Geophysical Research Abstracts
Vol. 14, EGU2012-9723-1, 2012
EGU General Assembly 2012

A Correlation among Shape, Composition, and Texture of Cosmic Spherules

T. Nakamoto (1), M. Doi (1), T. Nakamura (2), and Y. Yamauchi (3)

(1) Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Tokyo, Japan (nakamoto@geo.titech.ac.jp), (2) Department of Earth and Planetary Materials Science, Tohoku University, Miyagi, Japan (tomoki@m.tohoku.ac.jp), (3) Department of Earth and Planetary Sciences, Kyushu University, Fukuoka, Japan

Cosmic spherules are extraterrestrial origin spherical silicate grains. Their precursor particles, i.e. interplanetary dust particles, enter the Earth atmosphere and are heated to melt. They become spherical due to the surface tension and re-solidify as they cool to form cosmic spherules. Here, we focus on cosmic spherules that melted once completely. By measuring the shape, chemical composition, and texture of them, we look for a correlation among them. Then, we attempt to understand the mechanism that creates such a correlation.

Samples are collected from Antarctic ice. From ice in the blue ice field at the Cape Tottuki, 903 micrometeorites of sizes in a diameter range from 0.100 mm to 0.238 mm are identified based on the surface element abundance. The micrometeorites include fully, partially, and no melted particles. Among them, we only use the fully molten particles consisting of stony material. The number of such cosmic spherules is 525. In addition, we select cosmic spherules having a smooth surface, because the smooth surface suggests that they are once molten completely. We analyze 50 cosmic spherules with smooth surface. After the measurement of the shape, each sample is polished to have a flat surface and analyzed for major element concentrations. In the analysis, we exclude samples, which have cavities or unmelted parts in them. Then, the final number of samples becomes 27.

The shape of cosmic spherules is measured by approximating them as three-axial ellipsoids. The lengths of three axes are measured by a microscope. After the shape measurement, each sample is potted in epoxy and polished to have a flat section for microprobe analysis. Then their texture is observed, and their chemical composition is measured.

What we find by measuring cosmic spherules is described in short as follows: crystalline cosmic spherules have olivine-rich compositions and deform more, while non-crystalline cosmic spherules have pyroxene-rich compositions and are more spherical.

We then theoretically model the formation process of cosmic spherules. The motion and the temperature of a dust particle entering to the Earth atmosphere are calculated. The melting temperature is modeled as a function of the chemical composition. In addition, the deformation of molten particle due to the ram pressure of the gas is included. According to our theoretical model, the correlation found above can be understood as follows. Dust particles consisting of olivine-rich composition have higher melting temperature, so they solidify at a higher altitude under a higher ram pressure. Thus, they deform more. On the other hand, dust particles consisting of pyroxene-rich compositions hardly become crystal, so they keep on falling without solidifying. Their velocity is reduced enough, and when they solidify, the ram pressure is low. There, they experience the glass transition and form non-crystalline cosmic spherules.