Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PPS004-05 会場:101 時間:5 月 27 日 15:15-15:30

The Activity of Liqiud Water in the Early Solar System
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We are exploring the earliest history of water in the solar system through direct analysis of the oldest surviving samples of solar system aqueous fluids. Our ultimate goal is to understand how the solar system evolved to its current state, including the activity of liquid water in the early solar system, and its influence on the origin and evolution of the biosphere of the Earth and the character and extent of prebiotic chemistry on Mars and the moons of the outer planets.

Ten years ago we found the first analyzable, verifiable aqueous fluid inclusions in any extraterrestrial sample (Zolensky et al., 1999, 2000). These fluid inclusions were in halite (NaCl) and sylvite (KCl) crystals in two H chondrite regolith breccias, Monahans 1998 (H5) and Zag (H3-6). At that time we could do very little with the samples, so we carefully preserved them in dry nitrogen cabinets and waited. Finally, analytical techniques have caught up with these critical samples.

Recently we have located fluid inclusions in several other classes of meteorites, especially carbonaceous chondrites. We are collaborating with Y. Yurimoto and S. Itoh (Hokkaido University) in measuring the hydrogen and oxygen isotopic composition of the fluid inclusions aqueous solutions. Yurimoto and Itoh have already reported the first results of their studies (Yurimoto et al., 2010). We will use the O and H isotopic composition of the aqueous fluids to identify the bodies that were the parent objects, and to better understand the source for water on the Earth. We are measuring the bulk composition of the fluid inclusion-bearing phases in each meteorite, as a further guide to the aqueous fluid bulk composition and origin. We suspect that small solid grains from the halite parent body have been deposited in the halite, adjacent to the fluid inclusions, where they must have been preserved against any thermal metamorphism. We are testing this hypothesis using Raman microscopy, in collaboration with M. Fries (Planetary Science Institute) and A. Steele (Carnegie Institution). We will compare these solid inclusions with minerals from chondrites and comet Wild-2 to determine whether these phases had a common origin.

References:

Zolensky et al. (1999) Science 285, 1377-1379.
Zolensky et al. (2000) Antarctic Meteorites XXV: Twentyfifth Symposium on Antarctic Meteorites, 193-195.
Yurimoto et al. (2010) Meteoritics and Planetary Science 45, A222.

キーワード: water, fluid inclusions, meteorites
Keywords: water, fluid inclusions, meteorites