A CRATER DEPTH/DIAMETER BASIS STUDY

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Comparative studies of craters on different planets are difficult because each planet is characterized by a unique combination of the variables important in the cratering process, as has been discussed by Gault et al (1). This is compounded by observational inconsistencies in the use of apparent crater versus rim crater dimensions, as has been pointed out by Pike (2). Regardless of such difficulties we are intrigued by the possibility that there exists a common interplanetary meeting point for crater depth/diameter curves for different planets.

Studies by the authors (3) and others have shown that the distribution of impact craters is best described by a power law of the form

$$\text{Depth} = A(\text{Diameter})^{B} \qquad (1)$$

This functional relationship is sound since with most impact craters measured photometrically the accuracy of the crater's depth measurement is contingent on the accuracy of its diameter measurement.

Power laws are of course difficult to compare even if tabulated and in crater studies the problem is compounded due to the wide variety of ranges applicable. This may be more easily seen by comparing depth/diameter curves as shown in the following table:

Planet	Count	Diameter range (km)	Constants in Equation (1) A	B	Remarks	Reference
Mercury	<130	1 to 7	0.15	1.09	Fresh craters measured w.r.t. rim crest Mariner 9 data	(1)
Earth	206	8×10^{-5} to .2	0.165	1.00	Optimum burst measured w.r.t. apparent rim, explosive craters	(4)
Moon	1078	.6 to 40.01	0.198	.910	Best fitting line of Class 1 craters, Orbiter IV data	(3)
Mars	155	20 to 200	0.259	.366	Mariner 9 Data	(5)

By comparing the curves in the table, we have found the interesting relation revealed by the Figure. The double logarithmic scale allows for straight lines on the figure. If extrapolated (dotted lines), for Mercury, Earth and the Moon we notice an intersection at about 4 km in diameter implying a possibility of yet undetermined relations between a crater's depth/diameter and an angular dependence, i.e., a rotation at that point. Impact velocities would seem to be an underlying cause for the rotation since the inner planets have higher average impact velocities than the outer planets.

The model's utility might seem suspect in that we are comparing impact-produced craters described in terms of rim crest diameters (1, 3, 5) with man-made craters described in terms of apparent diameter (4). To check this, if one converts the curve governing the explosive crater's apparent diameter to one descriptive of rim crest by using Pike's (2) estimate of rim height for the depth and Baldwin's (6) apparent radius to lip radius conversion, then a power law can be determined that rotates the earth based data slightly above the Mars curve but which still intersects at about 4 km. If such crater conversions are valid, then this of course would reduce the possibility of relating angular rotation with average impact velocity.

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Anselmo, et al