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Using Mesoscale Computational Investigations to Investigate the Role of Material Heterogeneity in Geologic and Planetary Materials

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The propagation of shock waves through target materials is strongly influenced by the presence of small-scale structure, fractures, physical and chemical heterogeneities. Reverberations behind the shock from the presence of physical heterogeneity have been proposed as a mechanism for transient weakening of target materials [1] as are localized shock effects seen in some meteorites [2]. Pre-existing fractures can also affect melt generation [3]. Recent studies in computational hydrodynamics have attempted to bridge the gap in numerical modeling between the micro-scale and the continuum, the meso-scale. Methods are being devised using shock physics hydrocodes such as CTH and Monte-Carlo-type methods to investigate the shock properties of heterogeneous materials [4] and to compare the results with experiments[5]. Recent numerical experiments at the meso-scale using these statistical methods suggest that heterogeneity at the micro-scale plays a substantial and statistically quantifiable role in the effective shear and fracture strength of rocks [6]. This paper will describe the methodology to determine the shear and fracture strength of heterogeneous materials and apply the method to simulations of large crater formation. References: [1] Melosh, H. J. 1979, J. Geophys. Res. 84, pp. 7513-7520. [2] Walton E.L. & J.G. Spray 2003, Met. Planet. Sci. 38, pp. 1865-1875. [3] Kieffer, S. W. 1971, J. of Geophys. Res., 76, pp. 5449-5473. [4] Crawford, D.A. & O.S. Barnouin-Jha 2004, Abstract #1757, 35^{th} Lunar and Planet. Sci. Conf.. [5] Barnouin-Jha, et al. 2002, 33^{rd} Lunar and Planet. Sci. Conf., pp. 1738-1739. [6] Crawford, D.A. & O.S. Barnouin-Jha 2004, Abs. #5083, 67^{th} Annual Meteoritical Society Meeting.