

## **Impact vaporization of extraterrestrial objects: importance of liquid water and implication to the early Earth**

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Late Heavy Bombardment of extraterrestrial objects impacted dominantly onto the oceans during the late Hadean age. Such impact would have been vaporized large amounts of the meteorites. Impact vaporization is very important process to consider about environment of the early earth. Experimental evidence of impact vaporization of extraterrestrial objects has been lacking, because velocity of impact generated in laboratory is much lower and an effect of water on the vaporization had never been recognized. In this study, we report the formation of the ultrafine particles in shock-recovering experiments targeting iron, olivine and water. The ultrafine particles of transition metal oxides and olivine exhibit morphology characteristics of smoke particles of vapor growth. Their compositions also indicate that these particles were formed by elements from different sources. We speculate that super critical water, formed during shock experiments, expanded the solubility of solid materials and enhance the vaporization of the starting materials. This evidence suggests impact vaporization at low velocity and low water content implying that extraterrestrial objects that impacted to early oceans must have been vaporized extensively thereby formed large amounts of ultrafine particles. Because these particles have been supposed about 100 times larger than formed in this study, such ultrafine particles launched to the stratosphere would have stay long and formed post-impact clouds that obstructed sunlight and UV radiation for much longer than previously believed.