SHOCK COMPRESSION OF LUNAR FINES FROM APOLLO 17*, David M. Cole and Thomas J. Ahrens, Seismological Laboratory, California Institute of Technology, Pasadena, California 91109.

A series of samples of 70051 consisting of angular lithic and mineral fragments (~5 to 100 μ) of pyroxene (~60%), plagioclase (~30%), brown glass and opaques (~10%) has been shocked to pressures of 126 kbar. The sample is largely from rocks (70017, 70215, 76055, 77035 and 74035) collected in the BSLSS bag (EVA III) and is probably representative of the gross lithology at the base of the North Massif. Cylindircal samples, 4 mm thick, 16 mm diameter having an initial nominal density of 1.80 ± 0.01 g/cm^3 were prepared by cold compression. Initial densities (Table 1) are calculated from exact sample dimensions and masses. Projectile and shock velocities were obtained by laser obscuration and streak camera techniques [1,2]. Below 50 kbar, the present data (Fig. 1) lie close to the extrapolated static compression curve for the lunar fines examined by Stephens and Lilley [3] suggesting that the low pressure irreversible compaction behavior of these two samples is roughly similar. However, the single datum (Shot #304) for powdered Vacaville basalt [4] lies at least 25 kbar above the lunar data. In order to separate the effects of mechanical resistance to shock induced compaction and shock heating, we have constructed a theoretical intrinsic mineral Hugoniot (Fig. 2) from the following chemical and mineral model: SiO_2 (wt.%) 40; TiO_2, 9.3; Al_2O_3; 11.2, FeO, 17.3; MgO, 9.7; and CaO, 10.9. Agglutinates (vol. %) 32, basalt fragments 19, plagioclase 8.5, pyroxene 21, opaques 5.6, glass spherules, 5.7, metal spherules, 1.5. This model is based on an analysis of soil samples (70161, 70181, 71061, 71501, 75061, and 75081). Assuming Stephens and Lilley compression curve for a material with crustal density of 3.13 gm/cm^3 and a Gruneisen's parameter of 0.8, the theoretical Hugoniots for various distensions, $m = \rho_o/\rho_{oo}$, are calculated [5]. [Here ρ_{oo} and ρ_o are the distended and crystal densities.] The present data, corresponding to m = 1.74, lie close to the m = 1.7 curve. This analysis implies that irreversible shock compaction occurs at ~50 kbar and at higher pressure, the Hugoniot is controlled by heating effects. Above 150 kbar this model will be invalid due to phase changes in the silicates. Using the method of Ahrens and O'Keefe [6] the impact velocities required of iron and stoney meteoroids to produce complete post-shock melting of lunar fines is given in Table 2.

References

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Table 1. Initial Hugoniot Data, Lunar Sample 70051

Shot No.	Initial Density (g/cm^3)	Flyer Plate Velocity (km/sec)	Shock Pressure (kbar)	Shock Density (g/cm^3)
312	1.798 ±0.002	1.042[a] ±0.004	39.5 ±0.8	3.16 ±0.01
313	1.795 ±0.002	1.444[a] ±0.005	66.1 ±0.2	3.41 ±0.01
325	1.799 ±0.002	1.573[a] ±0.006	77.9 ±0.3	3.45 ±0.08
317	1.810 ±0.005	2.103[b] ±0.008	126. ±4	3.68 ±0.13
304	1.782[c] ±0.005	1.191[b] ±0.006	53 ±1	3.12 ±0.01

a) tantalum flyer plate
b) tungsten flyer plate
c) Vacaville basalt

Table 2. Calculated Impact Velocities for Complete Melting of Porous Basalt Composition Soil

Distension	Impact Velocity	
$m = \rho_o/\rho_{oo}$	Iron Meteroid (km/sec)	Stoney Meteroid (km/sec)
1.9	3.1	3.5
1.7	3.3	3.7
1.5	3.7	4.7
1.3	4.3	5.3

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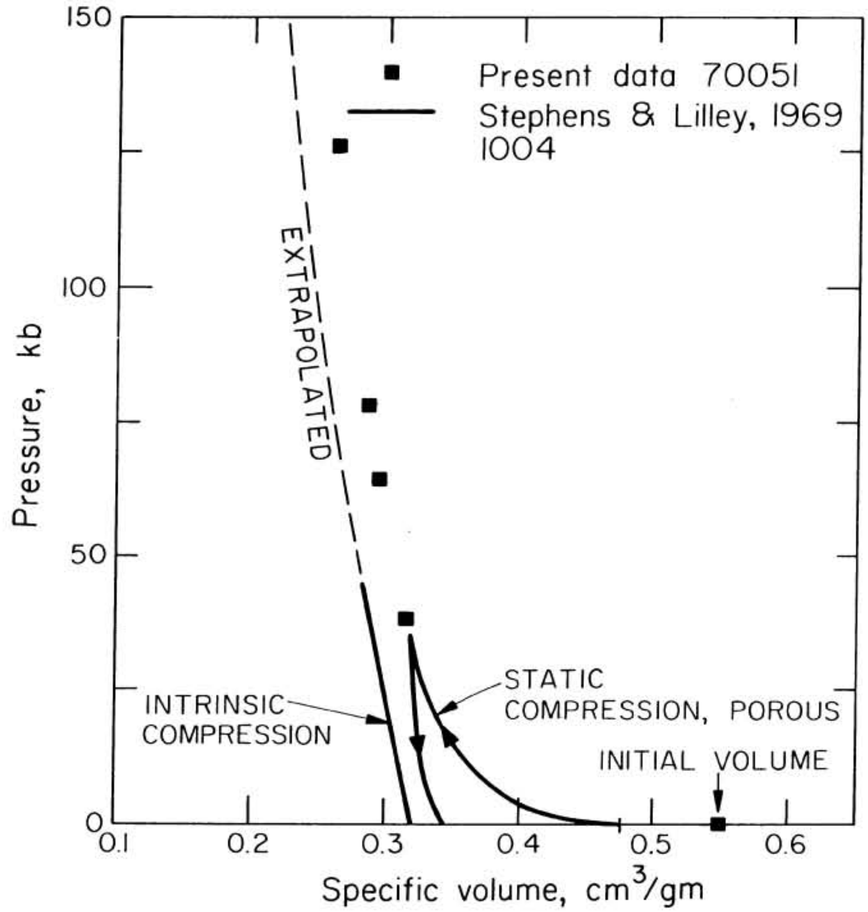

Figure 1

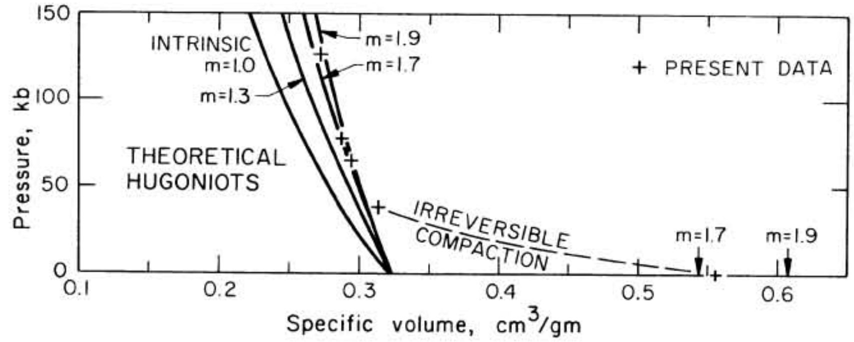

Figure 2