Presolar grains isolation using fusion technique from Murchison meteorite

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Presolar grains formed before the Solar System formation have been found from carbonaceous meteorites. Most of the grains are circumstellar condensates that formed in stellar ejecta. All these presolar grains show very different isotopic ratios (usual 100X to 1000X) from the terrestrial values for many elements. They provide information about stellar evolution and nucleosynthesis.

Isolation method of presolar grains from meteorites was developed by group of Chicago University and is widely employed for the purpose (Amari et al., 1994). In this method, all silicate phases were decomposed by hydrofluoric acid. Then presolar grains such as SiC and C were existed as acid residues.

We developed an isolation method of presolar grains using NaOH fusion (Chan et al., 1983) from Murchison meteorite. Since the fusion method is different from those of Chicago group, relative abundance of presolar grain species can be evaluated independently and it might be expected to identify new types of presolar grains.

Murchson CM2 carbonaceous chondrite was prepared for isolation of presolar grains. 0.1g of matrix materials were scraped carefully from Murchison meteorite using a steel dental pick. Matrix materials and 2g of NaOH pellets were well mixed in nickel crucible. The mixed samples were fused at 500 degrees centigrade in muffled furnace. After heating for 4 minutes, the crucible was once taken out from the furnace and shaken sufficiently. Then samples were heated for 4 minute again. After cooling, fused samples were dissolved by 50 ml of deionized water and pour into a beaker. At this treatment, iron hydroxide was precipitated. It was easily dissolved by 30ml of 6mol/l hydrochloric acid. The pH of the solution was about 3. Then solution was centrifuged and grains with the size larger than 0.5 micron were sunk. After 60ml of the float fraction was removed, the solution was diluted with deionized water. This dilution procedure was repeated until the acidity of solution was neutralized. Finally, 5ml of neutralized solution that contain the residual grains was prepared. 5 micro-liter of the solution were pipetted onto the 7mm x 7mm sized pure cupper substrate. And suspended grains were deposited sparsely on the substrate after evaporation of the solution.

Morphology and chemical composition of residual grains after fusion were analyzed by SEM-EDS (JEOL JSM-5310LV, Oxford LINK-ISIS). Isotopic compositions were analyzed by isotope-microscope system (Yurimoto et al., 2003), which is composed by a secondary ion mass spectrometer (Cameca ims-1270) and a stacked CMOS active pixel sensor (SCAPS) (Kunihiro et al., 2001).

300 grains were analyzed by the isotope microscope. 10% of grains are unidentified for the mineral types. About 70% (population in number percent) of the residual grains were spinel of 5~20 micron size. About 20% were chromite about 5~20 micron size. Among other 10 % of grains contained about 5 micron forsterite, about 5~20 micron magnetite, about 10~15 micron hibonite. Graphite was also included. The graphite was identified by EDS spectrum. The ratio of forsterite, magnetite, hibonite, and graphite was 2:2:1:1. SiC grain could not be identified in this sequence of analysis.

One graphite grain showed about +4000 permil 13C excess compared with terrestrial value. Grain has euhedral hexagonal shape. This grain resembles to the presolar graphite grain previously reported by Zinner et al. (1995).

It was succeeded to isolate the presolar graphite grain. The future direction of this study will be identifying new types of presolar grains.