Impact-induced dehydration reactions of Fe- and Al-hydrates as potential storage, carrier and source of water

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Hydrous minerals have been known to play an important role to preserve and carry water because a mechanism is required for water to reach the inner planets such as Earth far beyond the snow line that defines the boundary between water ice and vapor. In order to understand the detailes, we need to know the stability at high temperature and high pressure and impact resistance for possible hydrous minerals. Fe- and Al-hydrates (FeOOH and AlOOH) have been reported to be stable under static high temperature and static high pressure. In addition, they are observed in some meteorites and the surface on Mars. Although there are some data available on clay minerals and serpentine, those Fe- and Al-hydrates are considered to be present in the Earth’ s deep lower mantle according to the recent studies.

We have investigated the impact resistibility through shock recovery techniques. Our peak shock pressures are 24 GPa and 31 GPa for the recovered Fe- and Al-hydrates, respectively, where they displayed significant dehydration. We set various range of sample porosity and peak shock pressure to investing the dehydration reaction. These impact conditions correspond to impact velocities of 2.6 km/s and 4.9 km/s if we assume face to face impacts between carbonaceous chondrite such as Murchison. These are within a range of velocity for possible meteoritic collisions, and we need to know the relationship between impact condition and degree of dehydration. Using TG/DTA analyses of samples we estimated the relationship. The phase changes by impact dehydration are investigated by XRD, XAFS and Raman spectroscopy. We also try to understand dynamical void formation process by dehydration that can occur during adiabatic quenching through observation of void distribution in the recovered samples.

In our previous research for shock recovery experiments of hydrous minerals, we observed heterogenous temperature rise in dehydration process. We tried to confirm whether heterogeneous temperature rise occurs even in Fe- and Al-hydrates by comparison with the results between previously reported hydrous minerals. We will be able to select most possible candidate by comparing the thermal stability and impact resistibility among them.

Keywords: Shock recovered experiments, hydrous mineral, dynamic water loss, Powder x-ray diffraction

