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LABORATORY SIMULATION OF CRATERING ON SMALL BODIES

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A new technique using external pressure has been developed to simulate the lithostatic pressure due to self gravity of small bodies as suggested by Housen and Holsapple (1990). A 13-inch diameter cylindrical test chamber with L/D of 1 has been fabricated to accommodate firing explosive charges with gas overpressures of up to 6000 psi. The chamber has been hydrotested to 9000 psi. The method allows much larger scale factors than can be obtained with existing centrifuges and has the correct spherical geometry of self gravity. A simulant for jointed rock to be used in this fixture has been developed using weakly cemented basalt. The lowest strength variation of this material corresponding to a "rubble pile" is comprised of 50% basalt 2-mm aggregate, 20% 0.4-mm iron grit, 22% type F flyash, 2% type C flyash, and 6% water. The material bulk density is 2.6 gm/cc, the static unconfined compressive strength is 101 ± 33 psi and the static tensile strength (ASTM 496) is 17.2 ±0.94 psi. These strengths are averages based on 22 compression tests and 8 tension tests for cure times of 7 to 42 days corresponding to specific target ages. Increasing the amount of type C, while holding the total amount of flyash constant provides compressive strength to as much as 4500 psi with a tensile strength of 1100 psi and all other properties constant. Various strength/pressure scaling theories can now be examined and tested.

Samples were cast in 15 cm diameter spherical molds and allowed to cure for at least 7 days. Two standard cylindrical specimens were also cast with each sphere to obtain the strength measurements at the time the spheres were used. An explosive charge was grouted into each sphere. Although the equivalent charge burial depth to simulate impact fragmentation has not yet been established, a depth of approximately 1 charge radius was used, as suggested by Holsapple (1980) for impact cratering. Variations in the burial depth over the range of 1 to 2 charge radii did not seem to produce significant differences. However, some calibration experiments should be performed to verify this. A single impact test was conducted (shot 876), but was of insufficient energy to produce a useful evaluation of equivalence.

Crater configurations for various confining pressures and charge sizes are shown in Fig. 1, demonstrating significant pressure strengthening due to the applied pressure. In Fig. 2, a plot of cratering efficiency versus strength parameter provides a means to determine the value of μ for the coupling parameter directly. Lastly in Fig. 3, when the applied external pressure is equated to an equivalent lithostatic pressure due to self-gravity, the corresponding plot of cratering efficiency versus gravity scaled size, $\pi 2$ is obtained. These experiments also yielded valuable data on fragmentation of small bodies in the gravity regime which is presented and discussed in the last three listed references below.

Holsapple, K. A. (1980) Equivalent depth of burst for impact cratering, *Proc. LPSC 11th*, 2379-2401.

Housen, K. R. and K. A. Holsapple (1990) Fragmentation of asteroids, *Icarus* **84**, 226-253.

Housen, K. R *et al.* (1991) Scaling of fragmentation, *LPS XXII*, Lunar and Planetary Science XXII, pp. 593-594, Lunar and Planetary Institute, Houston, TX.

Schmidt R. M. and Housen K. R. (1991) Simulations of large scale fragmentation, *ibid.*, pp. 1185-1186.

Housen K. R. and Schmidt R. M (1991) Laboratory simulations of large scale fragmentation events, manuscript submitted to Icarus 2/12/91.

