HIGH-PRESSURE MINERALOGY OF SHOCK VEINS IN METEORITES DOES CONSTRAIN THE EQUILIBRIUM SHOCK PRESSURE AND ITS DURATION.

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Introduction: A recent paper on helium loss from Martian meteorites states that the high-pressure mineralogy of veins is not a good equilibrium pressure barometer.[1] We respectfully disagree. However we do agree with the authors that it is likely that helium loss from Martian meteorites is largely due to shock metamorphism. It is not certain that the shock metamorphism was coincident with the ejection event in every case.

Problems with Laboratory Shock Experiments: Significant differences between the conditions of laboratory shock experiments and natural events were noted as early as 1962 [2]. Effects of differences in loading path, post shock cooling rates, and shock pressure duration were discussed in 2002 [3]. Although the laboratory shock recovery experiments have provided valuable qualitative information, the use of their results to precisely calibrate the equilibrium shock pressures experienced by rocks or minerals does not appear to be justified.

Problems with Post-Shock Temperature Calculations: In the ideal one-dimensional laboratory experiment on a homogeneous material, given adequate experimental data, the calculation of post-shock temperature is trivial and the result is a uniform temperature. In the complex shock propagation geometry of a typical rock made of anisotropic minerals, the calculation taxes the capabilities of a supercomputer. Shock temperatures can differ by as much as an order of magnitude between grains and even within a single grain [4]

Shock Pressure Calibration: Chen et al. first demonstrated that the mineral assemblage of melt veins can provide a credible shock pressure calibration [5]. Subsequent work at many institutions has provided confirmation of the utility of melt vein analyses [4]. Langenhorst and Poirier performed the first thermal analysis of melt vein cooling [6]. Their study indicated that the shock associated with Zagami veins had an effective duration of milliseconds and an equilibrium peak pressure of less than 25 GPa. Zagami must have been too far below the surface for ejection via the now discredited spall mechanism. Low-pressure ejection by a high-velocity vapor or ejecta cloud has been suggested [7]

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