XXII. STUDIES ON SILICATE SPHERULES FROM OCEANIC SEDIMENTS IN THE GH79-1 AREA

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Introduction

The final goal of this study is to obtain extraterrestrial information from the silicate spherules from the deep-sea sediments, which cannot be or hardly be obtained from the meteorites, the major supply of the extraterrestrial materials. Since these spherules are extremely small in size, they possibly include small extraterrestrial materials such as cosmic dust that cannot be recognized as meteorites.

Friable meteoritic materials which would readily be broken to small fragments when entering the earth's atmosphere may be found in the spherules in higher percentages compared with those in the meteorites.

In the previous paper (NAGASAWA *et al.*, 1979), however, the large part of the silicate spherules from the deep-sea sediments are found to be terrestrial origin on the basis of the rare earth element (REE) abundance patterns which are very similar to those in the oceanic sediments. Thus, our immediate target is to establish a simple nondestructive procedure to identify extraterrestrial spherules and to classify them according to their chemical characteristics which are closely connected to their origin in extraterrestrial space.

In this report we present the results of our preliminary investigation of the spherules by scanning electron microscope (SEM) and instrumental neutron activation analysis (INAA).

Analytical procedures

Observation by SEM was done with a JEDL JMS 25 SII machine equipped with a Kevex 7000/25 energy dispersive x-ray analyser. The machine was obtained in late 1979, thus very small number of results was obtained by the end of 1979.

INAA was done in collaboration with Prof. L. A. HASKIN's group at Washington University, St. Louis, Missouri. The samples were irradiated by the Missouri reactor and measured at Department of Earth and Planetary Sciences at Washington University. The samples were irradiated at a very high neutron flux of 1×10^{14} n/cm^2, sec. for 130 jours and were measured by a computorized gamma-ray spectrometry system developed for ultrasmall samples. The results were published elsewhere (NAGASAWA *et al.*, 1980).

Samples

Deep-sea sediment samples, #1458G(B)925, #1466G(B)933, #1467G(B)934, #1474G(B)941, #1477G(B)944, and #1478G(B)945 were used. Spherules and

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associated samples were collected in the following manner: (1) Grains over about 100 μm in diameter were collected by washing out small grains suspended on stirring in water. (2) Solid grain samples thus obtained were sieved to +40, 40 ~ 100, 100 ~ 200, and >200 meshes. (3) Grains with densities lower than about 2.5 g/cm^3, which were composed mainly of those of biological origin were separated by a density liquid (a bromoform mixture). (4) Spherules and mineral grains were collected by hand-picking under binocular scope.

Electronmicroscope observations

The grains denser than about 2.5 g/cm^3 obtained by density liquid separation include several different types of spherules, micromanganese nodules, euhedral mineral grains, rock fragments, bones and teeth of fishes, skeltons of marine organisms, etc.

Among different types of silicate spherules, glassy spherules (type 4) (NAGASAWA, 1979) have been identified as "extraterrestrial" (Fig. XXII-1-a, b). The "ping-pong balls" (Fig. XXII-1-c) and the "meat-balls" (Fig. XXII-1-d) are of terrestrial origin. The "soccur balls" appear to be biological in origin (Fig. XXII-1-e). A micromanganese-nodule is also shown in Fig. XXII-1-f.

About 70 glassy spherules were found so far. Most are transparent and colorless, some transparent with light colors (brownish green or yellow), some opaque with deep colors. These spherules are easily identified from their smooth surfaces and perfect spherical shapes.

INAA results

11 glassy spherules were analyzed by INAA for REE and other trace elements. 7 spherules of them were identified as meteoritic based on the flat REE patterns (Fig. XXII-2). 3 spherules of them have REE abundances which are somewhat different from those "meteoritic spherules". However, high concentrations of siderophile elements such as Ir, Au, and Ni indicate these spherules are extraterrestrial in origin. Most of these spherules show relative depletion of Ce. This, together with depletion of volatile elements such as K and Na, indicates loss of volatiles by heating under high oxygen partial pressure (NAGASAWA *et al.*, 1979 and 1980), possibly heating when original meteoritic material entered the earth's atmosphere (BOYNTON, 1978).

A transparent green spherule showed relative enrichment of light REE over heavy REE (Fig. XXII-2). The REE pattern of this spherule is similar to those of crustal rocks, probably indicating this spherule is a microtektite.

