CRATER MORPHOMETRY ON VENUS: RELATIVE CRATER FLOOR SIZE AND INTERNAL CRATER MODIFICATION. R.W. Wichman, Dept. of Space Studies, Univ. of North Dakota, Grand Forks, ND 58202.

Summary: Although venusian craters are rarely embayed (from the outside) by surface volcanism, the lunar record of mare-filled craters indicates that volcanism can also occur inside craters without necessarily affecting surfaces outside the crater rim. Such crater-centered volcanism, however, should embay both the crater walls and any central peak structures, thereby increasing the observed floor size relative to both the pristine crater rim and the central peak complex. Since venusian crater floors show a dichotomy between young, radar-bright albedos and older, darker units resembling the surrounding volcanic plains, crater-centered volcanism also may be common on Venus. This hypothesis can be tested by an analysis of venusian crater morphometry. Based on a preliminary data set of 115 craters, there is no clear evidence for any change in floor size as a function of floor albedo. Nevertheless, the data are widely scattered, which may obscure minor changes in floor size as a function of age. Possible increases in crater floor size, however, are apparent for other classes of crater modification, including the youngest inferred craters on Venus (bright floored with dark halos), those craters embayed by external surface volcanism, craters showing internal modification similar to lunar floor-fractured craters, and craters greatly modified by regional tectonism. Since statistical comparisons of these measurements are hampered by both the wide scatter of the derived data and the small samples for some crater modification styles, a more detailed set of measurements is in progress to expand and refine the trends reported here.

Introduction: Although the nearly pristine rim structures and ejecta deposits around most venusian impact craters indicates that only minor crater modification has occurred on Venus in the last several 100 Ma [1,2], these observations provide little constraint on modifications within the crater interiors. The youngest crater floors on Venus, however, have significantly brighter (radar) albedos than older crater floors [3], suggesting that some form of internal crater modification is common on Venus. Several mechanisms can be identified for such floor modifications: (1) the albedo change reflects some form of surface alteration or weathering [4], (2) the albedo change reflects deposition of a thin (eolian) sedimentary unit [4], or (3) the albedo change results from crater-centered volcanism [5]. Based on lunar examples of mare-filled craters, the latter option can occur without significantly changing the crater exterior, and also may occur without nearby surface volcanism outside the crater. Moreover, since crater-centered volcanic units should partially cover both the crater wall and the central peak units, such modification can produce systematic changes in the crater floor morphometry. Consequently, this abstract presents a preliminary assessment of how crater morphometry in venusian craters varies with different attributes and modification styles.

The Data: This study is based on a nearly random sample of 115 venusian craters ranging in diameter from ~15 km to ~75 km. For each crater, an image was extracted from F- or C1-MIDR's on the Magellan CD-ROM's and resampled where necessary to fit into a 200x300 pixel format. The individual crater images were then transferred to a GIS software package where estimates were derived for the size of the crater rim, floor and central peak complex (if any) using the average pixel size as a scale.

Due to the preliminary nature of this survey, the measurements were derived by visually fitting a computer-generated circular trace of "known" size to either the apparent crater rim crest, the smooth crater floor, the central peak complex or the outer edge of a peak ring complex. Consequently, the derived estimates have fairly high uncertainties where the measured crater features are either elongated or highly asymmetrical. Still, these measurements should indicate the presence of any gross trends in crater morphometry, and a more detailed set of measurements based on the actual size and shape of crater features is presently underway to test for more subtle relations between crater morphometry and modification.

The Results: The derived morphometric measurements clearly reveal a broad general relation between crater floor and rim diameters on Venus, but it is difficult to analyze the variation of individual crater morphometries on such a direct plot of the data. Consequently, my analysis has focused instead on how the ratio of the floor and rim diameters (D_{fl}/D_{rim}) varies with crater size (Figures 1, 2). Such ratio plots show a fairly broad range of relative floor sizes in the studied craters. No clear differences are visible between the dark and bright-floored craters (Figure 1); nevertheless, variations in morphometry may be indicated for four other styles of crater modification (Figure 2): (1) Those craters which have been clearly embayed by external surface volcanism appear to have larger crater floors than most of the unmodified craters. (2) Craters like Balch and Tarbell, with floors showing extensive deformation by

regional tectonic systems, also show an increase in relative floor size, but no such increase is apparent for craters with less extensive tectonic modification. (3) Craters with evidence for structurally controlled, internal fracturing (e.g., Barsova, Leyster) may show a similar increase in crater floor size as well. (4) Finally, the 10 craters with dark halos or parabolic ejecta deposits in our sample also show higher D_{fl}/D_{rim}) ratios than most of the unmodified craters in our data. Since such craters are inferred to be the youngest craters on Venus, these observations may indicate variations in the cumulative effects of mass wasting or sedimentation along the crater walls.

