

MICROCRATER DIAMETER DISCREPANCIES

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Considerable difference exists between reported values of the crater size/projectile size ratio in the range 12 to 20 km s⁻¹. Two laboratories reporting extensive data in that range are in significant disagreement. Considering that the ratio of crater diameter/projectile diameter is employed in microcrater population studies, it is relevant to examine the extent of that disagreement.

Projectile velocity ranges attained in different laboratories are shown in Figure 1. Gault (1) and Carter and McKay (2) went only to 7 km s⁻¹, and McDonnell et al (3) had inadequate data to define a curve, so for data above 12 km s⁻¹ we have the three groups whose data is represented in Figure 2. The data of Leont'ev et al (4) was for iron against aluminum, so we have selected data for iron projectiles presented by Bloch et al (5) of the Heidelberg group (5,6,7) and for iron and aluminum projectiles from Vedder and Mandeville (8).

To obtain the data shown in Figure 2, Bloch et al (5) used a 2 MV Van de Graaff to accelerate iron particles (10⁻¹⁴ to 10⁻⁹ gm) up to 30 km s⁻¹ against quartz glass and norite targets. They obtained a straight line graph in which pit diameter/projectile diameter varied with velocity V as $D/d \propto V^{.67}$; for example $D/d = 2.2$ at 20 km s⁻¹ for Fe against quartz glass.

Leont'ev et al (4) accelerated spherical particles of various kinds against metal and polyethylene targets; shown in Figure 2 is their data descriptive of Fe particles (10⁻¹⁰ to 10⁻⁴ gm) impacting Al, but other materials show the same trend: the D/d ratio exhibits a sharp increase in slope, from a dependence as $V^{.62}$ below 12 km s⁻¹ to a $V^{3.07}$ dependence above that velocity.

Vedder and Mandeville (8) employed a vertical microparticle accelerator to project particles of mass in the range 10⁻¹³ to 10⁻¹⁰ gm up to 15 km s⁻¹. In Figure 2 is shown their central pit data for Al and Fe against soda lime glass (SLG), which are characterized by dependences of $V^{.38}$ and $V^{.33}$, respectively. For relative comparison we also give spall data for Al against SLG, for which $D/d \propto V^{.50}$. If extrapolated to 20 km s⁻¹ their pit data gives $D/d = 2.2$ for Fe→SLG.

Although it tends to support that of Bloch, the data of Vedder does not extend convincingly into the 12-20 km s⁻¹ range, so the documented discrepancy lies between the other two groups: Bloch does not observe the sharp slope change reported by Leont'ev at 12 km s⁻¹. At 20 km s⁻¹ Leont'ev's ratio is about 20.5 which if divided by a typical ratio $D_{\text{spall}}/D_{\text{pit}} \sim 3$ yields $D/p \sim 7$, compared to Bloch's 2.2.

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One might hypothesize that the discrepancy lies in the fact that Leont'ev's data was for Al targets and Bloch's was for glass or norite. However experiments done by the Heidelberg group (6,7) included Al targets for which they reported linear curves. In fact the D/d ratio has seemed relatively insensitive to material differences, as evidenced for example by the closeness of the Al→SLG, Fe→SLG and Fe→Quartz curves shown in Figure 2. Another factor might be that the vaporization threshold for nonporous materials lies in the range 12-20 km s⁻¹, though in any case the amount of vaporized material is expected to be small with respect to the mechanically excavated material (9,10,11).

In summary, the impact data of Bloch et al (5) and of Leont'ev et al (4) are in significant disagreement in the 12-20 km s⁻¹ range, and their predictions for the ratio of pit diameter/projectile diameter differ by a factor of 3 at 20 km s⁻¹. Further data is clearly needed.

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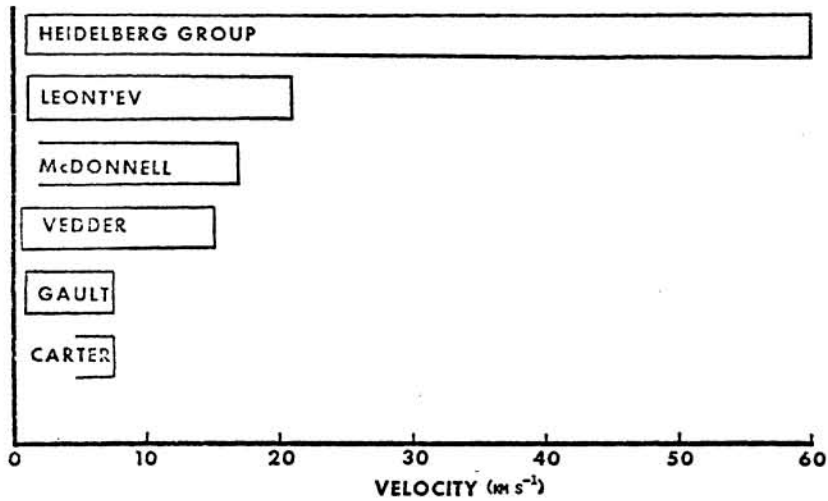


FIGURE 1

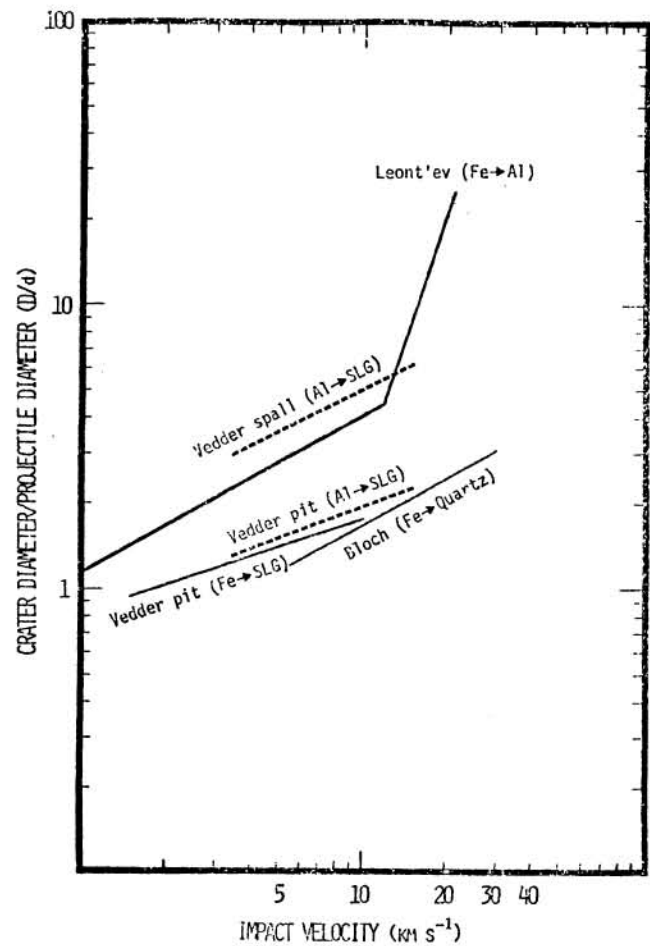


FIGURE 2