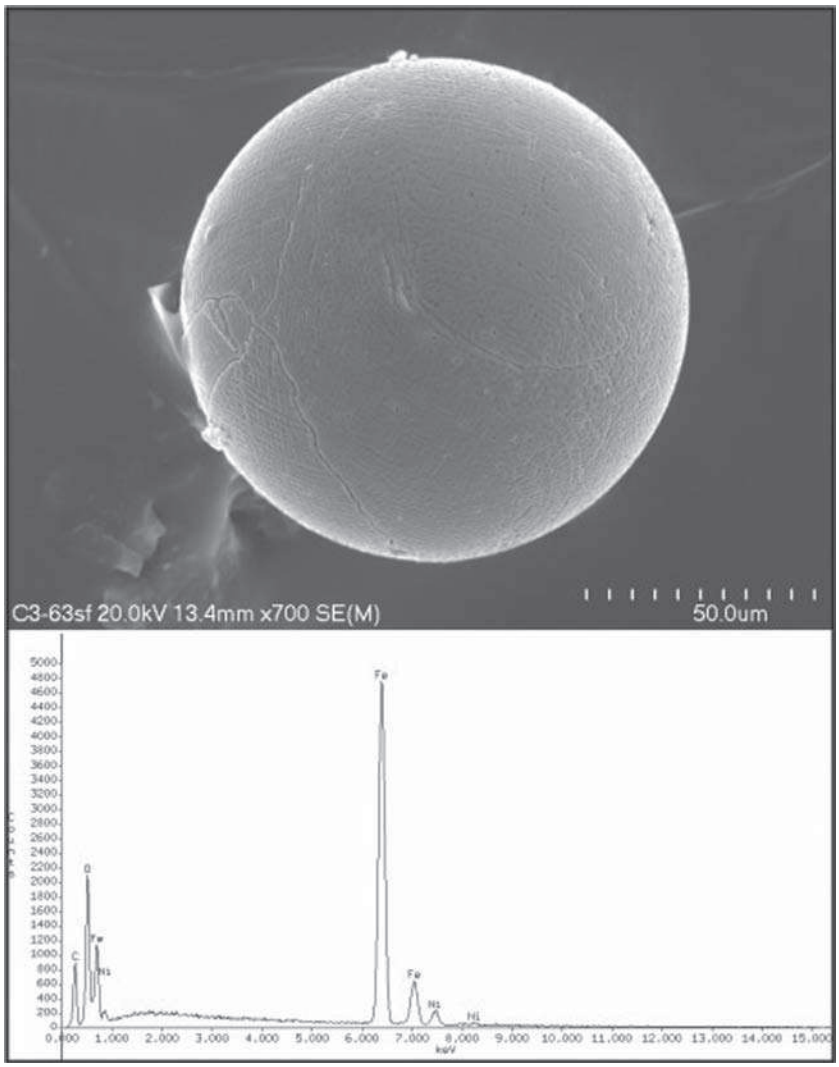

Fig. 1. Example of iron cosmic spherule (Fe and Ni peaks shown on the diagram). Author's photo.

The glacial ice assures access to many interesting data related to influx of extraterrestrial matter. The collection of the investigative material proceeds relatively easily, by melting ice. Unfortunately, the biggest disadvantage is huge quantities of ice that should be melted to get the satisfying sample of the space dust (Gabrielli *et al.* 2004).

The cosmic spherules can be also gained from the fine-grained oceanic sediments, with relatively low sedimentation rate. Beside the magnetic spherules the stony ones can also occur. Obtaining the particles from the fine-grained oceanic sediments does not procure larger difficulties. Such spherules were described in 1891 by J. Murray during his expedition on the "Challenger" (Manecki 1975; Stankowski 2006a).

