A DISCOVER OF IRON SPHERULES WITH GOLDEN Ni-Fe CORE AND SILICATE SPHERULES WITH GOLDEN Ni-Fe INCLUSION IN DEEP-SEA SEDIMENTS

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ABSTRACT: Recently, we found iron spherules with golden Ni-Fe core and silicate spherules with golden Ni-Fe inclusion in deep-sea sediments. This finding is of significance for further understanding of the origin of the deep-sea spherules.

1. INTRODUCTION

Since microscopic magnetic spherules in the deep-sea sediments were found by Marray and Renard (1891), many scientists have performed the overall studies of them, and divided them into three types: the iron spherules (type I), the silicate spherules (type S) and the glassy spherules (type G).

For the iron spherules, because of discoveries of Ni-Fe cores, whose chemical composition is similar to the iron meteorite, ones have an identical viewpoint on their extraterrestrial origin. But the shapes, sizes, colors, shines, surface structures of cores, and their place in the iron spherules have not been reported. For the silicate spherules, although many evidences have been discovered to prove that the are extraterrestrial, many people have been doubting their genuine origin.

Recently, we found many iron spherules with golden Ni-Fe core and a few silicate spherules with golden Ni-Fe inclusion in the deep-sea sediments taken from the North Pacific Ocean, and observed and analysed the cores and inclusions in details by using a microscope and a scanning electron microscope. Their chemical compositions were measured by using electron probing. The results show that these deep-sea spherules are different from material formed on the Earth, and may be cosmic material flying off the surfaces of meteoroids as they entered the atmosphere of the Earth.

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2. MICROSCOPIC CHARACTERISTICS

Under the stereoscopic microscope magnifying 50-60 times, the iron spherules can clearly be seen as black or brownish-black globular, oval, button, teardrop or other irregular shape. Their grain-size was general 100-200 μm. Most of them have strong magnetic properties.

The golden Ni-Fe cores were found in broken button-shaped iron spherules. The cores have metallic luster, globular. Their sizes are 1/4 - 1/8 of whole spherule. Because their hardness was clearly larger than that of their crust, they often fall down. All of the Ni-Fe cores are near the button-chaped plane or pit. Results of electron probing analysis indicate that Ni content of button-shaped iron spherules reaches 2.77% to 52.29%.

The silicate spherules are dark-green or greyish-white, globular, oval or irregular particles. There are some black spots with different sizes on the surface of some of them, and there are some circular pits on the spots, which seem to be the trace produced by airflow. Under the scanning electron microscope, octahedral magnetite cramed in the circular pits on the iron spots were found.

The golden Ni-Fe inclusions were found in broken Fe-Si mixing silicate spherule. The inclusions are globular, and have metallic luster. Their sizes are about 1/4 of whole spherule. Because their hardness is clearly larger than that of the crust, they will be dislocated when moving them lightly. Results of electron probing analysis indicate that the crust is olivine.

3. STRUCTURE AND CHEMICAL COMPOSITION

3.1 Scanning electron microscope analysis

To observe the iron spherules with golden Ni-Fe core and silicate spherules with golden Ni-Fe inclusion, a scanning electron microscope was used, by which it can clearly be seen that Ni-Fe core is near the button-shaped plane. The surface of the core is rough, and some of them also have a cavity. The cores are easily dislocated because of crack between the cores and their crust. In x-ray NiKa plane distribution pictures, nickel element of core concentrates highly (Fig.1). Results of electron probing analysis indicate that Ni content reaches 79.1% (Fig.1 A and C).

