Experimental simulations on impact-induced dehydration of porous surfaces

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It is now generally believed that accreation of planetesimal formed planets and collision with small-bodies evolved them. Impact-induced dehydration of impactors influenced the composition of primitive planetary atmosphere and the supply of water to planets. So it is required to understand impact-induced dehydration of planetary bodies in terms of the origin of water-planets. Lots of works about small bodies to reveal the origin of the solar system and planets have been performed including sample return missions from primitive bodies. Asteroid exploration Hayabusa2 will return samples of a C-type asteroid Ryugu which possibly has hydrated minerals. Understanding impact-induced dehydration is of importance in order to discuss the influence of dehydration of the returned samples.
A lot of experimental works related with impact-induced dehydration have been performed and most of the experiments are shock recovery experiments. In this method, the samples were capsuled in sealed metal containers and impacted by projectiles indirectly. This method derived impact-induced water loss as a function of shock pressure, but didn’t simulate real surface of planetary bodies very well because of the container. The relation between sample porosity and water loss has also been studied but is not fully understood. In order to discuss dehydration of asteroids due to impacts, it is necessary to reveal the relationship between dehydration efficiency and porosity in detail.
In this study, we performed shock dehydration experiments without sealed containers to simulate natural impacts on the surface of planetary bodies. In addition, we used gypsum targets with different porosities and examined the relationship between porosity and shock-induced water loss.
We set the sample in a cylindrical stainless container and shot a disk-shaped metal, stainless-steel or copper, projectile directly onto the surface. Targets were set inside a vacuum chamber under 0.1atm condition. We measured the velocity of projectile using a high-speed video camera. The shock pressure was calculated by impedance matching method. The post-shocked samples were recovered from the surface of the projectile. We analyzed the recovered samples by XRD and examined if dehydration occurred. After that, we measured the impact-induced water loss (wt%) by thermogravimetric analysis (TGA) and compared the results with those of XRD.
Impact-induced dehydration was observed in this study. We found that the results of XRD and TGA were consistent. We did not found any strong relationship between porosity and water loss in this work.

Keywords: impact-induced dehydration, porosity