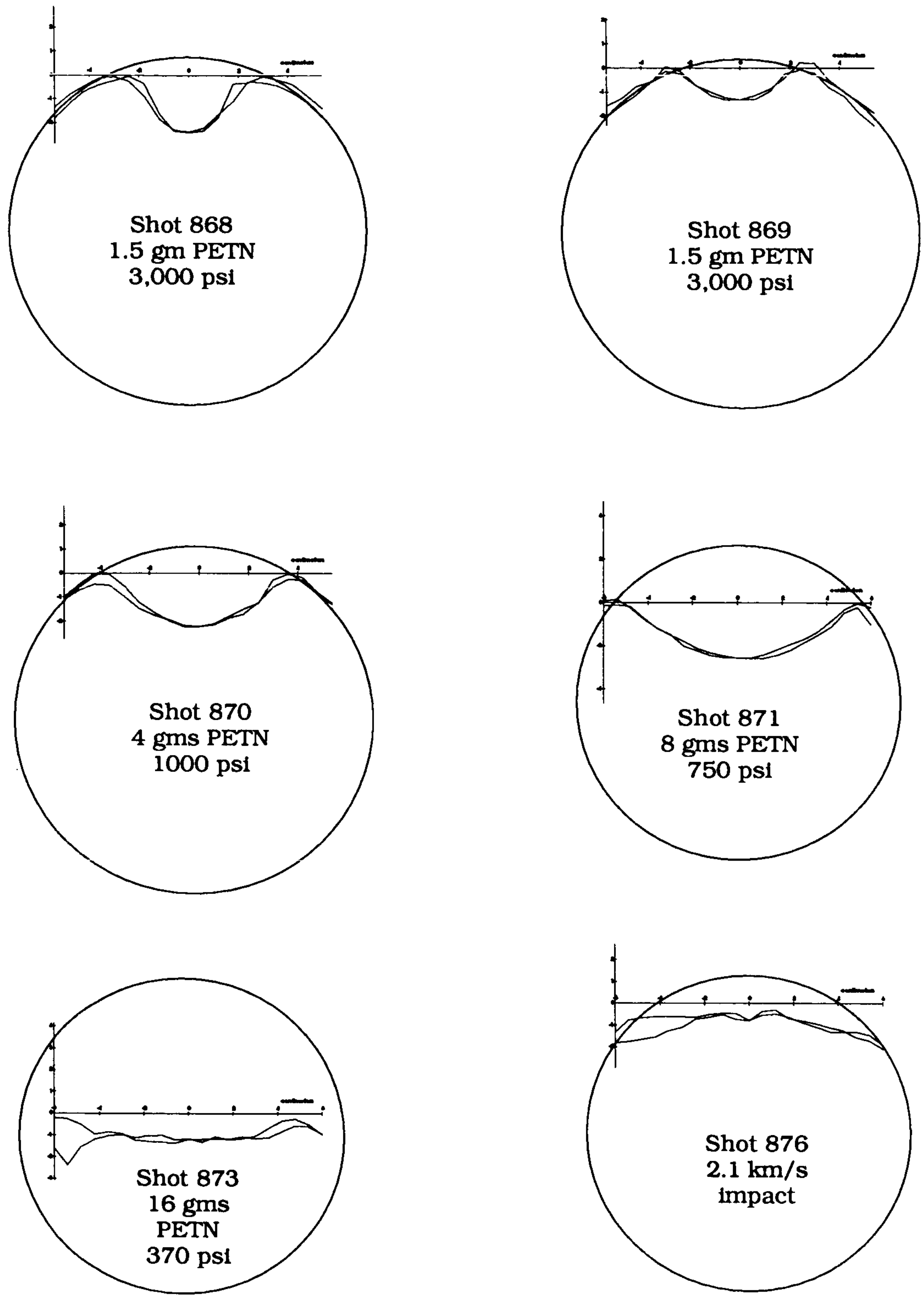

Figure 1 Typical craters formed in small bodies in a simulated self-gravity regime. Shot 873 shows a crater with diameter equal to that of the parent body having removed half the mass without disrupting the remaining largest fragment.

Figure 2. Pressure data is used to solve for μ directly giving a scaling law as follows: $\pi v = C \times \pi(t+p)$^$(-3\mu/2)$.

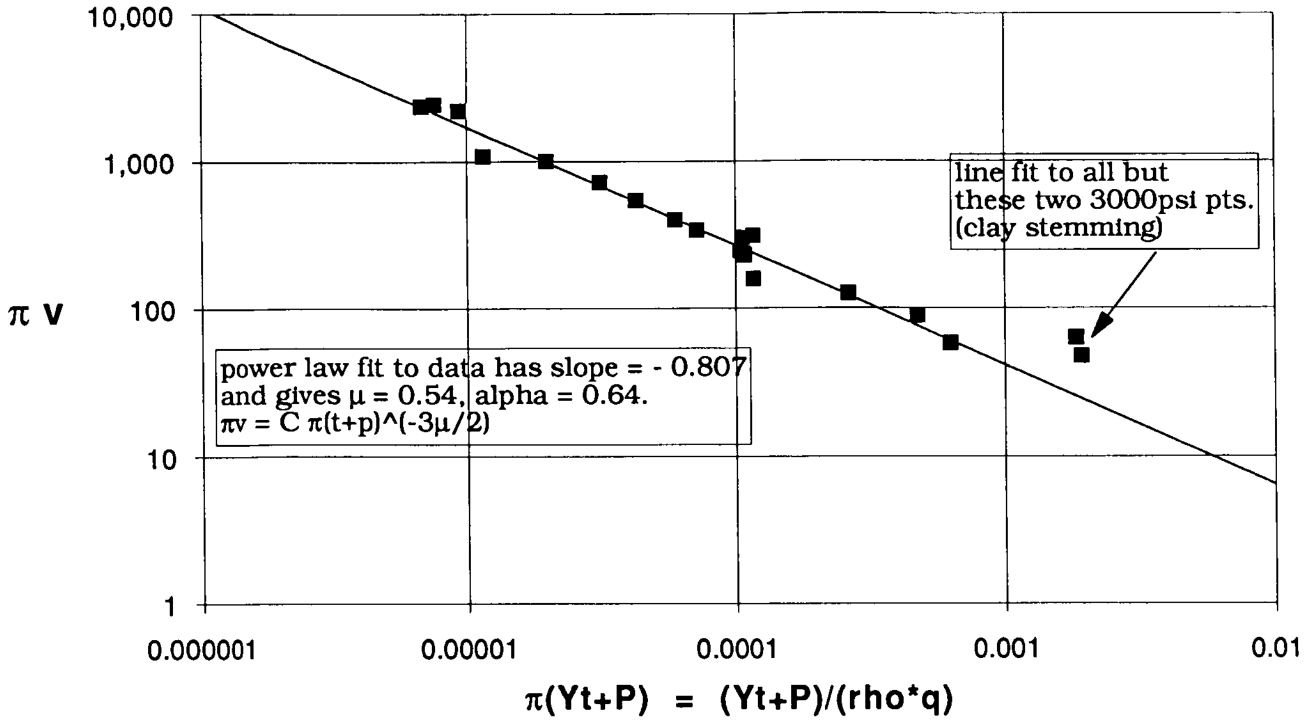

Figure 3. Cratering efficiency versus $\pi 2$ where applied external pressure is equated to "equivalent gravity" X density X crater depth.