THE CORONAE CONUNDRUM: RESULTS FROM DETAILED GEOLOGIC MAPPING OF AGNESI QUADRANGLE, (V-45; 25-50S/30-60E), VENUS.

V. L. Hansen[1] , E. R. Tharalson[2], K. M. McDaniel[3], K. L. Cole[4], and B. H. Goodge[5], [1-3]Dept. Geological Sciences, University of Minnesota Duluth, Duluth, MN 55812 (vhansen@d.umn.edu, thar0030@d.umn.edu, mcda0054@d.umn.edu), [4]University of Minnesota Duluth, Duluth, MN 55812 (cole0391@d.umn.edu), [5]Ordean Middle School, Duluth, MN 55804

Introduction: Venus preserves ~515 coronae, variably interpreted as endogenic diapirs [e.g., 1-4] and exogenic impact craters [e.g., 5,6]. Coronae range in size (60-1100 km diameter; 200-km median), planform shape (ellipticity form 1 to <0.4; [7]), topography [2], occurrence (68% in chains associated with chasmata, 21% in clusters associated with volcanic rises, and 11% as isolated features generally in the lowland), associated tectonic structures (radial fractures or ridges, concentric fractures), associated volcanic deposits (radial flows, internal flows, external flows, no observable deposits), and perhaps gross geologic age [8]. Many studies focus on identifying a single process to form all coronae [e.g., 1-3, 5,6].

We constructed detailed geologic maps of nine lowland coronae and two mons within the Agnesi quadrangle (V-45; 25-50S/30-60E). Based on these maps we divide these features into four to five groups, reflecting different morphological features and, likely recording, different evolutionary processes. We suggest that the term 'coronae' should be: a) used in a strict descriptive sense, free of genetic implications; b) redefined to include a specific unique subset of Venusian features; or c) abandoned as a term all together.

The Study Area: Agnesi (V-45) is situated within Venus' lowland, and hosts large to small arcuate exposures of ribbon-tessera terrain, nine coronae, two mons, 11 impact craters, and extensive lobate flows sourced to the west from Sephari Mons and Ubastet Fluctus. Geologic mapping is conducted as part of the NASA-USGS planetary Mapping program, with the goal of producing a 1:5 M scale geologic map. Data include correlated digital NASA Magellan data sets: full resolution (~100m/pixel) synthetic aperture radar (SAR) images, altimetry, synthetic stereo images, RMS slope data, and emissivity data. All geomorphic features are below the resolution of available gravity data. Geologic mapping has focused on the unraveling the geologic history recorded in ribbon tessera terrain, and on detailed geologic mapping of the coronae and mons features in order to understand evolutionary processes responsible for the formation of these features, individually and collectively. The coronae and mons are the topic of the current contribution.

V-45 hosts a relatively large number of coronae and Mons compared to typical VMap areas. Curiously, the coronae and mons in V-45, which range in size from 75-600 km, would not be described as occurring in chains, in clusters, or particularly isolated. Each, with the exception of Codidon Corona and Mou-nyamy Coronae and Gurshi Mons (SE corner of V-45), occur adjacent to lowland ribbon tessera terrain.

Results: Geologic mapping allows us to divide the coronae and mons into four or five geomorphic groups based on planform shape (topographic form (dome versus basin), structural character (radial versus concentric structures), ellipticity, and associated deposits, presumably mostly volcanic in nature (Table 1). Features A (Codidon, Inanna, and Mou-nyamy Coronae) are domical structures with ellipticity <0.75, and radial fractures (which can extend beyond their topographic dome taken to define the structure), and radial flows; these feature lack concentric structures, although they may concentric ridges. Features B, Gurshi and Tuzandi Mons share the characteristics of Features A, except that they are more circular in planform. We consider Features A and B most geomorphically similar to one another. Features C (Umay-ene, unnamed, Xcanil, and Zemlika Coronae) are basinal structures, with ellipticity >0.85; they lack radial structures and radial flows, and they are defined by concentric fractures. We call these features 'circular lows' [9]. Feature D, Mama-Allpa is marked by topographic ridges, and not recognizable as a circular structure based on topography, structural fabrics, or flow deposits. This feature likely represents the intersection of seemingly unrelated lineament trends (and probably not genetically singular features). Feature E, Ekhe-Bukhan the largest of the features, differs from the other features with its plateau-like form, its structural fabric akin to ribbon tessera terrain [10,11], and its lack of well-defined circular boundaries or limits.

Detailed geologic mapping of the 11 geomorphic features noted above, suggests that each geomorphic class, A-E, record quite different, and unrelated genetic processes, including: 1) intersection of unrelated tectonic events—that is, these features mark serendipitous spatial intersection of unrelated geologic events (Feature D); 2) the surface expression of endogenic diapirs in or within the crust (Features A and B) [e.g., 1-4], likely compositional in nature as opposed to thermal diapirs based on the relatively small size of these features [12]; 3) the surface expression of large lava ponds, and/or the spatial intersection of different tectonomagmatic events (Feature E); and 4) features formed due to: bolide impact on rheologically relatively weak crust, or caldera collapse structures, or negative endogenic diapirs (Features C). We currently favor the bolide hypothesis for the circular lows in V45.

