SHOCK19-2019-000117

Abstract for an Invited Paper
for the SHOCK19 Meeting of
the American Physical Society

The delivery of water during impacts: The view from experiments

R.TERIK DALY, Johns Hopkins University Applied Physics Lab

The fate of water during impacts is of fundamental importance to planetary formation and evolution. However, the mechanisms that trap impactor-derived water remain poorly constrained. Isotopic evidence indicates that carbonaceous chondrite (CC)-like objects delivered water to the inner solar system. Recent hypervelocity impact experiments at the NASA Ames Vertical Gun Range address two fundamental questions. First, how much of the water carried by CC-like impactors can be trapped in impact products? Second, where does impactor-derived water reside? We focus on oblique impacts (30 and 45 degrees with respect to horizontal), scenarios that lead to a wide range of pressure and temperature conditions in the both the impactor and target. (45 degrees is also the most probable impact angle.) The experiments reveal that impact melts and breccias capture up to 30% of the water carried by CC–like impactors under impact conditions typical of the main asteroid belt and the early phases of planet formation. This impactor-derived water resides in two distinct reservoirs: quenched impact melts and projectile survivors. Quenched impact melt hosts the bulk of the delivered water, and in these materials molecular water dominates over hydroxyl. Entrapment of water within impact glasses and melt-bearing breccias likely contributed to the early accretion of water during planet formation. Bodies too small to retain vaporized water could have nevertheless captured water in impact melt products. As such, water and other volatiles may have been sequestered within growing planets, with implications for geodynamics and planetary evolution.