MORPHOLOGIC CLASSES OF IMPACT BASINS ON VENUS

Wood, Charles A. and Wesley Tam, Space Studies, University of North Dakota, Grand Forks, ND 58202

An independent survey of 60% of Venus has resulted in the detection of 35 impact basins and associated transitional rings. Contrary to previous studies we identify central peak basins, as well as peak ring basins. But no unambiguous multi-ring basins have been detected. A new class of crateriform - expanded peak structure - has been noticed, which is transitional in diameter, but apparently not in structure, between central peak and peak ring basins.

Impact basins are the largest features on most solid planets and moons in the solar system. Their existence, diameters, and morphologies provide clues to a planet's crustal structure, surface age, thermal history, and erosional processes. Since their discovery thirty years ago by Hartmann and Kuiper (1), impact basins, with their tantalizing near-regularities, have provided considerable fun for ring counters, modelers, and other hand wavers. Each planet and moon has been found to have its own variations, but all appear to be variants on the basic diameter-dependent morphologic sequence recognized on the Moon (2): *central peak basins* [crater-like structures containing both a central peak and an inner ring; the protobasin of Pike and Spudis (3)], *peak ring basins* [two ring basin of (3)], and *multi-ring basins* (with three or more rings).

The completion of Magellan's mapping has led to the first systematic cataloging of basins on Venus. Schaber and others (4) have identified 33 basins and an additional 10 possible basins. Their more definite basins include 27 peak ring basins and 6 multi-ring basins. They found no central peak basins on Venus. Alexopoulos and McKinnon (5) also reported their identification of 52 peak-ring and 3 multi-ring basins.

Independently of the work of (4) and (5) we have searched for basins on the collection of Magellan photographic prints provided by the NASA Planetary Geology Office. These prints cover only ~60% of the surface of Venus; the main gap occurs between longitudes 210° and 330°. We have recognized 35 basins (Table). Our results differ from previous analyses. We found 10 central peak basins, and 17 peak ring basins, but failed to identify any multi-ring basins. Many of the inner rings are irregular or incomplete; we accept Schultz's convincing evidence (6) that such ring deformation is due to oblique impact. CP basins on Venus have larger peak and ring masses than do lunar examples.

