Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS02-P01 Room:Convention Hall Time:May 20 18:15-19:30

Impact production of carbon clusters in nitrogen gas by use of a gas gun

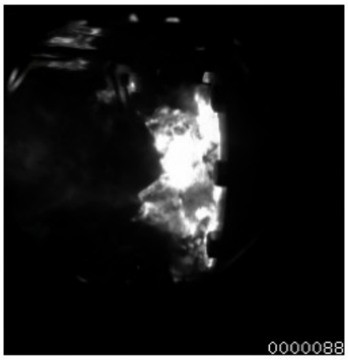
Tetsu Mieno[1*], Kondo Kazuhiko[1], Hasegawa Sunao[2], Kurosawa Kosuke[2]

[1]Dept. Physics, Shizuoka Univ., [2]ISAS/JAXA

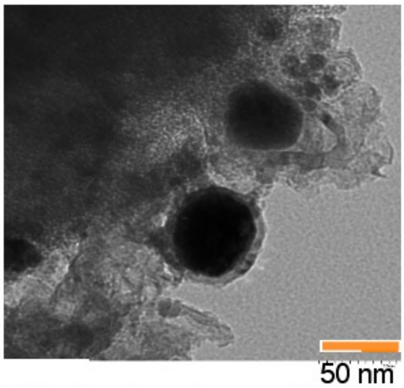
We are interested in the production processes of cabonaceous materials in space. Especially, asteroids coming to Titan satellite have made impact production of cabonaceous particles, for which we are doing simulation experiment. On the Titan surface, various material, produced by the impact reactions, has been stored under low temperature and dark condition. To do the simulation experiment, JAXA 2-stage light-gas-gun is used. A projectile with 6.5 km/s of speed hits a target in 1 atm of nitrogen gas, by which carbon clusters are produced in gas atmosphere. Figure (a) shows the target (75 mm in diam. in the pressured chamber). Figure (b) shows the profile of the plume on the target. Produced clusters are analyzed using a TEM, TOF-MS, FT-IR etc. As a result, production of fullerenes, carbon capsules (Fig. (c)), balloon-like carbons, nanotubes and carbon molecules with nitrogen atoms has been confirmed. As a target, aluminum, iron, iron + ice, iron + hexane etc are used, which are sometimes cooled down less than - 70 degree C. We are considering the reaction process in this impact reactions including the scale factors.

Keywords: impact reaction on stars, Titan, carbon cluster, carbon capsule, nitrogen gas, gas phase reaction

(a) A target inside the pressured chamber.



(b) Profile of the impact image on the target.



(c) Produced metal encapsuleted carbon particles measured by TEM.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS02-P02 Room:Convention Hall Time:May 20 18:15-19:30

Comparison of alteration of type B CAIs from CV3 chondrites Allende and Efremovka

Haruki Aragane[1*], Timothy Fagan[1]

[1]Waseda University

This study compares alteration histories of type B Ca-Al-rich Inclusions (CAIs) in two CV3 chondrites: Allende and Efremovka. Two CAIs from Allende (3655A and 4022) and one CAI from Efremovka (CGI-10) were studied. The main primary minerals of these CAIs are: melilite (Mel); fassaite (Fas); anorthite (Ano); Mg-spinel (Mg-spn). These minerals have similar interlocking, igneous-appearing (compact) textures in all three CAIs; however, secondary minerals and textures differ. Both the Allende and Efremovka CAIs have sodalite-rich alteration domains near CAI margins, but in the Allende CAIs, sodalite occurs with an assemblage of secondary minerals including nepheline, Fe-bearing spinel, grossular, an elongate Ca-Al-rich silicate (anorthite and/or margarite or possibly combinations of fine-grained minerals). We have not identified a similar assemblage in our initial work on CGI-10.

Furthermore, in the Allende CAIs, grossular-rich veins (GRV; mostly grossular (Grs) + monticellite (Mon) + wollastonite (Woll)) occur along grain boundaries of primary melilite. In contrast, melilite grain boundaries in CGI-10 appear fresh and free of replacement. The GRV and alkali-FeO-rich alteration domains indicate that the Allende CAIs have undergone a greater degree of secondary mineralization. This is consistent with the inference that Allende has been metamorphosed at higher temperatures than Efremovka (Bonal et al., 2006, GCA v. 70, 1849-1863).

It is obvious that a change in composition is necessary to produce the alkali-FeO-rich secondary minerals from the CAI primary minerals?namely an influx of Na, K, Cl and Fe and an outward flux of at least one element (possibly Ca). However, it is not obvious whether the GRV formed in an open system (elements being exchanged between CAI and surrounding environment) or closed system (little transport of elements between the CAI interior and surrounding environment during metamorphism).

