Internal textures and chemical compositions of Triassic deep-sea spherules in Japan

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We report the textures and major element compositions of cosmic spherules from the Middle Triassic radiolarian chert (ca. 245-235 Ma) of the Chichibu terrane in Japan. Radiolarian chert of the Chichibu terrane is considered to have accumulated in a mid-oceanic basin of the ancient Pacific Ocean. Although most of the Triassic spherules are degraded by chemical alteration, discovery of the spherules provide valuable information for understanding the flux and compositions of extraterrestrial particles into the Earth during the Triassic.

Spherules were discovered from the Triassic radiolarian chert succession of the Chichibu terrane on Ajiro Island, eastern Kyushu, southwest Japan. They were extracted from the samples of thin siliceous shale partings intercalated within radiolarian chert beds. Samples were mechanically crushed and the magnetic components were separated. Spherules were handpicked from the magnetic components under a binocular microscope and analyzed for detailed textural features using scanning electron microscope (SEM). For the qualitative elemental characterization of the spherules, energy dispersive spectra (EDS) was used.

107 spherules were obtained from 182 grams of the 44 shale samples from the Triassic chert succession in the Chichibu terrane. The Triassic spherules from the Chichibu terrane range in size from 5 to 128 microns. Based chiefly upon the textures and chemical compositions, two major spherule types were discriminated: iron-type (I-type) and silicate-type (S-type) spherules.

I-type spherules comprise about 84% of collected spherules. SEM-EDS analysis suggests that I-type spherules from the Triassic chert have been altered as indicated by the presence of Al, Si and K on the surface of the spherules. Internal parts of I-type spherules are dominated by Fe oxide with minor amounts of Fe-Ni oxide. S-type spherules are about 13% of total number of spherules. They are characterized by cryptocrystalline and porphyritic textures similar to those reported in deep-sea spherules (DSS). S-type spherules consist mostly of Mg, Si, and Fe with varying amounts of Al, K, Ca, and Ni. Some S-type spherules show characteristic energy spectra known from collections of Antarctic micrometeorites (AMMs), but most of S-type spherules from the Triassic chert are rich in Al and Si, and poor in Ca and Mg, as compared with AMMs. Relatively large amounts of Al and Si in S-type spherules are most likely derived from the radiolarian chert which has high SiO2 and Al2O3 contents.

The textures and major element compositions of the Triassic spherules are similar to those of DSS and AMMs. However, the Triassic spherules have a wide range in chemical composition, depending on degree of alteration. Our results suggest that the original composition of most of the Triassic spherules is obscured by intense alteration during diagenetic processes.