SHOCK-INDUCED COMPACTION AND POROSITY IN METEORITES. P. S. DeCarli[1,2] ,E. Bowden[2] and L. Seaman[1], [1]SRI International, 333 Ravenswood Ave, Menlo Park, CA 94025, USA pdecarli@unix.sri.com, [2]Dept of Geological Sciences, University College London , Gower St., London WC1E 6BT

Introduction: This paper was inspired by a paper presented by Guy Consolmagno at LPSC XXX. [1] Consolmagno and co-workers have studied meteorite porosity for clues to the processes by which individual mineral grains accumulate and are lithified. Present-day asteroids are much too small to provide adequate pressures, even in their centers, to account for lithification. They have noted that shock compaction might be a viable process, but suggest that there are problems explaining the existence of high-porosity meteorites.

In private discussions with Consolmagno, we have noted that there is a vast specialized literature on shock compaction (of both metal and ceramic powders) and on shock induced porosity and fracture. Two recent review articles [2,3], along with their cited references, can serve as an introduction to this literature. With Consolmagno's encouragement, we extrapolate from our own first-hand experience, as well as our knowledge of the literature, and attempt to make the case that shock processes can account for both compaction and the observed porosity of meteorites.

General Observations: Shock compaction and bonding can occur over a very wide range of shock conditions. A shock pressure as low as 1 GPa suffices to transform a dry clay soil into " instant rock ". At the other extreme, shock pressures approaching 100 GPa may be required to deposit sufficient energy in the most refractory mineral assemblages that they will be melt-bonded on release of pressure.

Shock compaction is not difficult. As a rule, the problem of shock recovery experiments is to design for the relief of shock pressure without permitting rarefactions to interact within the sample, thereby producing tensile stresses. Tensile stresses lead to the nucleation and growth of voids (ductile materials) or cracks (brittle materials) which eventually coalesce to form a fracture surface. The essential parameters, nucleation and growth rates as a function of temperature and stress, are determined for materials of interest in sub-microsecond duration experiments. These material parameters can then be used in computational simulations of dynamic fracture.

It is generally assumed that cratering or fragmentation will be the inevitable result of a high velocity (e.g. 1 km/s) collision between two bodies. Details are important. If one shoots a military rifle into a rock or a bed of densely packed sand grains, material will be ejected and a crater will be produced. If the target is a porous soil, the bullet will penetrate, compressing material in front of the bullet, and negligible material will be ejected.

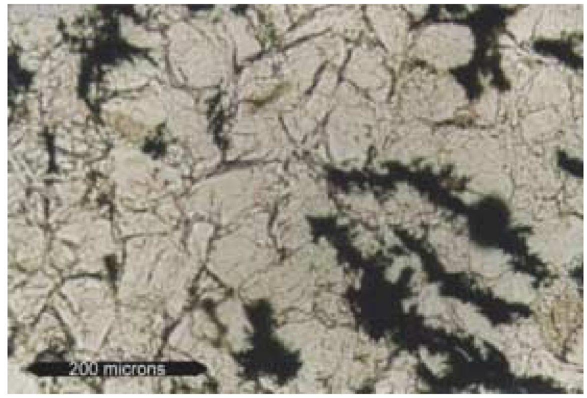

Fig.1 Shock-induced compaction and shock-induced porosity. The original sample was quartz grains (< 100 µm) packed to a density of 1.43 g/cm^3 in a PTFE container. A flyer plate impact produced a peak pressure of ~17 GPa in the sample, eliminating porosity and bonding the grains. On pressure release, the interaction of rarefactions produced short-duration tensile stresses which caused the fractures (black regions) observed in the lower right corner of this photograph.

References: [1] Consolmagno G. J. and Britt D.T, (1999)LPSC XXX CD [2] Shockey D.A. and Curran D. R. (2001) *Shock Wave and High-Strain-Rate Phenomena*,Elsevier, pp vii-xx [3] Prümmer R, *ibid*, pp 235-244