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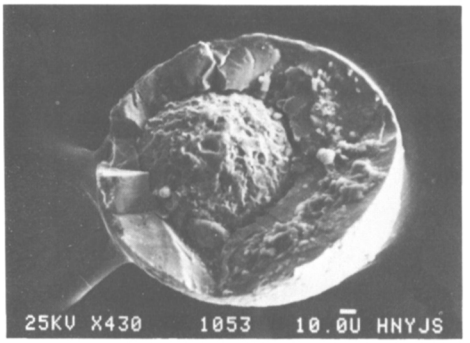

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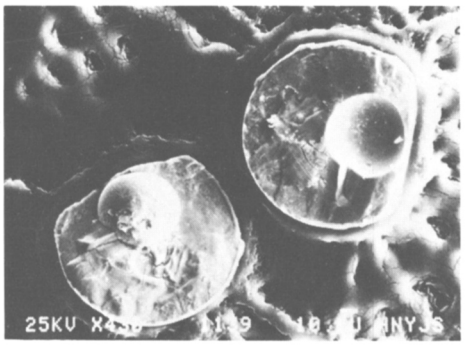

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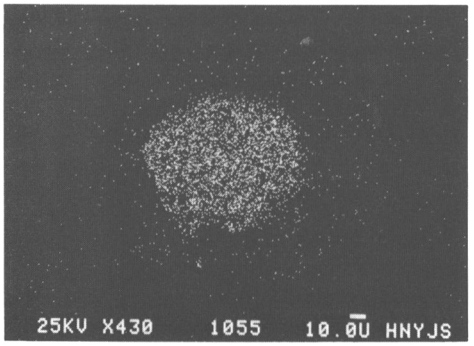

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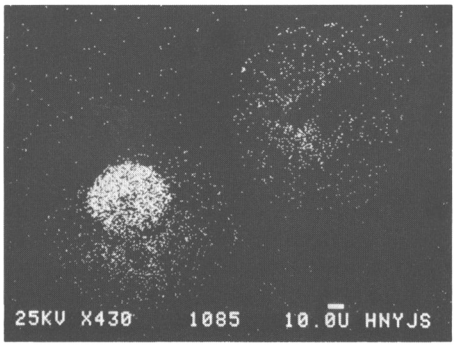

D

Figure 1. SEM Photographs of the iron spherules. A and B are broken iron spherules with the Ni-Fe core; C and D are respectively NiKa plane distribution pictures of A and B.

The Ni-Fe inclusions usually are near the sides of the spherules. They are easily dislocated because their hardness is larger than that of the crusts. The Ni-Fe inclusion is globular, and there are some parallel grooves on their surfaces. The crusts are olivine. X-ray NiKa plane analysis indicates that nickel elements are highly concentrated in the Ni-Fe inclusions (Fig.2).

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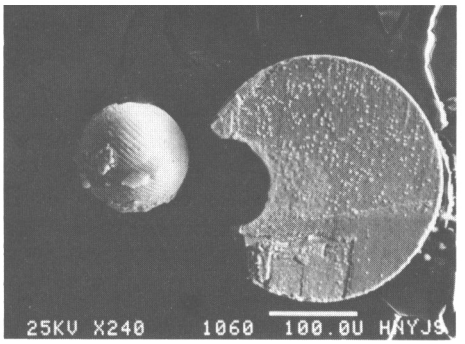

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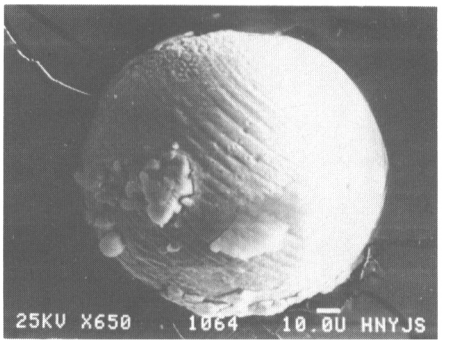

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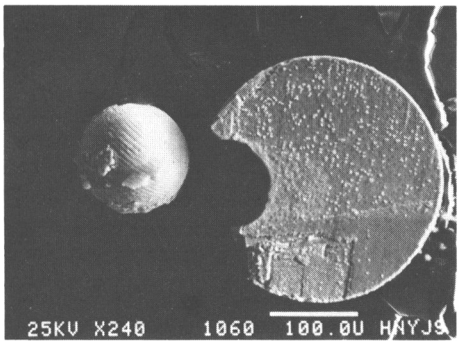

