

AN IMPACT HEATING MODEL NORMALIZED TO NUCLEAR EXPERIMENTS

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We wish to report some of the preliminary results obtained from a new thermodynamic model of lunar meteorite impact. This model has two features that are felt to be significant improvements over the older model by Rehfuss (1,2) in that it involves a four-parameter match to experimental data (as opposed to two) and in that it estimates shock-heating temperature versus distance in the target material.

The four parameters by which this model is tied to experimental data are:

- (a) contact-shock pressure
- (b) contact-shock density
- (c) total available energy
- (d) distant pressure-falloff rate

Whereas the usual one-dimensional shock model (3,4) and Rankine-Hugoniot conservation relations, yielding parameters a and b, have been in common use for some time, little empirical information has been available on the thermodynamic states of the target material as the shock wave travels a significant distance away from the immediate contact zone between meteorite and target. However, pressure versus distance information is available from the Hardhat and Piledriver underground nuclear events (5,6); the yields are also known; hence it is feasible to incorporate parameters c and d into an impact model. We are not saying that any meteorite impact necessarily produces effects similar to any nuclear event of the same energy, but we do contend that such a possibility is worth considering.

The main innovation which allows normalization of pressure falloff rates is the use of a power series expansion for the semi-relaxed residual pressure after the impact event. Our normalization procedure involves the choice of the proper coefficients which produce a relative pressure falloff rate similar to that of the nuclear event. For example, in the Piledriver event, the maximum pressures recorded at 52 and 110 meters were 45 kb and 8 kb, respectively. The distance ratio involved was thus 2.12. In our model we do not match the absolute distances involved, but only that distance ratio.

According to the model, peak pressures of 45 and 8 kb correspond to post-shock pressures of 34 and 6.1 kb when the material has decompressed to standard density, and the latter pressures are indicated by dots on the curve in Figure 1. In that Figure, along with Figures 2 and 3, are presented some preliminary results from a Piledriver-normalized run, designed to represent the impact of a meteorite against a basalt target. To match the meteorite kinetic energy with the 61 kT yield of the Piledriver device, we use a

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spherical basalt meteorite of radius 4.66 m, hitting at 20 km/sec. The irreversible shock heat and the residual temperature, plotted versus distance in Figures 2 and 3 respectively, are also descriptive of the moment when target material has decompressed to standard density.

In general the major differences from the previous model of Rehfuss (1,2) are that a larger target volume is subject to shock heating, and a larger fraction of the initial meteorite kinetic energy is partitioned into irreversible heat, as opposed to mechanical cratering energy.

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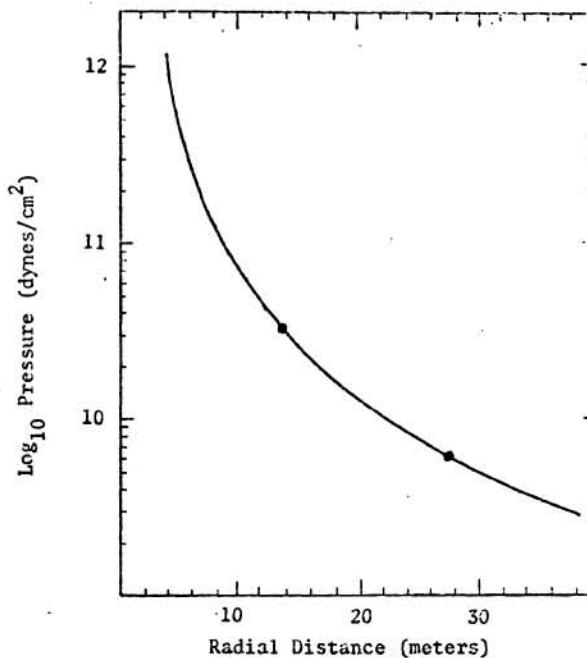


FIGURE 1

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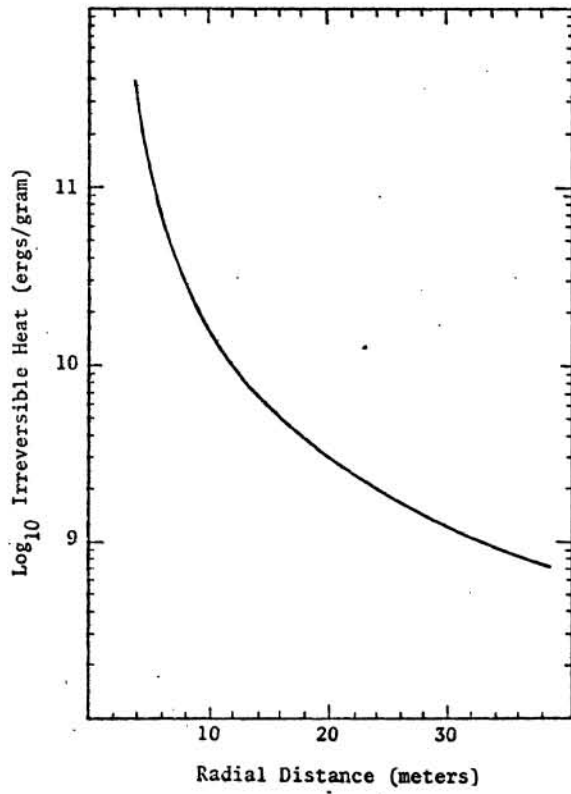


FIGURE 2

FIGURE 3

