The simulation experiments on hydrothermal formation of organic globules in carbonaceous chondrites

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Organic globules were found in the Tagish Lake meteorite (carbonaceous chondrite fallen in 2000). Since then, further characterizations of these globules in meteorites have been conducted. However, the formation processes of organic globules remain unclear. In order to simulate the globule formation processes, a series of hydrothermal heating experiments of an OH-bearing amino acid (threonine: Thr) have been conducted in the presence of some rocks (rhyolite, basalt).

40 ml of Thr solution with a rock piece was heated in a hydrothermal vessel at 160°C for 4 days, globules of 2 to 20 micrometers in size were observed under Scanning Electron Microscope (SEM) on the rock surface. By elemental analysis of the globules, they are found to be carbon rich substances. This result suggests that the organic globules found in Tagish Lake meteorite might be formed by organic-inorganic interactions during the aqueous alteration of the chondrite parent body.

In order to study quantitatively the globule formation processes, hydrothermal heating experiments of Thr solutions have been conducted with the silicate glass slide having smooth surfaces. SEM images of glass surfaces showed that diameters and numbers of globules increased with the heating duration and with the temperature. By image analyses, grain size distributions and mean diameters of globules have been determined. Growth rates of organic globules at different temperatures were evaluated by means of their mean diameters. Based on these results, formation of globules of about 300 nm in diameter would need several hundred years under the temperature of aqueous alteration (20°C). These results can be used to estimate temperature conditions and time scales of organic globule formation in the meteorite parent body.

Processes of biomineralization in freshwater cultured pearls

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Freshwater cultured pearls formed by the mussel *Hyriopsis* represent excellent examples to study processes of biomineralization in molluscs. They are grown by inserting a piece of epithelial tissue from the mantle lobe into the mussel where processes identical to those forming the mussel shell occur.

Resonance Raman Spectroscopy of polished pearl cross-sections revealed that ca. 50% of the samples contain vaterite in addition to aragonite. Vaterite is the thermodynamically most unstable polymorph of CaCO3 and is often discussed as a precursor phase in the mineralization of aragonite or calcite by organisms (Weiss *et al*., 2002). Vaterite forms relatively small areas in high quality pearls (1-1.5 mm diameter) which are spherical to irregular and always in close proximity to the center of the pearl. However, in low-quality pearls, they can be much larger, sometimes comprising the major part of the pearl, including the surface (Ma and Lee, 2006; Qiao *et al.*, 2006).

To further study the micro-structure of the vaterite zones, cross-sections were etched with Mutvei's solution (Schoene *et al.*, 2005). This etching method dissolves the calcium carbonate surface with acetic acid, while the organic matrix is stabilized with glutaraldehyde and Comassie Blue colours the organic material in intensities which correspond to the concentration of the organics. SEM analyses of the etched surfaces show that growth rings transect the vaterite areas, implying that vaterite and aragonite grew simultaneously, and that vaterite may not have been an initial template for aragonite growth.

LA-ICP-MS and electron microprobe were used to quantify minor and trace elemental differences between the calcium carbonate polymorphs. Vaterite areas have about 1400 ppm Mg and 1000 ppm Na, versus around 30 ppm Mg and 1650 ppm Na found in aragonite. The Sr concentration in vaterite (250 ppm) is about half of that found in aragonite, while for Mn, Zn and Ba no significant differences were detected.

References

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