Present micrometeoroid flux estimates might be in error, due to a discontinuity reported in the velocity dependence of the microcrater depth/diameter ratio. Leont'ev et al. (1) accelerated spherical particles in the speed range 1-21 km s\(^{-1}\) against metal or polyethylene targets. Up to 12 km s\(^{-1}\), crater dimensions increased with increase of impact velocity, but above that there was an abrupt increase in diameter, accompanied by a decrease in crater depth. The result is a steep falloff in the depth/diameter ratio, \(P/D = V^{-14}\). The full extent of the reported data would take their curve beyond the point shown in Figure 1, out to \(V \approx 20\) km s\(^{-1}\), at which velocity Leont'ev et al. reported some indication of another change (an increase) in slope. They interpreted the effect as evidence that "the explosive nature of the interaction is fully formed at impact velocities of 17-20 km s\(^{-1}\)". Because of that remark and the nature of their data, it seems important to review parameters which influence \(P/D\) ratios, whether explosion- or impact-formed. Those parameters include crater size, explosive depth-of-burial (DOB), cratering energy, target temperature, and projectile velocity, which we discuss in turn:

A discontinuity in \(P/D\) versus \(D\) has long been recognized in studies of large lunar craters; For \(D < 15\) km, \(P/D \propto D^{-0.05}\), whereas craters larger than 15 km exhibit much more rapid decrease in depth, \(P/D \propto D^{-0.65}\) (2,3). Pike (3) attributed that slope change to post-formation isostatic adjustment as well as to the fact that less ejecta can escape from the vicinity of larger craters.

For man-made explosions above ground (negative DOB's), Lynch et al. (4) showed that \(P/D\) increases as the detonation center approaches zero DOB. Chabai's (5) data shows that as one increases the DOB from zero to optimum that crater depth \(P\) increases at a faster rate than does diameter \(D\). An equivalent DOB which decreases with impact velocity would thus be consistent with the Leont'ev Effect.

For a large explosion of energy \(W\), Vortman (6) reported \(P/D\) ratios proportional to \(W^{-0.891}\) and \(W^{-0.783}\) for HE surface bursts in basalt and for Pacific nuclear explosions respectively. Westine (7) and White (8) elect no dependence whatever, for buried HE and nuclear bursts respectively. For impact craters in basalt, Gault (9) reported \(P/D \propto W^{-0.013}\) for projectiles up to 4 gm in mass and velocities up to 7.3 km s\(^{-1}\). Leont'ev's data (1) gives \(P/D \propto W^{-0.65}\) below 12 km s\(^{-1}\) and \(\propto W^{-7}\) above, for Fe projectiles up to \(10^{-4}\) gm in mass impacting Al targets.
Concerning the projectile velocity parameter, Dienes (10) and Riney (11) did not give P/D ratios, but proposed from theory that $P \propto V^{0.58}$ and $V^{0.60}$, respectively, while a $V^{0.75}$ dependence was found experimentally by Leont'ev et al (1) for $V < 12 \text{ km s}^{-1}$. But Leont'ev also found $P \propto V^{0.62}$, hence $P/D \propto V^{0.13}$ under $12 \text{ km s}^{-1}$; above that the dependence changes radically, to $P/D \propto V^{1.4}$, as shown in Figure 1. That Figure also includes data from Vedder and Mandeville (12) for soda lime glass (SLG) targets and $V$ to $13 \text{ km s}^{-1}$; the dependence is $V^{0.44}$ for Fe, or $V^{0.33}$ and $V^{0.47}$ for Al spall and pit data, respectively. The same impact curves are shown (for a mass of $10^{-10} \text{ gm}$) versus energy in Figure 2, which allows one to place in perspective impact and explosive crater $P/D$ ratios across an energy range of almost 25 orders of magnitude.

Target shock-heating effects, which increase with $V$, might offer an alternate hypothesis to the "explosive nature" explanation of the Leont'ev Effect. Carter and McKay (13) demonstrated that $P/D_{\text{spall}}$ decreases with increase of target temperature in the range 500 to 800°C, for Al hitting glass at velocities up to 7.3 km s$^{-1}$. In Figure 2, the incompatibility of the Gault and Leont'ev curves is misleading; Leont'ev's velocity range is 3 times that of Gault's and extends to specific energies 9 times higher, for example including vaporization thresholds between 12 and 21 km s$^{-1}$. To reconcile the data of Vedder with that of Leont'ev one might hypothesize that $P/D$ ratios exhibit humps close to phase-change thresholds, and that Vedder's velocity was not high enough to reveal this hump for SLG targets; note that the melting or vaporization temperatures are considerably higher for glass than for the aluminum target material employed by Leont'ev et al.

REFERENCES

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Rehfuss, D. E. et al

FIGURE 1

FIGURE 2

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