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Phyllosilicate and its role on the evolution of organic materials in the early solar nebula

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We have investigated the chemical interaction of silicate, organics, and water at various temperature conditions to get better understanding of evolution of solid materials in the solar nebula with special interest to the evolution of organic materials on silicate. The stability of amorphous silicate was thermodynamically evaluat-ed by using the thermodynamic data by Golczewski (1998). The reaction investigated are 4MgSiO3 (En) + 2H2O (gas)= Mg3Si4O10(OH)2 (talc)+ Mg(OH)2(brucite) and 2Mg2SiO4(For) +3H2O(gas) = Mg3Si2O5(OH)4(serpentine) + Mg(OH)2 (brucite). The results show that hydration of the amorphous silicate lies at much higher temperature portion compared to crystalline silicates; the hydration of amorphous MgSiO3 takes place at higher temperatures by $\sim$300° compared to crystalline enstatite, and amorphous Mg2SiO4 by $\sim$200° than crystalline forsterite.
The time scale for the hydrous mineral formation from amorphous silicate is experimentally studied. We have prepared silicate glass as the analog for the amorphous silicate. The glass has a composition of Mg/Si$\sim$1, which assumes that the amorphous silicate in the mo-lecular cloud is the average of the solar abundance. Two types of experiments are carried out: one is an open system reaction, where water vapor gas is flowing through a glass tube, which is continuously evacuated. The other is a closed system experiments, in which water vapor was poured into a once evacuated capsule with the samples. For the former experiments, temperature was at the room temperature. For the latter experiments, temperature ranged from the room temperature to 80°C. The weight change was measured and the surface of the samples was observed with SEM-EDS-EBSD.
In order to evaluate the stability of hydrous silicate, dehydration experiments for natural serpentine (chrysotile) and talc were conducted in the temperature range from the room temperature to 1000°C in vacuum chamber. Dehydration rate of serpentine is rapid in the initial stage and slowed with time. Complete dehydra-tion to attain $\sim$12% weight loss was achieved at high temperatures above 500°C. From the time dependent mass loss rate, dehydration time scale was estimated as a function of temperature. Extrapolation of the experimental results to lower temperatures shows that serpentine can survive for the life time of the solar nebula if it is retained at temperatures as low as $\sim$300K (Fig. 2). In order to retain hydrous silicates, they should be transported to cooler region of the nebula rapidly.
The hydrous phyllosilicates act as the catalyst for the organic compound formation as is well known in the terrestrial material science. The organic components in the core-mantle type dust grains evolve if the core amorphous silicate is converted to phyllosilicate, suggesting that organic materials can evolve in the early solar nebula before incorporation into parent bodies. The present work shows that organic materials could evolve before accretion to a parent body, which may be important for the origin of precursor materials for life on planets.