EXTRATERRESTRIAL SPHERULES WITH Fe-Ni CORE AND Pt GROUP NUGGETS IN PLEISTOCENE SEDIMENT FROM HUNGARY

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Abstract

Magnetic spherules were collected and investigated from Pleistocene terrestrial sediment overlying Paleozoic granitic rocks in Southern Hungary. Some of them have characteristic feature suggested extraterrestrial origin: Ni-bearing crust, Ni-rich core and especially the platinum group nuggets with unique chemical composition. Their formation can be a meteorit ablation process.

Introduction

Spherules of presumed extraterrestrial origin were first discovered in snow samples by Nordenskjöld, Swedish geologist [1] and in deep-sea sediments during the Challenger Expedition [2] more than century ago. Since than cosmic spherules have been found in different places so as in ice layers, deep-sea sediments, sedimentary rocks or around meteorite craters [3-6]. The results of spherule research in Hungary are summarized Detre et al. [7]. In recent work spherules from Plestocene sediment (South Hungary) were studied by stratigraphical position. Here we are reporting about some of the spherules having particular property with its metal core or nuggets suggested their cosmic origin.

Geologycal setting and methods

About 50 m thick Pleistocene sediment with paleosoil-loess layers was systematically sampled. After tratement with hydrogenperoxide and fractionation by grain size the magnetic spherules were concentrated using magnetic collection in two fractions (1.00-0.06mm and <0.06mm). 182 samples were collected and 59 ones contained magnetic spherules. The morphological and chemical analysis were made by an AMRAY 1830I/T6 scanning electronmicroscope equipped with MORAN energy dispersive X-ray spectrometer using 20 keV acceleration potential, 1-2 nA beam current and standardless analysis file of the instrument.

Results

The diameter of investigated spherules is between 40μm and 500μm, their shaps are regularly or near sphere, rearly drop. After chemical composition there are different types: Fe, Fe(Mn), Fe(Ni) and glassy (silicate) spherules (Fig.1). The first three types have smooth or rough surface depending on the size and shap of the covering crystals. The Mn-content is generally between 0.3-1.0 wt%, while the Ni-content varies between 0.9-6.3 wt% on the surface of above mentioned type of spherules. The glassy spherules can be characterized by surface more or less covered with Fe-bearing crystals (magnetite), sometimes they present bubbles due to gas evolution and rapid cooling.

Some cases the cosmic origin can be assumed after EM+EDX investigations.

- Ni-content may refer to cosmic origin of spherule. We identified this type in five cases (Fe(Ni)-spherule group, Fig. 1/c).

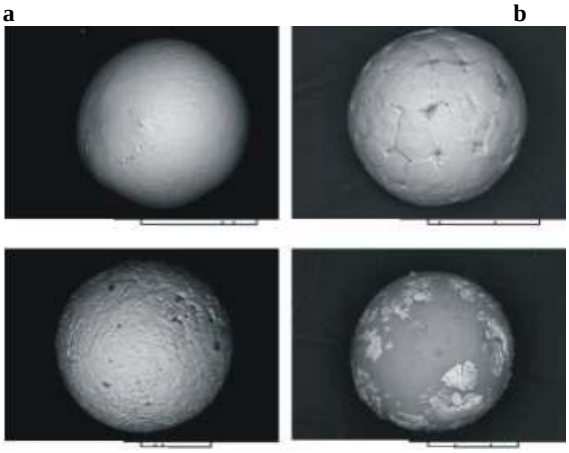

Fig. 1. ***Types of spherules, a: Fe-, b: Fe(Mn)-, c:(FeNi)- and d: glassy spherule; marker: 50 μm***

- In one of the particle of Fe-spherule group a Ni-Fe-Co core (Ni: 33.0 wt%, Fe: 22.0 wt% and Co: 1.0 wt%) can be observed owing to damage of the covering pure iron oxide crust (Fig. 2). In the literature the extraterrestrial origin of spherules with this type of nickel-rich cores has been proved [4].

