STRUCTURAL MAPPING OF MAXWELL MONTES; Myra Keep and Vicki L. Hansen, Southern Methodist University, Dallas, Texas, 75275.

Introduction. Four sets of structures have been mapped in the western and southern portions of Maxwell Montes. An early north-trending set of penetrative lineaments is cut by dominant, spaced ridges and paired valleys that trend northwest. To the south the ridges and valleys splay and graben form in the valleys. The spaced ridges and graben are cut by northeast-trending graben. The northwest-trending graben formed synchronously with or slightly later than the spaced ridges. Formation of the northeast-trending graben may have overlapped with that of the northwest-trending graben, but occurred in a spatially distinct area (regions of 2° slope). Graben formation, with northwest-southeast extension, may be related to gravity-sliding. Individually and collectively these structures are too small to support the immense topography of Maxwell, and are interpreted as parasitic features above a larger mass that supports the mountain belt.

Observations. Maxwell Montes comprises several physiographic provinces including; the northwest arm, the modified area associated with the impact crater Cleopatra, eastern and western ridges and the southern slope. Similar provinces are described by Kaula et al. [1]. This work addresses structural styles observed in the western ridges and southern slope. Structures in this area are mapped with confidence as they are relatively unaffected by flooding or ejecta-type modification from the impact crater Cleopatra. Structures with similar trends and timing relationships exist in other parts of the mountain belt.

Structural mapping of Magellan SAR images (C- and F-MIDR's) and framelets reveals the existence of four families of structures on the western ridges and southern slope of Maxwell Montes. Northwest-trending ridges, which dominate the structural fabric, extend from the northwest arm down to the southern slope (~ 700 km). Individual ridges vary in length from 150 to 500 km, have an average spacing of 8 to 10 km, and are relatively straight. Some of the ridges appear to anastomose, but this may be the effect of interaction with other lineament sets. Right-looking SAR images reveal radar-bright, west-facing slopes, enhanced by their contrast to a band of radar-dark material that runs the length of the western ridged area. To the east, spaced ridges continue through the modified, radar-bright bands associated with the impact crater Cleopatra, into the eastern flooded area, where ridge crests separate flooded valleys. To the west, ridges become increasingly radar-bright toward the steep western boundary with Lakshmi planum, and the spacing of ridges changes slightly, to ~ 6 km. On the southern slopes of Maxwell Montes ridge spacing increases and graben appear along the trace of the valleys. These graben are straight, parallel, paired lineaments which extend to the southern terminus of the mountain range and record northeast-southwest extension [2].

The third set of structures, which trend northeast, occur predominantly on the southern slope of the mountain range. This set contains a series of narrow, straight, paired, parallel-sided lineaments, with an average length of 20 km. We interpret these features as extensional because the area between lineaments is commonly filled with radar smooth material, both dark and bright, apparently filling topographic lows. These northeast to east-northeast trending graben occur mainly south of latitude 63N, in areas of 2° regional slope [2].

A fourth, weaker set of lineaments lies within the ridge-dominated area of central and western Maxwell Montes. This third set of structures contains closely spaced (6 to 12 km), wispy, north-trending, penetrative lineaments, which are especially well-developed between 3E and 5E, 64N. These lineaments interact with the spaced ridges, causing variations in strike direction and length that make their length and continuity difficult to ascertain. However, their penetrative nature readily distinguishes them from the spaced ridges. These penetrative lineaments continue into the crater-modified area, and the flooded area further east. They do not occur on the steep western slope.

Timing. As mentioned above, where the penetrative lineaments interact with the spaced ridges, their strike is modified. As a north-trending lineament approaches a ridge, the strike changes, becoming parallel to the ridge. Away from the ridge, the strike reverts to north. This modification occurs everywhere the penetrative lineaments encounter a ridge. The same effect is seen wherever penetrative lineaments encounter northwest-trending graben on the southern slope, but the relationships are obscured by flooding in the graben. The overall effect is that the penetrative lineaments snake their way north in a sigmoidal fashion. This suggests that the spaced ridges and northwest-trending graben postdate formation of the penetrative lineaments. Northeast-trending graben on the southern slope are interpreted as the youngest of the four sets of structures as they crosscut the ridges and northwest-trending graben. In places, these northeast-trending graben also clip the ends of the penetrative lineaments, causing irregularly-shaped depressions that have the tips of the penetrative lineaments and parts of the ridges preserved as "islands"(e.g., 63N, 6E). Their orientation, perpendicular to the trace of the spaced ridges, is consistent with a single strain regime in which the trend of the spaced ridges parallels the maximum principal strain axis and the trace of the grabens parallels the direction of maximum shortening. The orientation

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of the northwest-trending graben is additionally controlled by the abrupt decrease in topography. In summary, the penetrative lineaments are the oldest structures, crosscut and modified by the spaced ridges and northwest-trending graben, which are themselves cut at their downslope extremities by northeast-trending graben. The periods of formation of these sets of structures may have overlapped with each other within the given temporal framework.

