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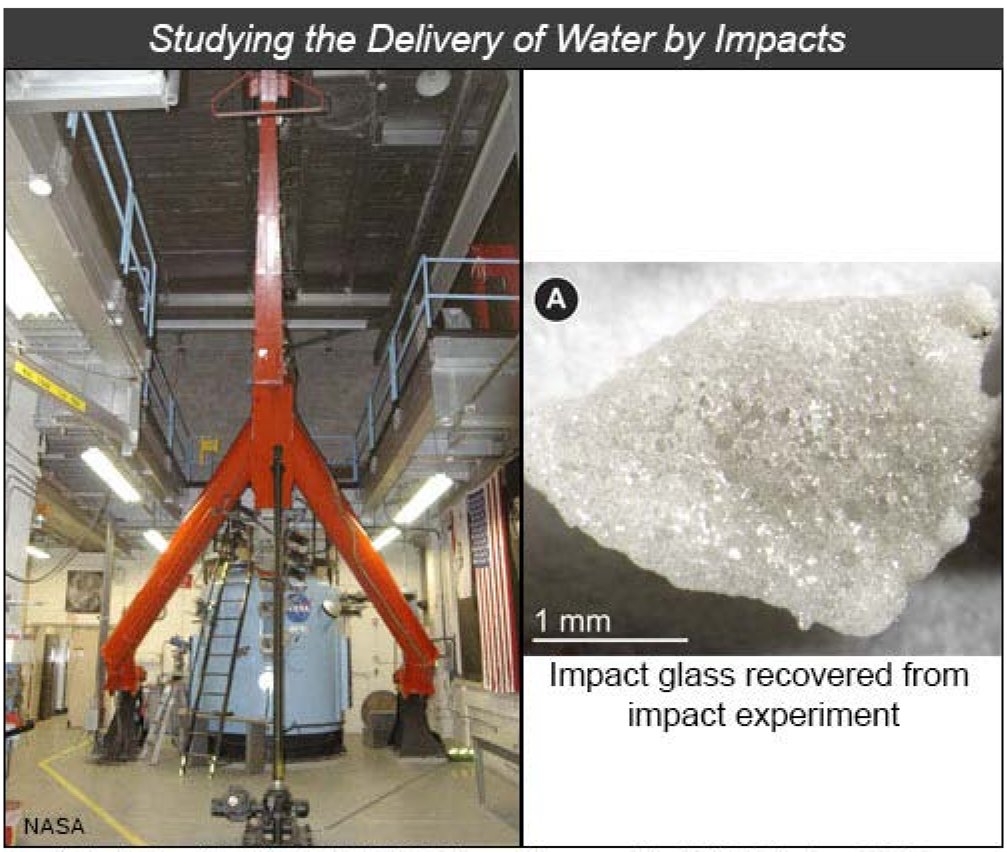
Quick Views of Big Advances

Water Delivery by Impact During Planetary Accretion... and Even Now

The inner planets and the Moon contain variable amounts of water, a lucky thing for us because it is essential for life. Compositional comparison of the ***isotopic*** composition of hydrogen in water suggests that water-rich asteroids with compositions resembling **carbonaceous chondrites** were an important source of water in the inner Solar System. An unresolved question is how water was trapped during planetary ***accretion*** or during more recent asteroid impacts into fully-formed bodies such as the Moon or asteroid Vesta. Impact events are energetic, producing copious amounts of heat. How could water have been retained during this messy and violent process? R. Terik Daly and Peter H. Schultz (Brown University; Daly is now at Applied Physics Laboratory at Johns Hopkins University) examined this question experimentally.



(Daly, R. T. and Schultz, P. H., 2018, Science Advances, doi: 10.1126/sciadv.aar2632)

[LEFT] Photo of the NASA Ames Vertical Gun Range used by the authors for hypervelocity impact experiments.
[RIGHT] Photo of an impact-generated glass product from an impact experiment by Daly and Schultz.

Daly and Schultz used the NASA Ames Vertical Gun Range (***AVGR***), a stalwart laboratory facility located at NASA Ames Research Center in Moffett Field, California. The range allows for images to be taken of the impact of high-speed projectiles into a target, such as sand, as shown ***here***. Daly and Schultz made targets of pumice powder that was heated to remove all water (analogous to planetary surface materials). Then they launched pieces (a few millimeters across) of the mineral antigorite (an analog for carbonaceous chondrite-like objects) into the unsuspecting pumice at 5 kilometers/second. Antigorite is a member of the serpentine family of minerals. It forms by reaction between water and ***ultramafic*** rocks such as dunite (rich in olivine), and is an important mineral in ***subduction*** zones on Earth (places where an oceanic plate slides beneath another oceanic plate or a continent). The important feature of antigorite is that it contains about 12 wt% H_2O (most in the form of OH), about the same as carbonaceous chondrites (10 to 15 wt%). The experiments show that the impact melt (which quenched to form glass) and ***breccias*** produced by the impacts capture up to 30% of the water in the impactors, with most of it occurring in the impact melts. This suggests that much of the water in impacting projectiles is retained. For the full range of implications, see the interesting discussion in the article.

See Reference:

· Daly, R. T. and Schultz, P. H. (2018) The delivery of Water by Impacts from Planetary Accretion to Present, *Science Advances,* v. 4, eaar2632, doi: 10.1126/sciadv.aar2632. [***article***]

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