It was mentioned that there was a possibility of collecting cosmic material from the terrestrial sediments. During the last few years, the fine-grained magnetic matter was recognized in the "Reserve meteorite Morasko" and its vicinity. The grains are mainly built of hematite and magnetite (Stankowski *et al.* 2006). Similar spherules were found in the surroundings of the Kaali (Estonia) craters (Raukas 1996, 2000a, 2000b; Marini *et al.* 2004). According to the well documented, meteoritic origin of the region where the spherules were found, their origin is connected with cosmic processes (Stankowski 2001, 2006; Stankowski *et al.* 2006). In Poland, excluding Morasko region, extraterrestrial spherules were found in the salts of Wieliczka, Inowrocław and Kłodawa as well as in carboniferous rocks of the Upper Silesia (Mazur 1973; Manecki 1975).

THE PROBLEM OF CONTAMINATION

Admixtures of dust, which external figure is similar to those of cosmic origin can be also found in the sediments. The difference is that their origin is connected with both natural and anthropogenic processes. The volcanic dusts are classified as natural contaminants. However there is also a subgroup of the man-made contaminants. Dust connected with industrial activity (result of burning of the solid fuels, side product of welding), the processed fragments of space infrastructure which entered the Earth atmosphere can be included in this subgroup. The most intriguing elements in this subgroup are spherical objects made of oxides of aluminum. The origin of these spherules is not explained. They are supposed to be the products of burning of the solid rocket fuel.

The possibility of the anthropogenic dust occurrence in mineral sediments is a problematic matter. If the possibility of occurrence of the natural "dirt" is obvious (for example: volcanic dusts) the author does not see the industrial dusts ability to penetrate deep layers of sediments. It is hard to perceive natural processes that could get the possibility of migration of the industrial spherules into the deeper layers of profile.

However the occurrence of anthropogenic spherules in the superficial layers of sediments is possible. Such sediments, except cosmic spherules (which fall to the Earth surface is constant) can be enriched in man-made contaminants (industrial dusts). Therefore in author's opinion separating extraterrestrial spherules from the youngest sediments (susceptible on anthropogenic factors) should be avoided or special caution should be kept. Nevertheless industrial spherules could be also used for correlation purposes. Industrial spherules may be useful indicators of post-industrial age deposits (Puffer et al., 1980).

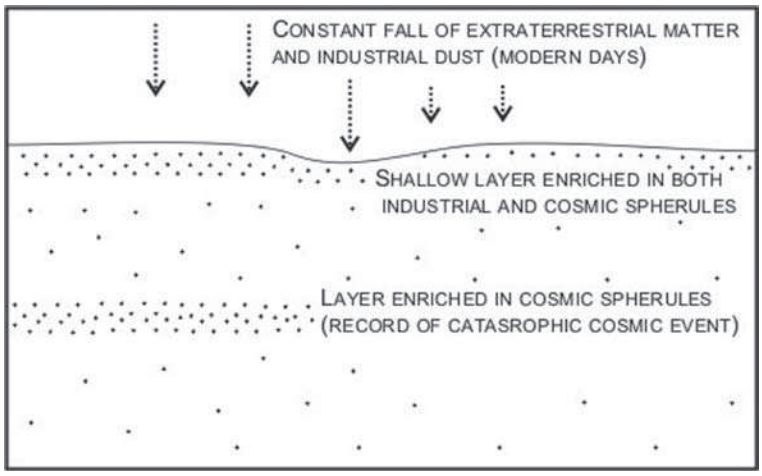

Fig. 2. Diagram showing the main ideas of the paper.

CONCLUSIONS

Different kinds of spherules are expected to occur in the Cenozoic sediments. The occurrence of cosmic spherules, formed mainly as a result of ablation of meteoritic surface during their crossing through the atmosphere, is rather doubtful. What is more, we can found similar objects, which creation is connected with man's activity but also with different natural processes (Fig. 2).

To put it in a nutshell, the extraterrestrial and volcanic spherules can be found in deep, ancient layers. In more recent sediments all kinds of spherules are mixed (extraterrestrial, volcanic and anthropogenic). In author's opinion both extraterrestrial and anthropogenic spherules can be used as a stratygraphic marker. Ancient sediments enriched by the extraterrestrial spherules are possible markers of catastrophic cosmic events, such as meteoritic impact. Industrial spherules are possible indicators of the post-industrial (man's activity) age. The concept is difficult, but at the same time, interesting in context of solving various scientific problems.

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