VARIATION IN COMPRESSIONAL STRUCTURES ACROSS MAXWELL MONTES: EVIDENCE FOR A SEQUENCE OF EVENTS IN A VENUSIAN OROGENY R. W. Vorder Bruegge, Science Applications International Corporation, 400 Virginia Ave., S.W., Suite 400, Washington, D.C. 20024

Summary. Structural mapping of Maxwell Montes has revealed a variation in the character of ridges and valleys from the toe of the mountain belt in Lakshmi Planum to the crest of the belt. This variation is interpreted as an evolution in thrust systems from simple fold-bend anticlines as they are incorporated into belt at the toe to steeply dipping duplexes at the crest. A shallow depth of decollement and displacements of several kilometers are indicated. This model may permit gravitational relaxation of the highest part of the mountain belt through normal faulting of the steeply dipping duplexes along pre-existing thrust faults. The mechanism for support of the mountain belt at depth is probably not crustal thickness variations, alone, and its true nature remains elusive. Nevertheless, the evolution of Maxwell Montes can still be interpreted as quite comparable to that of terrestrial fold-and-thrust belts, with a key difference being the lack of erosion on Venus.

Introduction. Structural mapping of Maxwell Montes, Venus, is being performed with Magellan data in order to characterize the tectonic processes associated with the creation and evolution of the mountain belt, their sequence, timing, and overall relationship to the rest of Ishtar Terra. Earlier examination of Venera and Arecibo radar images led a number of workers to interpret the surface deformation as occuring through folding, thrusting, and buckling of the crust [1-4]. More recent examination of Magellan data has led others to confirm this preliminary assessment [5-7]. Suppe and Conners [8] determined that the topography of the western face of Maxwell is consistent with its formation through critical taper wedge mechanics involving the upper-most crustal layers. The purpose of this work is to explictly document the characteristics of individual structures present across Maxwell Montes, incorporate them into an evolutionary sequence of events, and compare that to the evolution of terrestrial fold-and-thrust belts.

Observations and Interpretations. The mapping of western Maxwell Montes has revealed a predominance of structures related to crustal shortening, primarily in the form of thrust faulting and folding. The nature of these features varies from west to east and appears to be correlated with the large-scale topography (Figure 1). Off the western edge of Maxwell Montes, in the smooth, low-lying plains of Lakshmi Planum (~63-64°N), small folds or flat-topped anticlines are observed trending to the north or slightly west of north. These folds are on the order of several hundred meters across and occur at spacings of approximately 5-6 km. They are separated from one another by relatively flat, undeformed plains. An interpretive cross-section of these folds that assumes a shallow depth to decollement is shown in Figure 2A. To the east the surface slopes upward rapidly on the western face of Maxwell, and more north-northwest trending anticlines are observed. In this region, the flat-topped anticlines broaden while the width of flat regions between them decreases to almost zero. On the lower reaches of the toe of western Maxwell, the spacing of the anticlines can be as little as 3 km, or half that observed in the plains (Figure 2B). The increase in fold width and decrease in spacing are interpreted to be the result of large displacements (several km) along the shallow-dipping thrusts. Farther up the slope the spacing increases to approximately 5-6 km (as in the plains) but the width of individual anticlines also increases, so that there are only narrow, flat valleys between anticlines (Figure 2C). This is interpreted to be a result of merging of adjacent anticlines. Near the crest of the mountain belt, the nature of the compressional features changes again. Instead of flat-topped anticlines, the general structure appears to consist of steep west-facing scarps (<1 km wide) and long, shallow east-facing slopes (~10 km wide). The east-facing slopes terminate at the base of a subsequent west-facing scarp. Although radar foreshortening and elongation will tend to exaggerate the relative widths of these slopes, the geometry of these features is consistent with their representing stacked duplexes in an imbricate sheet (Figure 2D).

Synthesis. The cross sections of Figure 2 suggest the following sequence of events in Maxwell Montes from the toe to the crest. Anticlines first form in the plains (Fig. 2A), then become incorporated into the toe of the mountain belt through further shortening along existing thrust faults which increases the width of the existing anticlines and decreases the spacing between them (Fig. 2B). Farther up the wedge the increased width and spacing of the anticlines is interpreted to be the result of further slip along the decollements and merging of adjacent anticlines (Fig. 2C). Finally, at the crest of the mountain belt duplexes are formed and rotated backwards (Fig. 2D). This may ultimately lead to normal faulting along steeply dipping thrust surfaces, which would expose more of the flat, east-facing slopes. Such normal faulting would be indicative of gravitational relaxation and has been observed along pre-existing thrust faults in the Himalaya [9].

The Maxwell cross-sections show good agreement with those of terrestrial thrust systems [e.g., see 10]. A major difference is that the Maxwell cross-sections show no evidence of erosion. Another difference is that the Maxwell cross-sections are not yet balanced from toe to crest. Efforts are being made to produce a balanced cross-section for Maxwell in order to predict relationships at depth and to examine the implications for support of the mountain belt.

References. [1] Basilevsky A.T. et al. (1986) *PLPSC 16th, JGR, 91*, suppl. D399. [2] Ronca L.B. and Basilevsky A.T. (1986) *EM&P, 36*, 23. [3] Crumpler L.S. et al. (1986) *Geology, 14*, 1031. [4] Vorder Bruegge R.W. et al. (1990) *JGR, 95*, 8357. [5] Solomon S.C. et al. (1991) *Science, 252*, 297. [6] Solomon S.C. et al. (1992) *JGR, 97*, 13199. [7] Kaula W.M. et al. (1992) *JGR, 97*, 16085. [8] Suppe J. and Conners C. (1992) *JGR, 97*, 13545. [9] Burchfiel B.C. and Royden L.H. (1985) *Geology, 13*, 679. [10] Boyer S.E. and Elliott D. (1982) *AAPG Bull., 66*, 1196.

Figure 1. Topographic profile across Maxwell from 0.0°E/63.0°N to 3.0°E/64.0°N. Elevations shown are relative to mean planetary radius of 6051.84 km. Letters A-D refer to cross-section locations in Figure 2.

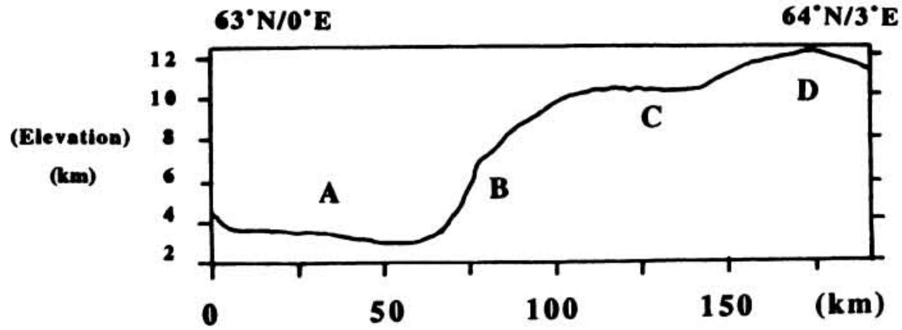

Figure 2. Interpretive cross-sections of different structures on Maxwell Montes. Letters "A" - "D" correspond to locations on topographic profile of Figure 1. East is to the right. Heaviest lines indicate 'active' thrust surfaces. Note scale change between "B" and "C." D1 and D2 represent the progressive growth of a duplex.