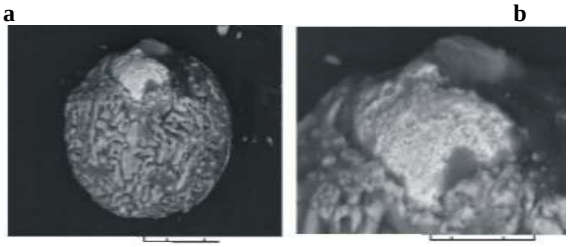

Fig. 2. ***Spherule with Ni-rich core (white) covered by pure Fe-oxide (gray); marker a: 20μm, b: 10μm***

- Two of the Ni-bearing spherule have a separated phase containig platinum group elements. One of them can be seen only as a little (1x2 μm) bright spot between the covering crystals (Fig. 3/a), the other appears on the top of the spherule as a small (near 3μm) sphere just escaping from the surface (Fig. 3/b). This type of platinum group nuggets (PGN) were discovered by Brownlee et al. (1984) in deep-sea sediment [5] and have been mentioned by Misava et al. (1989) in a condritic spherule [9]. Similar metal nuggets not easy to fined even in the polished section because of the small size and varying positions of the nuggets inside of the spherules [5].

The measured chemical composition of our a and b PGNs: Fe (5.1and 12.1wt%), Ni (1.7 and 0.6 wt%), Ru (12.2 and 10.1 wt%), Os (32.6 and 37.9wt%), Ir (32.4 and 37.9wt%), Pt (16.1 and 3.1wt%) respectively; the crust layer of spherules: Fe (93,9 and 99.1wt%) and Ni (6.1 and 0.9wt%) respectively.

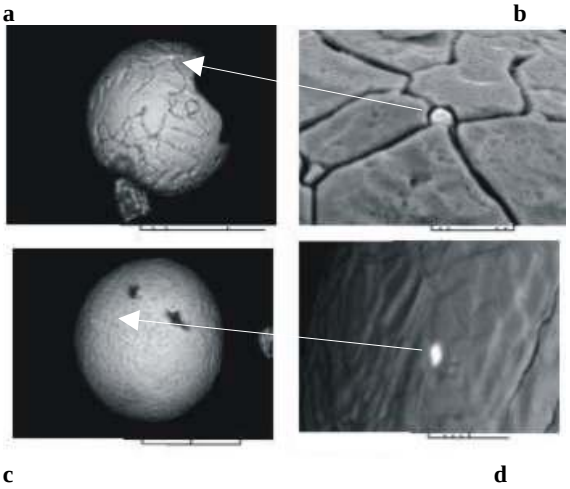

Fig. 3. ***Fe(Ni) spherules with platinum group nugget (b: bright small sphere escaping from the surface, d: bright spot between the covering crystals); marker a and c: 100μm, b and d: 10μm.***

The unique composition and ratio of elements (compared to the solar abundance; Os=1.0) in our PGNs are similar to the data of PGNs from deep-sea sediment [5] confirmed their extraterrestrial origin.

- The investigations of polished section of Fe, Fe(Mn), Fe(Ni) spherules are planed.
- The glassy spherules have probably volcanic origin.

Conclusion

The formation of extraterrestical spherules with Ni-rich core or with PGNs [3, 4, 5] can imagine as a meteorite ablation process (Fig. 4). A meteorite is heated and metal droplets will be ablated from the surface during its entry and traversing in atmosphere, where owing to high-temperature oxidation a growing iron oxide shell developes leaving the elements more noble than iron (Ni, Co and the platinum group elements) inside in the molten metal core. During the progress of oxidation the metal core becames more and more rich in nickel. The following oxidation process can finally lead to the formation of PGN. The Ni-rich core or PGN may move to the surface of spherule (Fig. 2,3) or may be ejected (Fig. 3) because of density differences between core or PGN and host molten oxide.

The form, chemical composition and structure of the cosmic spherules depend on a lot of facts, among them meteorite type ablated, entry angle, velocity and so the temperature of oxidation resulting many variation of spherules, while an event may cause similar ones (Fig. 2/a,b).

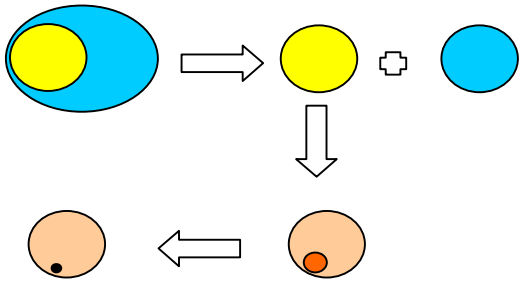

Fig. 4. ***The formation of cosmic spherules with Ni-rich core or PNGs after Brownlee et. al [5]. (yellow: Fe(Ni) metal, blue: silicate melt, orange: Fe-oxide melt, red: Ni-rich FeNi metal, black: platinum group nugget***

References

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