DEPOSITIONAL UNITS IN WESTERN MAXWELL MONTES: IMPLICATIONS FOR MOUNTAIN BUILDING PROCESSES ON VENUS R. W. Vorder Bruegge, Science Applications International Corporation, 400 Virginia Ave., S.W., Suite 400, Washington, D.C. 20024

Summary. Structural mapping of western Maxwell Montes, Venus has led to the recognition of a number of units that are best characterized as depositional in nature. These units occur in local topographic lows and tend to embay adjacent structures, indicating their relative youth. While much of eastern Maxwell is blanketed by continuous deposits associated with Cleopatra crater, the western slopes of the mountain belt are characterized by scattered deposits. Several of the patches in western Maxwell exhibit characteristics of fluid flow, including evidence for channel formation. Possible origins include: local debris from landslides and other downslope mass movements; impact crater ejecta and outflow materials; weathering products; wind-blown materials; and volcanic deposits. None of these origins may be ruled out yet. It is critical to determine if volcanism played a role in forming these deposits, since a lack of volcanism would imply the presence of either a cold mantle or cool, thick crust beneath Maxwell, while abundant volcanism would imply a hot mantle beneath the mountain belt. Defining the nature of these deposits may also provide insight into weathering processes at high elevations on Venus.

Observations. The dominant characteristic of western-most Maxwell Montes (defined here as approximately between 359-002°E and 63-67°N) is a ridge-and-valley structure that parallels the topographic trend of the mountain belt and extends from the north-northwest to south-southeast [1-4]. In addition to this structure, the current mapping effort has led to the recognition of a number of units within western Maxwell Montes that may best be characterized as depositional in nature. These units typically are found in local topographic lows and at times embay adjacent structures. They tend to be characterized by a uniform radar backscatter texture that is unbroken over tens to hundreds of square kilometers. In the Magellan SAR images, these units are most often bright, indicating that they either: (1) consist of materials that are rough at the scale of the radar wavelength (10-15 cm); (2) incorporate materials having electrical properties that make them highly reflective to the Magellan radar; or (3) form relatively flat surfaces, which makes them appear bright in contrast to east-facing slopes when viewed by Magellan from the west at incidence angles of 25-35°. The latter factor is least likely since in some cases intermediate-to-low radar backscatter units are also seen, indicating materials that are either less rough or less highly reflective than the brighter materials.

In plan view, these units most often occur as long, narrow 'strips' 25 km or more in length, but no more than 5-7 km in width. The long axis of the strips is oriented parallel to the ridges and valleys within Maxwell. The eastern edge of a strip is usually defined by a sharp discontinuity in brightness which is consistent with deposition against a steep, west-facing scarp. The other edges of individual strips rarely exhibit such sharply defined boundaries. Instead, these edges are often arcuate and tend to be more diffuse, consistent with deposition upon more subdued, east-facing slopes. These units appear to pond within the valleys of the Maxwell Montes ridge-and-valley structure. An example of this type of feature is seen at ~0°E/65.75°N. Individual strips sometimes appear to extend between adjacent valleys and surround intervening ridges. An example of this occurs at ~0.25°E/65.8N. In at least one case (~359.5°E/65.25°N, Figure 1), several very narrow strips radiate from an equidimensional patch of this unit. Magellan stereo data of this area reveal the equidimensional patch to be in a local low, with the strips radiating upslope to the west. Farther west these strips widen and merge before they intercept a graben oriented perpendicular to them. To the south there is also a short channel that appears to cut through existing ridges connecting several smaller patches of bright, ponded material.

A common characteristic of the units described above is their marked embayment of surrounding structures. In a few cases these units occur as shorter swaths (< 20 km) that appear to flow over or cut downslope through the ridge and valley structure from east to west. The swaths appear more diffuse than the ridge-parallel strips and an example may be found at ~0.25°E/65.25°N. In one case (~359.5°E/65.95°N) the eastern end of a swath occurs at a scalloped scarp which is concave to the west, while the distal end is a fan-shape bright region that is convex to the west (downslope). In between, the lateral edges appear bright, while the interior is dark.