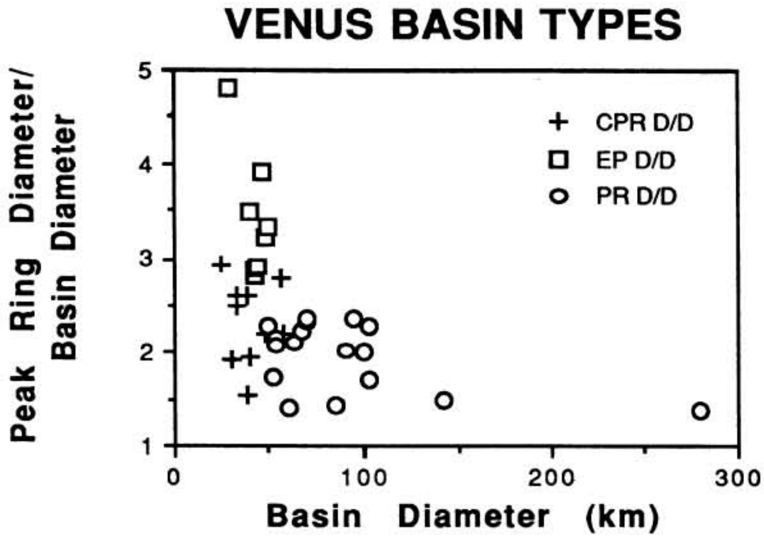
PARTIAL LIST OF VENUS IMPACT BASINS

Name	Lat	Long	D	Dr	Type
Fredegunde	-50.50	93.15	25	8	CPR?
Simonenko	-26.70	97.60	29	6	EP
Erxleben	-50.79	39.65	30	16	CPR
Ferrier	15.75	111.32	32	12	CPR?
Sitwell	16.63	190.40	32	13	CPR?
Flagstad	-54.31	18.85	38	25	CPR?
Zenobia	-29.32	28.55	39	15	CPR
Agnesi	-39.40	37.50	40	20	CPR?
no name	2.34	198.26	40	12	EP
Manzolini	25.68	91.25	42	15	EP
Tiyoni	-47.60	95.65	43	15	EP
Corpman	0.30	151.80	44	15	EP
Khatun	40.33	87.00	47	12	EP
Danilova	-26.30	337.05	48	22	CPR
Cunitz	14.47	350.90	48	15	EP
Wharton	55.65	61.99	50	22	PR
Zhilova	66.38	125.55	50	15	EP
de Beauvoir	1.95	96.05	52	30	PR
Cori	25.45	73.00	54	25	PR
Vigier Lebrun	17.25	141.15	54	26	PR
Carreno	-3.87	16.10	56	20	CPR?
Yablochkina	48.26	195.32	58	26	CPR?
Hepworth	5.10	94.60	60	42	PR
Aglaonice	-26.60	339.55	63	30	PR?
Stuart	-30.75	20.20	67	30	PR
Boulanger	-26.60	99.20	70	30	PR
Andreianova	-3.00	68.77	70	30	PR
Mona Lisa	25.65	25.20	85	58	PR
Bonnevie	-36.10	126.90	91	45	PR?
Greenaway	22.95	145.20	95	40	PR
Joliet-Curie	-1.60	62.50	100	50	PR
Cochran	51.85	143.35	103	45	PR
Cleopatra	65.85	7.15	103	60	PR?
Klenova	78.15	104.20	142	95	PR?
Mead	12.50	57.20	280	200	PR?

D = basin diameter; Dr = ring diameter.

We have also found a new class of transitional structure (from central peak craters to basin morphology) which we call *expanded peak* craters (EP). These have apparently also been noticed by Alexopoulos and McKinnon (5). EP appear to be normal craters with relatively small diameter rings in place of their central peaks. The average ratio of basin diameter to peak ring diameter for EP is 3.4, compared to 2.3 for central peak, and 1.95 for peak ring basins.

VENUS BASINS: Wood, C.A. and Tam, W.



Our available photography shows only two of the proposed multi-ring basins (Mead and Klenova), but we have examined photos of the other one (Meitner) in reference (4). Mead shows no evidence of a third ring; indeed Mead is admittedly classified as a multi-ring basin by (4) largely because of its large size. Klenova has two, nearly contacting inner rings, somewhat like Orientale's Inner and Outer Rook rings, but they are contained within an outer ring that looks like a normal crater rim. Meitner appears to be a peak ring basin with a very low and perhaps incomplete outer circular trace. Images available to us make it difficult to discern if the trace is of ejected material or is structural. What is missing from all proposed multi-ring basins on Venus is a scarp-like, Cordillera style ring. Considering the exquisite preservation of impact features on Venus, the lack of true multi-ring scarp morphologies may mean that they never formed. Additionally, the smallest unequivocal multi-ring basins on other planets have onset diameters of > 300 to 400 km (3);Venus' putative multi-ring basins are as small as 86 km wide (Mona Lisa; ref. 4). At this moment we have seen no evidence that Venus has any true multi-ring basins, rather some of its peak ring basins may have modifications unfamiliar from other planets.

Conclusions: Impact basins exist on Venus. Identified morphological classes include central peak basins and peak ring basins as on the Moon, Mercury, and Mars, but, unlike those planets, no multi-ring basins have been unambiguously recognized, presumably because such basins would have formed before the planet-wide resurfacing event, 0.5 by ago. Alternatively, according to the ring tectonic model of Melosh (7) the poor development of multi-ring basins may imply that Venus had a thick lithosphere during basin-formation time. A new morphologic type, expanded peak structures, has been discovered that is transitional in diameter between central peak basins and peak ring basins, but ring diameter ratios suggest they are not part of the basin continuum. Central peak basins are more abundant (percentage wise) on Venus than on any other planet, and thus transitional structures (expanded peak and peak ring basins) are much more prevalent that elsewhere. Melosh's (7) model would explain this observation as indicating that the upper layers of Venus act more like a Bingham fluid than does the crust of other planets.

REFERENCES: 1: Hartmann, WK and GP Kuiper (1962) *Comm. Lunar Planet. Lab. 1*, 51-66. **2:** Hartmann, WK and CA Wood (1971) *The Moon 3*, 3-78. **3:** Pike, RJ and PD Spudis (1987) *Earth, Moon Planets 39*, 129-194. **4:** Schaber, GG and others (1992) *J. Geophys. Res. 97*, 13,257-13,301. **5:** Alexopoulos, JS and WB McKinnon (1992) *Internat. Coll. Venus* (LPI Pub. # 789), 2-4. **6:** Schultz, PH (1992) *J. Geophys. Res. 97*, 16,183-16,248. **7:** Melosh, HJ (1989) *Impact Cratering*. Oxford University Press, NY, p. 180.