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Possible Temperature-Related Slope and Surface Roughness Differences Between the North and South Walls of Coprates Chasma, Mars

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This study is concerned with the effect of temperature on the topography of the near-equatorial trough of Coprates Chasma. One of the outstanding questions concerning the evolution of the Valles Marineris troughs, and of equatorial landforms in general, concerns the possible presence of ground ice and its role in landscape evolution. Over geologic time, surface heat (by its influence on the stability and rheology of ice-rich frozen ground) may be a factor in the evolution and morphology of the trough walls by controlling the distribution of ground ice. This study aims to determine whether the expected surface temperature difference between the north and south walls of Coprates Chasma, results in a measurable difference in trough wall stability, slope angle, and surface roughness. To determine whether temperature is a factor, systematic variations in topographic parameters with predicted mean annual surface temperature, location (latitude and longitude), and trough geometry (wall height, rim elevation, and trough width) were examined, as were differences in topographic parameters (slope angle, curvature, and surface area ratio) between the north and south walls of Coprates Chasma. Slope angles, surface roughness, and other derivatives were calculated from the 1/64 degree MOLA gridded elevation dataset. 247 profiles were drawn across the trough, extracting topographic data, which was related to surface temperature, location, and trough geometry. Comparisons of differences in topographic and other parameters between the north and south walls were made. Predicted mean annual surface temperature varies from 202-212 K along the north wall and from 216-218 K on the south wall. The temperature difference between the two walls varies from ~7.5 K at the western end of the trough to ~11.5 K at the eastern end, and averages 9.7 K. The north and south walls have average slope angles of ~22.4$\deg$ and ~21.1$\deg$ respectively, the north wall being steeper by ~1.3$\deg$. Because the ranges of slope angle are similar for both walls, but the temperature range differs, slope angle decreases as a function of temperature at ~6$\deg$ of slope per K for the south wall, compared with ~1$\deg$ per K for the north wall. The difference in slope angle between the two walls for all the profiles measured correlates significantly with the surface temperature difference between the two walls. Correlations of slope angle and slope angle difference with location or trough geometry factors are weaker or insignificant. In addition, the pattern of slope angle variation along the trough is not associated with known or suspected faulting patterns. Furthermore, the slope angle asymmetry is not due to an asymmetric graben geometry for the trough as there is no tilt on the floor across the trough. Rock mass strength differences between the walls are unlikely given that layering in the walls appears to be horizontal. All these results suggest that it is temperature differentials, rather than location or trough geometric factors that have produced the systematic, trough-averaged difference in slope angle between the two walls. The results are consistent with a differential presence and depth of ground ice within the north and south walls. The depth to the ice table is shallower

underneath the north wall by a few tens to ~100 meters, and the cryosphere deeper by ~1 km; the ice table is also predicted to be colder underneath the north wall. Given the known increase in the strength and resistance of ice to deformation with decreasing temperature, the north wall is considered to be more stable and stronger, and therefore can maintain steeper slope angles on average than the south wall.

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