TECTONIC RECONSTRUCTION OF THE OPHIR PLANUM REGION, CENTRAL VALLES MARINERIS, MARS (OR HOW DO YOU MAKE A COPRATES CHASMA?),

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Introduction. A portion of Valles Marineris was chosen for study and mapped in detail in order to clarify the dominant processes responsible for the formation of the central troughs. The Ophir Planum region was mapped at a scale of 1:500,000 as part of the Mars Geologic Mapping Program (1). Ophir Planum occupies 40% of the map area; portions of Candor, Melas, and Coprates Chasmata comprise the remainder. The troughs contain distinctive landslide deposits, normal faults, possible young volcanics, and layered sedimentary materials. Ophir Planum enjoyed deformation by normal faults and grabens that define an echelon array unique along the Valles Marineris system. The purpose of this project is to reconstruct the deformation sequence in the central troughs in order to test popular models for trough formation.

Results. New crater counts of units in the map area (Figure 1) show that the Ophir Planum plateau has a Late Hesperian crater age, whereas trough floor preserved in Coprates Chasma has an Early to Late Hesperian crater age. Caprock on Ophir Planum appears to correlate best with Syria Planum Formation. Trough floor in Coprates probably correlates with ridged plains material in Lunae Planum and Coprates plateau and represents a reasonably continuous block rotated downward by normal faulting. These new stratigraphic assignments are important in drawing constrained cross sections using the available topography, and stratigraphic offsets of plateau caprock along the major trough bounding normal faults are now documented.

Preservation of an Hesperian crater population on trough floors such as Coprates and northern Melas Chasmata (this work; ref. 2) indicates that these trough floors are (a) shallowly buried (tens to hundreds of meters only) and (b) structurally continuous enough for these craters to be preserved. The identification of structurally continuous, downfaulted plateau caprock on trough floors (this work; see also ref. 3) indicates that models for the development of this part of Valles Marineris based on chaotic removal of ice or carbonates (4) or random collapse and subsurface drainage into cracks (5) are not applicable.

Tectonic models of trough formation based on "keystone" collapse of high topography and concomitant symmetric graben development are not supported by the detailed mapping. Instead, an asymmetric, *half-graben* geometry is identified because the stratigraphic offsets of plateau caprock are greater near Ophir Planum (>8 km) than to the south (~2-7 km). Coprates Chasma occupies a half-graben with the continuous normal fault scarp along its north wall corresponding to a south dipping master fault. North and south dipping faults that bound the spur of trough wall material to the south are antithetic and synthetic normal faults formed during flexure of the hanging wall due to slip along the master fault (e.g., ref. 6). The structural width of Coprates Chasma in the map area, ~60 km, is only 60% of its erosional width (100 km). The depth of faulting in western Coprates Chasma may range from 30 km, assuming semicircular listric faults, to 50 km, assuming planar faults dipping at 60°. Candor and Melas Chasmata probably also occupy half-grabens with northern master faults. This interpretation of trough structure contrasts with previous suggestions of symmetric (full-) graben geometry (5,7) and can be tested by precise measurements of slopes of the trough floor in Coprates by the Mars Observer laser altimeter.

Conclusions. Detailed mapping of the central part of Valles Marineris significantly alters our concept of trough evolution. Genesis models based on erosion, collapse, or symmetric grabens are not supported by the mapping. New crater counts of key units establish the stratigraphic positions of caprock on Ophir Planum and material comprising the trough floor in Coprates and its extension to the west in Melas Chasma. The structure of Coprates Chasma is best interpreted as an asymmetric half-graben. If Ophir Planum is indeed capped by Upper Hesperian materials, the faulting that culminated in Valles Marineris was relatively young. An earliest Late Hesperian age for the initation of faulting on the plateau is comparable to that obtained in the westernmost troughs, suggesting that faulting along the entire trough system was approximately synchronous on the timescale of Late Hesperian and Amazonian crater rates. This result explains why Tharsis related principal stress trajectories (8) fit the overall trough orientation so well. However, deformation of Ophir Planum plateau by grabens rotated 30° clockwise from the trend of Coprates Chasma indicates that the local principal stresses within the trough system differed significantly from geophysical model predictions (8). The oblique grabens probably record the complex interaction between differentially subsiding troughs.

References. (1) USGS, Controlled photomosaic of part of the Valles Marineris region of Mars, scale 1:500,000 (sheet MTM -10067), *USGS Misc. Invest. Ser., Map I-1591*, 1984. (2) Blasius et al., *J. Geophys. Res., 82*, 4067-4091, 1977. (3) Lucchitta et al., The canyon system on Mars, in *Mars*, Univ. of Arizona Press, in press. (4) Spencer and Fanale, *J. Geophys. Res., 95*, 14,301-14,313, 1990. (5) Tanaka and Golombek, *Proc. Lunar Planet. Sci. Conf., 19th*, 383-396, 1989. (6) Melosh and Williams, *J. Geophys. Res., 94*, 13,961-13,973, 1989. (7) Nedell et al., *Icarus, 70*, 409-441, 1987. (8) Banerdt et al., Stress and tectonics on Mars, in *Mars*, Univ. of Arizona Press, in press.

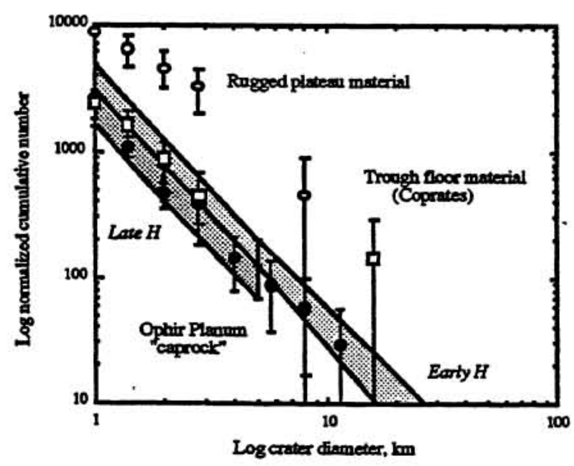

Figure 1. New crater counts of surfaces in Valles Marineris. Reference ages represented by shaded strips: Early Hesperian, Late Hesperian. Ophir Planum, filled circles; Coprates floor, open squares; rugged plateau, open circles.