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**Rubble Pile Impacts: The Influence of Regional Slopes and Weak Boulders**

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##### ABSTRACT

When predicting how an asteroid may respond to an impact for a kinetic impactor deflection scenario, properties such as target material strength, composition, and porosity can influence the momentum transfer efficiency. Recent results from missions such as Hayabusa-2 and OSIRIS-REx suggest that the simplified assumption of a homogeneous, ideal asteroid may not capture the full story; many of the observed asteroids are, instead, heterogeneous, rubble-pile type structures. With the potential prevalence of rubble-pile structures, questions about the influence that boulders have on kinetic impactor planetary defense scenarios arise. For example: if the boulders are weak, and potentially similar in strength to the surrounding regolith matrix, how will the target asteroid respond to impact? How does the local topography affect the momentum transfer? And, do boulders or rubble-pile structures enhance or minimize that effect? Here, we present results from the Adaptive Smoothed Particle Hydrodynamics (ASPH) numerical simulation code Spheral of impacts into rubble-pile structures to address some of these questions. Building off work presented at the 2019 Planetary Defense Conference, we will discuss how local boulder topography alters the momentum transfer from an impactor to a target. We will further present how regional slopes can minimize the momentum transfer, an effect that was seen in simulations with homogeneous targets. This indicates that the regional slope of a target may be of greater importance than the local boulder environment. Additionally, results from the Hayabusa-2 and OSIRIS-REx missions suggest that boulders at or near the surface of Ryugu and Bennu may be very weak, and we will discuss the influence of boulder strength on deflection velocity. Together, with previously reported simulations, we aim to place constraints on the uncertainties that boulders may add to simulation predictions to aid in characterizing the deflection efficiency of a kinetic impactor planetary defense scenario.

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