Finally, the Magellan SAR images reveal many parts of Maxwell that exhibit a patina of bright material. This patina does not embay underlying structure but, instead, appears to coat ridge crests, their slopes, and intervening valleys. The patina is very diffuse, with indistinct edges, and it does not appear to effect the texture of the underlying materials, just their relative brightness. This patina is most prominent around the edges of Maxwell Montes, where it contrasts sharply with the low-radar backscatter of the surrounding areas. This patina also seems to be absent at the highest elevations of Maxwell, in the central part of the belt.

Potential Origins. The low Magellan SAR incidence angles and steep slopes present at Maxwell Montes make this a prime candidate for occurrences of layover. However, most of these areas can be interpreted as containing depositional units with great confidence. The materials that make up these units may arise from a number of sources including chemical and mechanical weathering, tectonic disruption, impact cratering, and volcanism. The means by which these materials have been emplaced may include downslope (gravitationally driven) movements, ballistic emplacement, *in situ* weathering, and wind-borne transport.

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The specific nature of the depositional units on Maxwell remains to be determined. Much of that observed on western Maxwell may just be the result of downslope material movement associated with the steep slopes there. The morphology of the swath at ~359.5°E/65.95°N (scalloped scarp at eastern edge, with fan-shape deposit downslope at western edge) is consistent with the morphology of rock/block slide avalanches elsewhere on Venus [5]. The ponding of materials associated with the patch at ~359.5°E/65.25°N (Figure 1) is consistent with emplacement through fluid flow, and the channels (?) to the west and south could be indicative of an erosive fluid flow. A number of fluids could form such channels including lavas [6], impact melts and other crater outflow materials and debris [7-8], and water [6]. The most likely of these is the volcanic origin, with the graben to the west serving as a potential source. However, this conclusion must be viewed as preliminary, subject to reinterpretation of the channels (?) as erosive in origin

One interpretation that is in less doubt is that of the fine patina. The distribution of this patina corresponds directly to low-emissivity regions on Maxwell, which Klose et al. [9] interpreted to be due to a change in the surface mineralogy caused by weathering above a critical altitude. The fact that the patina does not alter the observed texture of the surface, just the brightness, indicates that this effect only occurs in the uppermost centimeter to meters.

Discussion. The depositional units in western Maxwell are of interest for the clues they may provide to the sequence of events within the mountain belt and the geodynamics at depth. The majority of these units appear to embay the adjacent structures, indicating they are the more recent features. In western Maxwell a few of the mapped depositional units may have a volcanic association. In one location a graben may represent a volcanic source, but indisputable evidence supporting such an origin is lacking. Should this apparent lack of widespread volcanism in western Maxwell be confirmed, then it could indicate that the crustal column there is still relatively cool, consistent with relatively recent crustal shortening and support at depth by crustal thickening, in which temperatures at depth remained low. If the crustal thickness beneath Maxwell is not large, yet there still is little evidence of volcanism, then a cool mantle is anticipated. However, should the existence of widespread volcanism be confirmed in western Maxwell, then a hot mantle is expected beneath Maxwell.

References. [1] Campbell D.B. et al. (1983) *Science, 221,* 644. [2] Basilevsky A.T. et al. (1986) *PLPSC 16th, JGR, 91,* suppl. D399. [3] Crumpler L.S. et al. (1986) *Geology, 14,* 1031. [4] Vorder Bruegge R.W. et al. (1990) *JGR, 95,* 8357. [5] Malin M.C. (1992) *JGR, 97,* 16337. [6] Baker, V.R. et al. (1992) *JGR, 97,* 13421. [7] Schultz P.H. (1992) *JGR, 97,* 16183. [8] Asimow P.D. and Wood J.A. (1992) *JGR, 97,* 13643. [9] Klose K.B. et al. (1992) *JGR, 97,* 16353.

Figure 1. Sketch map of region in vicinity of ~359.5°E/65.25°N. North is to the top. Depositional unit embays plains and ridge-and-valley structure in east. To the west, linear strips of this unit merge and intersect a graben. To the south are several ponds connected by a channel which cuts through ridges. A volcanic origin is suspected for the unit.