References

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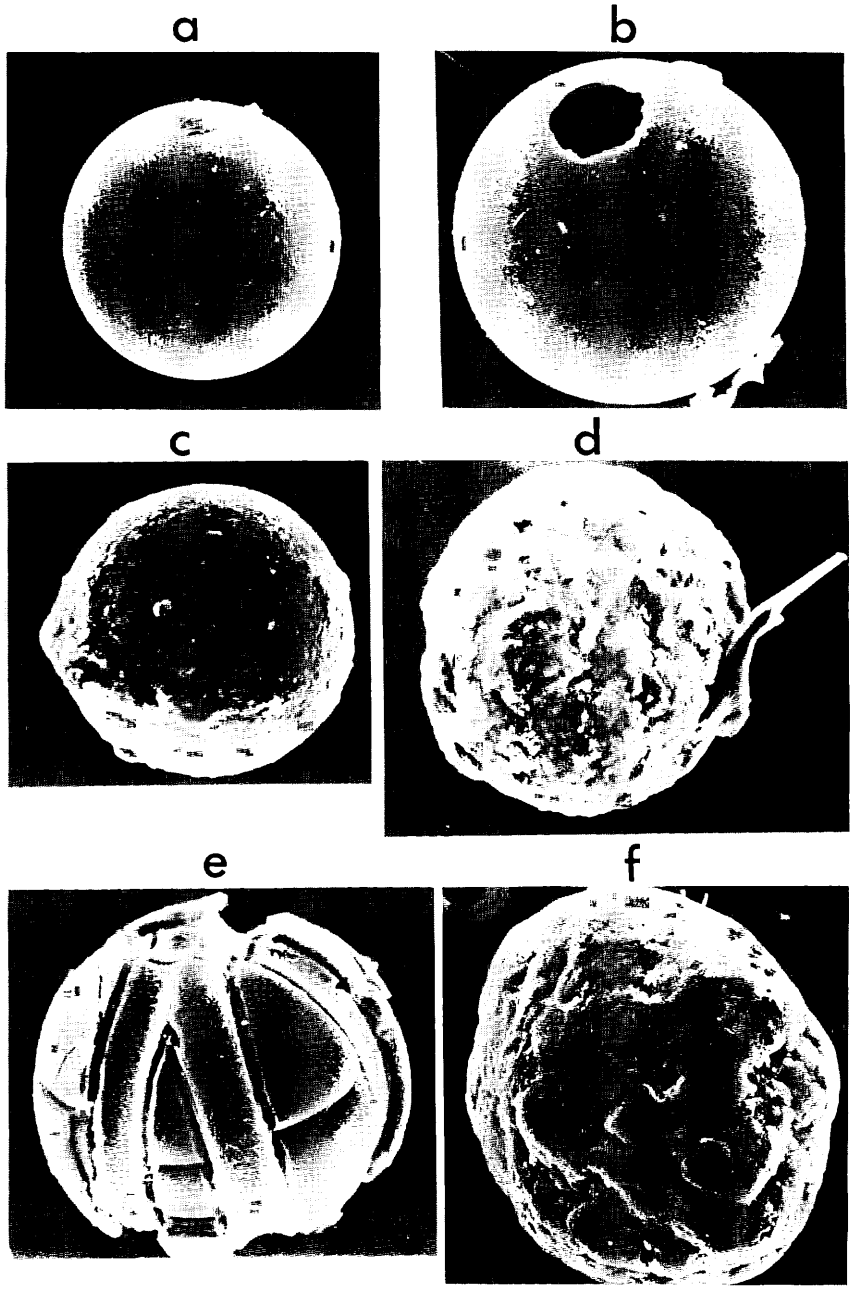

Fig. XXII-1 SEM photographs of silicate spherules from the GH79-1 area. (a) Glassy silicate spherule, diameter 190 μm. (b) Glassy silicate spherule with a large vesicle, diameter 240 μm. (c) A "ping-pong ball" spherule, diameter 190 μm. (d) A "meat-ball" spherule, diameter 230 μm. (e) A "soccur ball" spherule, diameter 260 μm. (f) A micro-manganese-nodule, diameter 250 μm.

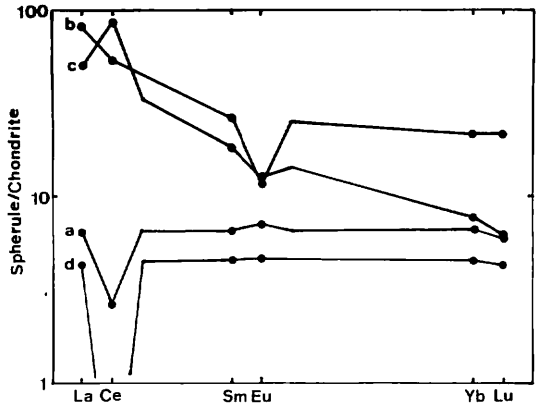

Fig. XXII-2 REE abundances of glassy spherules relative to chondritic average value plotted against atomic number. (a) indicate a typical "meteoritic" spherule, (b) indicate a possible microtektite and (c) a terrestrial silicate spherule (NAGASAWA *et al.*, 1979), (d) A meteoritic spherule reported in the previous paper (NAGASAWA *et al.*, 1979).