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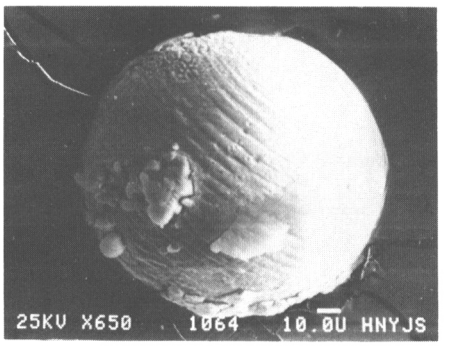

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Figure 2. SEM Photographs of the silicate spherules with Ni-Fe inclusion. A and B are the Ni-Fe inclusions falling down from the crust; C is NiKa plane distribution pictures of the Ni-Fe inclusions; D is olivine in the crust.

3.2 Electron probing analysis

The chemical compositions were analysed by using an electron probe. The analysis results are shown in Table I.

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TABLE I

Results of electron probing analysis of iron sperules and silicate spherules with golden Ni-Fe cores (or inclusions)

	Oxides								
	MgO	Al_2O_3	SiO_2	CaO	Ti_1O_2	Na_2O	K_2O	MnO	FeO
M_{2-5} Crust	tra.	tra.	tra.	0.02	tra.	tra.	tra.	0.51	94.56
Core	tra.	tra.	tra.	0.16	tra.	tra.	tra.	0.14	-
M_{12-21} Crust	-	-	-	-	-	-	-	-	-
(I)Core	-	-	-	-	-	-	-	-	-
M_{20} Crust	-	-	-	-	-	-	-	-	-
Core	-	-	-	-	-	-	-	-	-
M_{2-39} (S)Crust	20.31	tra.	32.45	0.18	tra.	tra.	tra.	tra.	47.39
Inclu.	-	-	-	-	-	-	-	-	-

	Metals					Remarks
	Fe	Co	Ni	Cu	Au	S	
M_{2-5} Crust	-	0.21	2.17	tra.	tra.	-	
Core	19.96	1.05	79.10	tra.	tra.	-	Fig. 1 - A.C
M_{12-21} Crust	72.69	0.21	0.43	-	-	-	
(I)Core	46.26	1.89	52.29	-	-	-	
M_{20} Crust	68.02	0.43	1.01	-	-	-	
Core	70.12	0.55	28.07	-	-	-	
M_{2-39} (S)Crust	-	tra.	tra.	-	-	-	
Inclu.	35.76	0.65	33.29	-	-	31.16	

Note: (I) Iron spherurles; (S) Silicate spherules;
"-" Content is Zero; tra. trace.

As seen from Table I, the chemical compositions of the crusts and cores in the iron spherules with golden Ni-Fe cores are completely different. The major chemical component of the crusts is Fe(or FeO), also including a small amount of Ni, Co, etc.; the major chemical component of the core is Ni, minor component being Fe, and a small amount of Co, etc..

The major chemical components of crusts in the silicate spherules with golden Ni-Fe inclusion are FeO, SiO , MgO and others,

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which are the chemical components of the olivine; the major chemical components of the includion are Fe, Ni and S, and a small amount of Co, which are the chemical components of the Pentlandite.

4. DISCUSSION

The above analysis results indicate the following facts:

1) The shapes, sizes, colors, lusters, surface structures and existing places of the core contained in the iron spherules are first observed. That has an important significance for further exploring and proving the origin and formation mechanism of deep-sea iron spherules.
2) Most of the iron spherules with the button-shaped structure contain golden Ni-Fe core, whose Ni content is very high. Therefore, their characteristics can be used to identify them among the polluting spherules.
3) The discovery of the silicate spherules in the Fe-Si mixing silicate spherules and the golden inclusions, whose features are identical with the Ni-Fe core in the iron spherules, further proves that the deep-sea silicate spherules are extraterrestrial material. It is highly possible that they are products flying out of the surfaces of the iron-stone meteorites. Because of incomplete disjunction of material, they are different both in structure and in composition.

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