

Isolation of presolar grains using fusion technique from Murchison CM2 meteorite

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Introduction

Primitive meteorites contain presolar grains. Conventionally, the method developed by group of Chicago University is widely employed for isolation of presolar grains [1]. This method basically treats an acid dissolution to dissolve silicates. Here we developed an isolation method of presolar grains using NaOH fusion from Murchison CM2 meteorite. Since the procedure is different from that 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.

Methods

0.1g of matrix materials were scraped carefully using a stainless steel dental pick. Matrix materials and 2g of NaOH pellets were well mixed in nickel crucible and fused at 500°C for 8 minutes in a muffled furnace. The fused sample was dissolved by 50 ml of deionized water. The precipitation of iron hydroxide was dissolved by adding of 30 ml of 6 mol/l hydrochloric acid. The pH of the solution was about 3. Then grains with the size larger than 0.5 μm were sunk by centrifugation. After 14 cycles of this dilution procedure, 5 ml of neutralized solution that contains the residual grains was prepared. 5 μl portions of solution were dried on the 7 mm x 7 mm sized pure copper substrate.

Morphology and chemical composition of the residual grains were analyzed by SEM-EDS. Isotopic compositions were analyzed by isotope-microscope system [2].

Results and discussion

We measured 300 residual grains. the residue consist of spinel, number percent: ~45%, grain size: 1-20 μm, chromite, ~20%, 1-20 μm, magnetite, ~10%, 1-20 μm, Forsterite, ~5% were, 1-5 μm, and unidentified phases (~15%). Other 5% of grains consist of hibonite (5-15μm) and graphite (~4μm).

Among graphite one grain showed about +4000‰ ¹³C excess relative to the terrestrial value. The grain was 4μm across with euhedral and hexagonal shape. This grain resembles to the presolar graphite grain previously reported by Zinner et al. (1995) [3].

References

- [1] Amari et al., (1994) *Geochim. Cosmochim. Acta*, **58**, 459-470. [2] Yurimoto et al., 2003 *Appl. surf. Sci.*, **203-204**, 793-797. [3] Zinner et al. (1995) *Meteoritics*, **30**, 209-226

Hydrothermal environments in the primitive ocean and its implications on prebiotic evolution

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Hydrothermal environments in the primitive ocean could have been multi-functional in facilitating various phases of prebiotic evolution.

Reduction of carbon dioxide could be possible deep below the sea floor near heated magmas where both water and carbon dioxide coexist as contacting heated metal oxides at temperature about 1000 degrees C. Main products of the reduction include formic and acetic acids.

Synthesis of amino acids could be expected from nitrogen and other ingredient molecules in the supercritical conditions of water deep inside the hydrothermal vents at temperature above 400 degrees C.

Oligomerization of amino acids and its elongation are made feasible when the reactants recycle between hot and cold regions of water repeatedly. Since amino acids and their oligomers are vulnerable to hydrolysis at high temperatures, both the reactants and the half-made products cannot remain stable if they stay in the hot water for long. The best temperature of the hot water in which the reactants stay only for a limited interval for each visit is about 200 degrees C.

When saturated fatty acids such as decanoic acid are made from formic, acetic or oxalic acids via the Fischer-Tropsch-type reaction, they can be aggregated into vesicles in water. Decanoic acid vesicles can encapsulate amino acid molecules if they are also present in the reaction solution. Amino acid molecules encapsulated into the vesicles can enhance the extent of oligomerization, compared to the cases otherwise, when they are allowed to visit both the hot and cold regions of water repeatedly.

Oligomerization of nucleotide molecules such as AMP could also be possible in the hydrothermal circulation of the reaction solution between hot and cold regions. Oligomers of nucleotide molecule are, however, more vulnerable to hydrolysis compared to oligopeptides. The highest yields of oligomers of AMP are obtained when the temperature of the hot regions is about 100-110 degrees C.

A likelihood of co-evolution between oligopeptides and oligonucleotides could also be envisioned in water environments. To facilitate such a co-evolution, lipid vesicles encapsulating the both types of oligomer should further be required. The lipid molecules as ingredients for making lipid vesicles in the reaction solution utilizing the temperature difference between hot and cold should be those whose melting point is lower compared to that of saturated fatty acids (e.g, decanoic acid). Lipid molecules more suitable for lower temperatures are unsaturated fatty acids such as oleic acid or phospholipids.