SUBLIMATION MODEL FOR FORMATION OF RESIDUAL CAP DEPRESSIONS. S. Byrne[1] and A.P. Ingersoll[1]. [1]Division of Geological and Planetary Sciences, Caltech, 1200 E. California Blvd., Pasadena, CA 91125, US. Correspondence Email: shane@gps.caltech.edu

Introduction: The Mars Global Surveyor (MGS) spacecraft, through the Mars Orbital Camera (MOC), has provided unprecedented views at high resolution of the southern residual polar cap. Since the orbit is not quite polar (3^o off) there is a ring at 87 south which the spacecraft must pass tangent to in every revolution about the planet. Hence there is an extremely well imaged ring at this latitude that intersects the residual cap. Several terrain types unique to this area are apparent [1]. Some of the most unusual geomorphic features revealed are circular/quasi-circular depressions which are steep walled and flat floored, with a characteristic depth of ~10m [1] and a broad range of lateral sizes. We have developed a sublimation driven model to explain the formation of these features.

Observations: An example of this terrain is shown in figure 1. Characteristics of these features were discussed by Thomas et al [1].

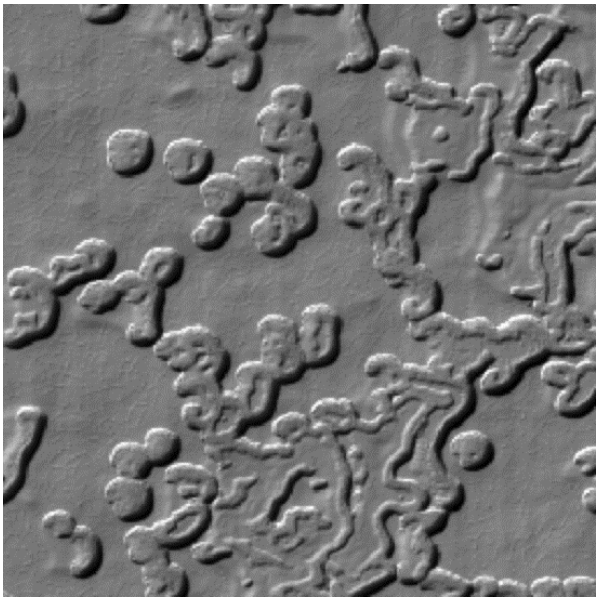

Figure 1*: Subframe of M07-02823 taken at 11 meters per pixel, 87 S, 6 W. The scene here is approximately 3 Km across, sunlight is from the bottom right, north is to the left. Several depressions are visible in this image, some have merged to form larger non-circular shapes.*

In general, as discussed above, they have circular or near circular shapes, flat floors and steep walls. They appear only on the residual cap itself (as mapped by Viking [2]). They show no noticeable changes as the southern summer season progresses. Each depression appears to have an interior moat of constant width. The moat width is independent of the lateral size of the depression. Inside the moat, at the center of the depressions, are elevated areas approximately 2 meters above moat level, which are possibly lag deposits remaining after sublimation of the interior [1]. One of the most intriguing observed properties is the existence of four or more layers within the medium in which the depressions are incised [1]. Figure 2 (as shown in the Thomas et al [1] article) shows a more detailed view of the layering, each layer is roughly two meters thick and so when slopes are this steep can only be discerned in the highest resolution MOC images.

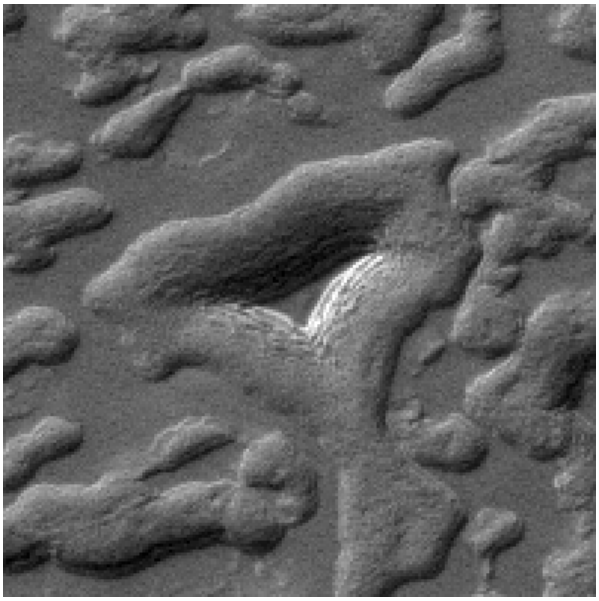

Figure 2*: Subframe of M07-2129 taken at 2.2 meters per pixel, 87 S, 78 W. The scene here is approximately 500 meters across, sunlight is from the bottom right, north is to the left. The layers in the sidewalls are just visible.*

These layers are observed in other images within the walls of the depressions. The layers are not perfectly parallel and appear to branch, merge and get pinched out. It is possible that there are thinner layers which are not being resolved and which are responsible for this irregular behavior.

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Model: Our model assumes cylindrical symmetry. The sun circles each day at a constant height above the horizon (which varies as a function of season). This would be true if one were exactly at the pole and provides a very good approximation at a latitude of 87 degrees. The medium in which the depressions form can have horizontal layering incorporating changes in albedo, thermodynamic properties, composition and density as a function of depth. The model is started with some small depression and run forward to examine the evolution of its shape. This model accounts for the effects of incident sunlight, reflected sunlight within the depression, emitted thermal radiation within the depression, reflected thermal radiation and the effects of partial shadowing due to low sun elevations. The surface temperature is fixed at the sublimation temperature of CO_2. Sublimation and redeposition of frost occurs depending on the difference between incoming and outgoing radiation. The rates of these processes may differ across the depression. This model should be sensitive to events occurring on timescales as short as 1^o of L_s, even though there is no evidence for change this rapid. This model is the first step in a larger modeling effort to explain the full asymmetrical nature of these features.

Discussion: We investigate the conditions necessary to form features similar to those observed in the MOC data. The possibility of significant amounts of water ice and variations in dust fractions from layer to layer are also considered. We will report on our findings and their implications.

References: [1] Thomas P.C. et al., (2000), Nature, 404, 161-164. [2] James P.B. et al (1979), J. Geophys. Res., 84, 2889-2922.