We are not the first workers to question whether all coronae form in a similar fashion. Squyres et al. [13] questioned whether some coronae, marked by large interior depressions, could be caldera, as did other workers [e.g., 14,15]. In addition others (mostly, by not completely, prior to acquisition of Magellan data) questioned whether some coronae (some of these workers state that all coronae) might represent impact craters [e.g., 16-26].

Perhaps it is important to return to careful description of quasi-circular geomorphic features on Venus, and to study and map these features individually with an aim toward understanding how various features may have formed, individually, rather than assuming genetic association. Careful attention to geologic terminology free of genetic implications has been an important lesson of terrestrial geology, and as a community we should embrace such lessons in the exploration and mapping of planetary bodies within our solar system and beyond.

We suggest that in the future the term 'coronae' should be either: a) used in a strict descriptive sense, free of genetic implications (note that this requires agreement by the community with regard to the descriptive definition of coronae what defines a corona; b) redefined to include only a specific unique descriptive subset of Venusian features; or c) abandoned as a term all together. There are numerous examples in the history of geology in which terminology has been abandoned as a means to shed genetic connotations that have crept into broad usage, and as such hamper discussion, debate, and ultimately the understanding of how various features formed.

References: 1. ER Stofan et al., *JGR* **97**, 13347 (1992). 2. ER Stofan et al., Venus II, 931-968 (1997). 3. SE Smrekar & ER Stofan, Sci. 277, 1289 (1997). 4. DM Koch & M Manga, GRL. 23, 225 (1996). 5. WB Hamilton, GSA SP388, 781-814 (2005). 6. C Vita-Finzi et al., 388, 815-824 (2005). 7. VP Kryuchkov et al., LPSC38, 1630.pdf (2007) 8. MG Chapman & JR Zimbelman, Icarus 132, 344 (1998). 9. K McDaniel & VL Hansen, LPSC 36, 2367.pdf (2005). 10. VL Hansen & JJ Willis, Icarus, 123, 296-312 (1996); 11.VL Hansen & JJ Willis, Icarus 132, 321–343 (1998); 12.VL Hansen, GSAB 115, 1040 (2003). 13.SW Squyres et al., *JGR* **97**, 13611 (1992). 14. ER Stofan, et al., JGR **96**, 20933 (1991). 15. JE DeLaughter & DM Jurdy, Icarus 139, 81 (1999). 16. VL Barsukov et al., JGR **91**, D378 (1986). 17. AT Basilevsky et al., JGR 92, 869 (1987). 18. DB Campbell & BA Burns, Sci. 204, 1424 (1979). 19. RAF Grieve & JW Head, Episodes 4, 3 (1981). 20. JW Head & SC Solomon, Sci. 213, 62 (1981). 21. H Masursky et al., JRG **85**, 8232 (1980). 22. GG Schaber & JM Boyce, in Impact and explosion cratering Planetary and terrestrial implications D. J. Roddy, R. O. Pepin, R. B. Merrill, Eds. (Pergamon Press, New York, 1977) pp. 603-612. 23. OV Nikolayeva, et al., Geochem. Intern. 23, 1-11 (1986). 24. OV Nikolayeva, LPSC 24, 1083 (1993). 25. PH Schultz, LPSC 24, 1255 (1993). 26. CA Stewart, e. al., EOS, Trans AGU, Suppl. 26, 80 (1993).

Table 1. Characteristics of coronae and mons within V-45.

Feature	lat/log	D(km)	ellipticity	topo	concentric		radial		flows/deposit		rtt	type
					ridge?	str	str	flows	in	sh		
Codidon	46S/56E	250	~.65	d	Y	n	Y	Y	NA	Y	ND	A
Ekhe-Bukhan	50S/40E	600	NA	d	P	fo	P	P	Y	Y	syn	E
Gurshi Mons	47.5S/58.5E	210	>0.85	d	N	n	Y	Y	NA	Y	ND	B
Inanna	37S/35.9E	350	<0.75	r	Y	n	Y	Y	NA	Y	post	A
Mama-Allpa	27S/31E	300	NA	d	N	n	N	N	NA	Y	post	D
Mou-nyamy	49.5S/59E	200	<0.75	d	N	n	Y	P	NA	Y	ND	A
Tuzandi Mons	42.5S/41.5E	200	>0.85	d	N	n	Y	P	NA	Y	post	B
Umay-Ene	27.5S/50.5E	370	>0.85	b	P	fr	N	N	Y	Y	post	C
Unnamed	38S/42.5E	75	~1	b	N	fr	N	N	Y	Y	post	C
Xcanil	37S/443E	200	~1	b	N	fr	N	N	Y	Y	post	C
Zemlika	33.5S/50E	150	~1	b	Y	fr	N	dep	Y	Y	post	C

D, diameter; topo, topography; d, domical; r, ridges; b, basin; Y, yes, P, possible, N, no; str structures;
n, none; fo, folds; fr, fractures; in, internal flows; sh, shields; rtt, ribbon tessera terrain;
syn, synchronous; post, post-dates rtt; ND, not determined