Interpretation.. The sigmoidal nature of the interference of the spaced ridges and the penetrative lineaments is similar to S-C shear geometries [3]. However, S-C geometries require specific angular relationships (0-45°) between the S (penetrative) and C (spaced ridges) planes. Although these relationships are seen for most of the interactions, to the south the spaced ridges change orientation slightly toward west-northwest, whereas the penetrative lineaments keep a northerly trend, and the angular relationship between these two sets of structures changes from acute to perpendicular. These observations are not compatible with S-C geometry, but are common with the development of crenulation cleavage [4], which simply records evidence of two sequential deformation events. We believe that the two sequential events on Maxwell Montes are the formation of the penetrative lineaments and the formation of the ridges. The short wavelengths and close spacing of the penetrative lineaments resemble surface deformation in a thin layer, such as wrinkles on a lava flow [5]. We therefore interpret the penetrative lineaments to be the result of contraction of a thin cover (over Maxwell Montes), forming "wrinkles". Continuing contraction, with a rotation of the principal axes of the strain ellipse, or later contraction in response to a new stimulus, produced the spaced ridges. The downslope splaying and extension of the spaced ridges in southern Maxwell indicates that contraction was stronger in the central part of Maxwell than on the southern slope. A good analogy to this downslope extension of spaced ridges would be that of stretching a thin or weak layer over a block. The thin or weak layer is extended both parallel and perpendicular to the slope. In areas of high topography on Earth, e.g., the Himalayas, extensional collapse parallel to the direction of maximum contraction accompanies contraction [5]. No such extension occurs on Maxwell, as evidenced by the lack of extensional overprint of the penetrative lineaments. This indicates that the highest points of Maxwell, away from areas of 2° regional slope, are stable. During formation of the spaced ridges, extensional features with traces parallel to the direction of maximum shortening developed on the flanks of the ridges in areas of 2° regional slope. As contraction progressed, extension was ongoing, perhaps as a result of gravity-sliding on the slopes of Maxwell Montes [2]. Although northeast-trending extension occurs only on the southern slope, the other lineament sets are seen throughout the modified area in the center of Maxwell, and in the flooded region to the east. Extensional faults may be present but obscured by flooding. We therefore extrapolate our interpretations to the modified area and the flooded eastern ridges.

These timing relationships allow us some insight as to the processes operating on Maxwell Montes. However, we interpret these processes to be surface processes only. The nature of the deformation (penetrative ridges, spaced ridges) is inconsistent with the great height of the mountain range; these structures are not responsible for the great elevation. Rather, the small scale features have the character of parasitic structures developed over a larger mass. We propose that the surface structural features on Maxwell Montes are the equivalent of "cover" deformation, and that Maxwell Montes is underlain by a rigid block of strong material. The shape and elevation of the underlying block controls the type, wavelength and orientation of features at the surface. Evidence in favor of this theory include: 1) the small scale of structures at the surface; 2) extension only in areas of 2° slope (i.e. defining the margins of the block; extension is downslope; 3) lack of extension parallel to contraction in the main part of the spaced ridges (the highest points of the mountain belt are not collapsing); and 4) the splaying of ridges and graben formation after a critical slope angle is reached. The more complexly deformed northwest arm of Maxwell Montes also has ridge structures parallel to those of the western ridges. Additional deformation in this area is largely parallel to the discontinuity separating the arm from the rest of Maxwell. This discontinuity may also represent a boundary to the underlying block.

[1] W.M. Kaula et al. (1992) JGR **97**, 16085; [2] S. E. Smrekar and S. C. Solomon (1992) JGR, **97**, 16121; [3] D. Berthe et al. (1979) J. Struct. Geol. **1**, 31; [4] J. G. Ramsay and M. I. Huber (1983) The Techniques of Modern Structural Geology, Academic Press, London, 307 pp.; [5] J. Green and N. M. Short (1971) Volcanic landforms and surface features, Springer-Verlag, New York. 519 pp., plate 143A; [6] B. C. Burchfiel et al. (1989) Geology **17**, 748.