To address this question, we used two approaches: (1) examine the GRV to identify exotic minerals; (2) make a model mass balance (reaction space) system to ask whether closed or open system models make better fits to the observed mineral abundances and textures. In approach (1) we were able to identify troilite (FeS) and wadalite (Ca6Al5Si2O16Cl3) in GRV in the interior of CAI 3655A, indicating that some S and Cl (and possibly Fe) were introduced into the CAI interior during metamorphism.

In approach (2) we construct a model reacting system including Ano, Mel, Grs, Mon, Woll, with Tschermak exchange (Al-1Al-1MgSi) to describe gehlenite-akermanite, and MgCa-1 for garnet solid solution (textures and low Ti-contents of secondary minerals indicate that Mg-spinel and fassaite are not consumed in significant quantities during formation of the GRV). These minerals and solid solutions can be described by the components CaO, MgO, Al2O3, SiO2 (CMAS). We invert the composition matrix and determine the following reactions for this system: (r1) 3tkr + 4Mel + 4 Ano = 5Grs + 3mc, (r2) 3tkr + 4Mel + 2mc = 5Mon + Ano, (r3) 5tkr + 5Mel = 5 Woll + 5 Mon. We determined modes for CAIs 3655A and 4022 to calculate the forward progress on reactions r1, r2, r3. Solutions can be calculated for both CAIs, but the solutions predict that the volume ratio of Ano/(Ano+Mel) consumed exceeds 0.3 and that the composition of melilite consumed exceeds Ak70. This Ak-content exceeds exceeds the Ak-contents of melilite present in the CAIs. The Ano/(Ano+Mel) consumed ratio is estimated as <0.1 for 3655A and <0.2 for 4022. Better fits to these parameters are reached if CaO is lost during formation of the GRV. These results suggest that, even though the main GRV minerals are CMAS phases, the CAIs were open metamorphic systems and that CaO was lost from Allende CAIs during formation of the GRV.

Keywords: CV chondrites, CAIs, alteration, metamorphism

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS02-P03 Room:Convention Hall Time:May 20 18:15-19:30

Hydrothermal alteration experiments representing the early Ceres

Koyo Horiguchi[1*], Hiroshi Isobe[1]

[1]Grad. Sch. Sci. Tech., Kumamoto Univ

Variations of asteroids correspond to meteorite parent bodies. Meteorites show wide range of variations from the primitive chondrites to the fractionated meteorites. Carbonaceous chondrites, the most primitive meteorites, include low-temperature aqueous alteration products. Aqueous alteration processes depend on the size and thermal history of involving the parent bodies. The Ceres, the dwarf planet, is the subject to convection of hydrothermal fluid in its early formation history (Mccord and Sotin, 2005). The infrared spectrum of the Ceres correspond to approximately 14% of phyllosilicate and 6% of carbonate such as siderite, and about 80% of carbonaceous chondrite (Rivkin, 2006). In this study, hydrothermal experiments representing the alteration process occurred in the early Ceres were carried out.

Experimental fluid is presumed based on Mousis and Alibert (2005) for H_2O 49.14% ,CO_2. 44.23%, CH_4 4.42% and H_2S 2.21%. For the experiment, CH_3OH 18.6% solution and appropriate mass of silver oxalate are used to provide hydrocarbon and CO_2, respectively. The starting material is powdered Allende meteorite, which is typical unhydrous carbonaceous chondrite. The ratio of a solid and a liquid is 1:1.8. Experimental temperature and durations are as follows; 100, 200 and 300 degree C; 3, 6 and 12weeks, 400 and 450 degree C; 1, 2 and 3weeks, respectively.

Main products phases are phyllosilicate and carbonate. In the run products of 100 degree C, magnesite-siderite crystals with various grain size and compositions occur. The Mg/Fe ratio in carbonate increases with run durations depending on dissolution of Mg-rich olivine. Over 200 degree C, Fe-poor carbonate occur. In 200 degree C, main carbonate phase is dolomite, and over 300 degree C, main phase is calcite.

Mg and Fe may be consumed by phyllosicate over 200 degree C. Phyllosilicate is most abundant at 300 degree C. Mg/Fe composition of phyllosilicate varies to Fe-rich field. This suggests that the phyllosilicate composition may be affected by the reduced alteration condition in this study.

The infrared signature of siderite and phyllosilicate is reported from the Ceres (Rivkin, 2006). Siderite on the surface of the Ceres may suggest that the alteration temperature of the Ceres did not exceed 200 degree C. Abundance of phyllosilicate also suggests that alteration temperature was below 300 degree C. The infrared spectrum of the run products may be comparable to those of dwarf planets or meteorite parent bodies to understand early evolution processes including aqueous alteration with reducing conditions.