Unfortunately, due to the small number of sampled craters in each of the above modification classes, the statistical similarity/independence of the observed ratios relative to unmodified craters is poorly constrained. While the mean values differ, the standard deviations for these various data sets overlap. Similarly, while the dark and bright floored crater measurements seem inseparable, both of these data sets are widely scattered. Since the dark floored craters show only minor reductions (~100-400 m) in crater depth relative to bright floored craters [6], any change in floor area resulting from volcanic flooding of these craters should be small. Considering the number of crude approximations in the floor size estimates of this preliminary data set, therefore, any signal of crater modification may have been lost with the noise. A much more detailed set of measurements is currently in progress which should allow both a statistical analysis of the morphometric differences (if any) between dark and bright floored (but otherwise unmodified) venusian craters, and a statistical characterization of the apparently increased floor sizes in more heavily modified craters.

REFERENCES: [1] Schaber, G.G. et al. (1992) *J. Geophys. Res. 97*, 13257-13301. [2] Phillips, R.J. et al. (1992) *J. Geophys. Res. 97*, 15923-15948. [3] Campbell, D.B. et al. (1992) *J. Geophys. Res. 97*, 16249-16278. [4] Arvidson, R.E. et al. (1992) *J. Geophys. Res. 97*, 13303-13317. [5] Wichman, R.W. (1994) *Lunar Planet. Sci. Conf. 25*, 1489-1490. [6] Sharpton, V.L. (1994) *Geol. Soc. Am., Sp. Paper 293*, pp. 19-27.

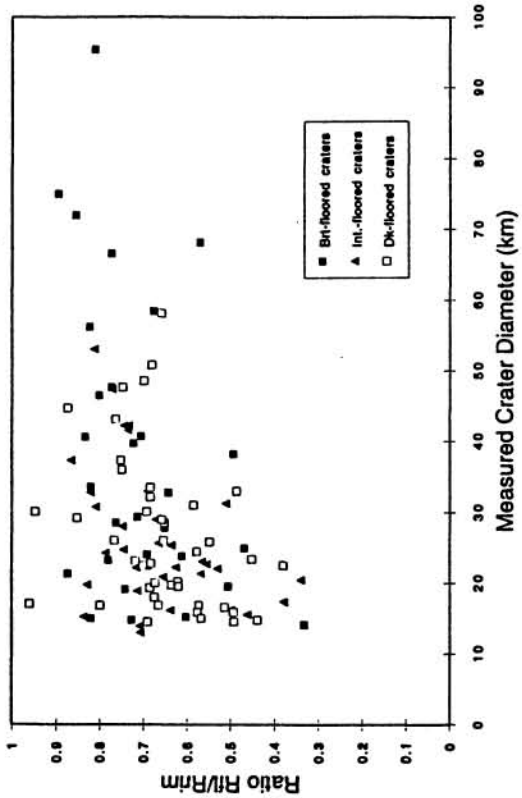

Figure 1. Floor/Rim Ratios divided by Floor Albedo.

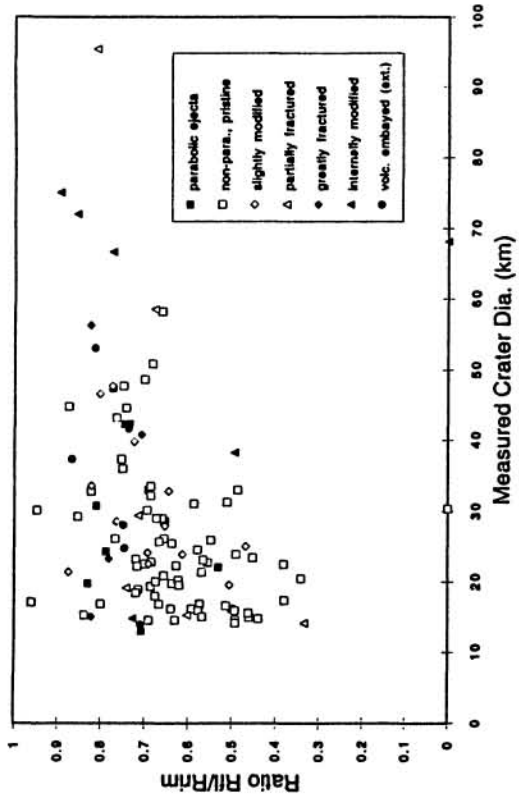

Figure 2. Floor/Rim Ratios divided by Modification Class.