Keywords: Asteroids, Ceres, Hydrothermal alteration, carbonate, phyllosilicate

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS02-P04 Room:Convention Hall Time:May 20 18:15-19:30

The change of texture of olivine and plagioclase by the shock process in troctolite

Daiki Mutou[1*], Masahiro KAYAMA[2], Toshimori Sekine[3]

[1]Department of Earth and Planetary Systems Science, Graduate School, Hiroshima University, [2]Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University, [3]Graduate School of Science, Hiroshima University

The collision phenomena are important for understanding evolution of planets, their surfaces. Although there are a lot of experimental studies on plagioclase and olivine, two constituent minerals of an ordinary meteorite, we need to know the shock wave effects on these minerals more detailed. We conducted shock experiments on a troctolite using a single stage propellant gun at NIMS in Tsukuba. At peak preasures of 10 GPa, 20 GPa, 30 GPa, 45.5 GPa and 58.3 GPa. The recovered samples are investigated by SEM, EPMA, XRD and the cathode luminescence method (CL method). In samples recovered at 10 GPa and 20 GPa, the intense cracks were observed. Above 30 GPa, however, the polished surface of plagioclase became, indicating that it transformed into glass. At 45.5 GPa and 58.3 GPa, the textures indicated partial melting. From XRD analyses, we found that the diffraction peaks of plagioclase decreased greatly at 30 GPa and most plagioclases changed amorphous. The CL emission intensity decrease. There are three peaks centered at about 330 nm, 400 nm and 550 nm for the initial plagioclase. In the 30 GPa sample, two peaks centered at ˜ 330 nm and 380 nm. The EPMA analyese indicates no compositional change but a slight deviation from the total of 100 %.

On the other hand, the irregular cracks were observed in olivines recovered samples from 10 GPa, 20 GPa, 30 GPa and 45.5 GPa. At 58.4GPa, however, cracks were not observed, suggesting that olivine became soften.

During analysis by EPMA, amphiboles were found in all samples except the sample at 20 GPa, and calcite left at 58.4 GPa. On the other hand, clay minerals disappeared above 45.5 GPa. We keep detailed study further.

Keywords: troctolite, shock pressure, shock experiment, olivine, plagioclase

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS02-P05 Room:Convention Hall Time:May 20 18:15-19:30

Ca-phosphates and role of H2O during evolution of lunar rocks Northwest Africa 773 and Apollo 15405

ATSUSHI SHIMODA[1]*, Timothy Fagan[1]

[1]Waseda University

Ca-phosphates are rich in incompatible elements and are relatively abundant in evolved igneous rocks on the Moon. This study makes use of apatite (Ca10[PO4]6[F,Cl,OH]2) and RE-merrillite (also called whitlockite, Ca16REE2[Mg,Fe]2[PO4]14) to characterize the origin of the following evolved lunar rocks: (1) incompatible element-rich pockets in olivine cumulate clasts in the Northwest Africa 773 breccia (NWA 773, a lunar meteorite); (2) fayalite-hedenbergite-silica symplectites in the NWA 773; (3) FeO-alkali-rich clasts in NWA 773; (4) quartz monzodiorite (QMD) from Apollo sample 15405. The abundance of whitlockite exceeds that of apatite in all of the rocks above except for the symplectites–apatite only was identified in symplectite. This suggests that most evolved lunar rocks are poor in halogens and H2O compared to granitic rocks on Earth, which tend to have higher abundances of apatite.

Low-voltage (7 kV), low-current (2 nA) analyses of lunar apatites in the NWA 773 incompatible pockets, FeO-alkali-rich clasts and symplectites were analyzed for the presence of F and Cl (and by subtraction, OH). Analytical conditions were checked using terrestrial Cerro de Mercado apatite. Fluorine Ka count rates remain steady for the above conditions for apatite with c-axis oriented perpendicular to the electron beam, but drop to below detection after 60 seconds of beam exposure if the c-axis is oriented parallel to the electron beam.

Apatites in the incompatible pockets, FeO-alkali-rich clasts and symplectites are F-rich, but suggest that OH is present (~F-1.5 Cl-0.05 OH-0.45). If so, H2O was present in the igneous liquid from which clasts in NWA 773 crystallized. Both the FeO-alkali-rich clasts and the symplectites are interpreted as evolved differentiation products from the same magmatic system that produced the olivine cumulate. If this interpretation is correct, then OH must have partitioned away from the FeO-alkali-rich parent material and into the symplectite parent material to result in the distribution of Ca-phosphates in these evolved clasts.

Keywords: lunar rocks, basalts, phosphates