THE SOUTH POLAR RESIDUAL CAP OF MARS: LANDFORMS AND STRATIGRAPHY. P. C. Thomas[1]
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The south polar residual cap (sprc) of Mars is morphologically distinct from that in the north, and is largely compositionally distinct as well, apparently dominated by CO_2 rather than the H_20 present in the northern residual cap. This work addresses questions of the history and significance of these distinctive deposits by mapping the many forms using MOC images and MOLA data.

Depositional units: There are two primary sets of depositional units in the sprc: 1) An older unit, approximately 11 m in thickness with four included layers, widely distributed over the sprc, and expressed as mesas or broad surfaces cut by a variety of circular to linear depressions, and commonly having polygonal troughs (Fig. 1a).

2) One or more younger units, approximately 2 m thick, that have superposed and filled depressions formed in the older unit, and also formed in local discrete deposits. This unit also has a wide variety of depression types (Fig. 1b, c) Both of these sets of units occur on the flatter topography of the polar deposits (slopes under 2°), and terminate in troughs at elevations only a few m lower than where the layers are fully developed. Both units show scarp retreat of up to a few m over one Martian year [1].

Erosion and other modification forms: The sprc topography has unique erosional topography [2,3]. There are a great variety of these forms, many are seen to merge into other forms. While the large circular depressions have received the most attention, these are not even the "typical" form. We have mapped the following forms: generic depressions, large circular depressions, parallel sets of linear depressions (fingerprint terrain), other linear depressions, moats, and curled depressions, among others

Fingerprint depressions define a few coherent patterns, and are not simply oriented with one side toward the pole; their consistent trends suggest underlying structural control; their shapes show common upper surface fracture control (Fig. 1e). They occur in a restricted area of the sprc (Fig. 2a).

The *curl* depressions (Fig. 1d,f) are oriented with openings dominantly within 60° of north (Fig. 2d). The surface indenting the curl commonly is in a ramp form (Fig. 1f), rather than a pedestal.

Moat-like depressions occur within some nearly circular forms as well as bounding a variety of mesas and other remnant topography. Moats within other depressions show two distinct widths: ~20 m and ~70 m. The latter is indistinguishable from moat widths around mesas and other remnants (Fig. 2c).

Development of the depressions and deposits: Changes between 1999 and 2001 indicate some backwasting of the forms of order 1-4 m/ Mars year [1], with a few instances over 5 m. Initiation of the forms, and enlargment of many, however, involve mechanisms other than backwasting of steep scarps. Disruption of the older upper surface occurs at least in part by sag and collapse; development sequences of curled depressions can be found, and examples of enlargement almost entirely by collapse are also found (Fig. 1d,i). The sag and collapse features may explain the development of "escher" terrain, whereby an upper surface appears contiguous between different cycles of erosion (Fig. 1j).

Thin layers preferentially develop pits and other depressions over underlying topography, and on some upper convex slopes (Fig. 1b). These pits, "peels", and moats indicate modification of overlying deposits by exposure of relief or a critical layer thickness. There are examples of inverted relief, wherein the older, thick deposits have collapsed after deposition of thin deposits within the large depressions .

Non-uniform deposition is also found in some tongues of material several m in depth and a few hundred m long in restricted areas of the sprc. These appear to be part of the later deposits.

Pattered ground: Slopes from remnants of the thick, older unit commonly show surfaces with brick or cobblestone appearance, sometimes giving a false impression of large numbers of layers exposed in the mesas (1a). Material underlying the sprc in some troughs displays a slightly different patterned appearance.

Interpretations: Several different cycles/changes in polar depositional and sublimational regime are indicated:

1). Change from main polar layered deposits to deposition of the 11 m set of layers: H_20 rich deposits to CO_2 rich ones.

2) Cycles producing layering within the 11 m stack, about 4 cycles. Some differences in physical characteristics/ composition.

3) Significant erosion of the deposits in the form of merging depressions and sag and collapse modification.

4) Before or during the subsequent steps, development of polygonal troughs in much of the surface of the thick deposit.

5) Deposition of one or two, ~ 2 m layers in the erosional topography of the thick deposits.

6) Renewed sublimation of both deposits. Included in this step is the scattered development of inverted relief. This activity may continue at present.

The primary interpretive difficulty is the similarity and merging of deposits formed by sag and collapse of the thick units, and thinner, younger layers (step 5 above). Both units are clearly present; however, which is present at a particular site is sometimes unclear.

The evident variety of layer types, thicknesses, and cycles of deposition and erosion (including inverted relief) show there are several combinations of composition and/or texture within these deposits. More than one type of climate cycle is required to form these features' current appearance.

References:

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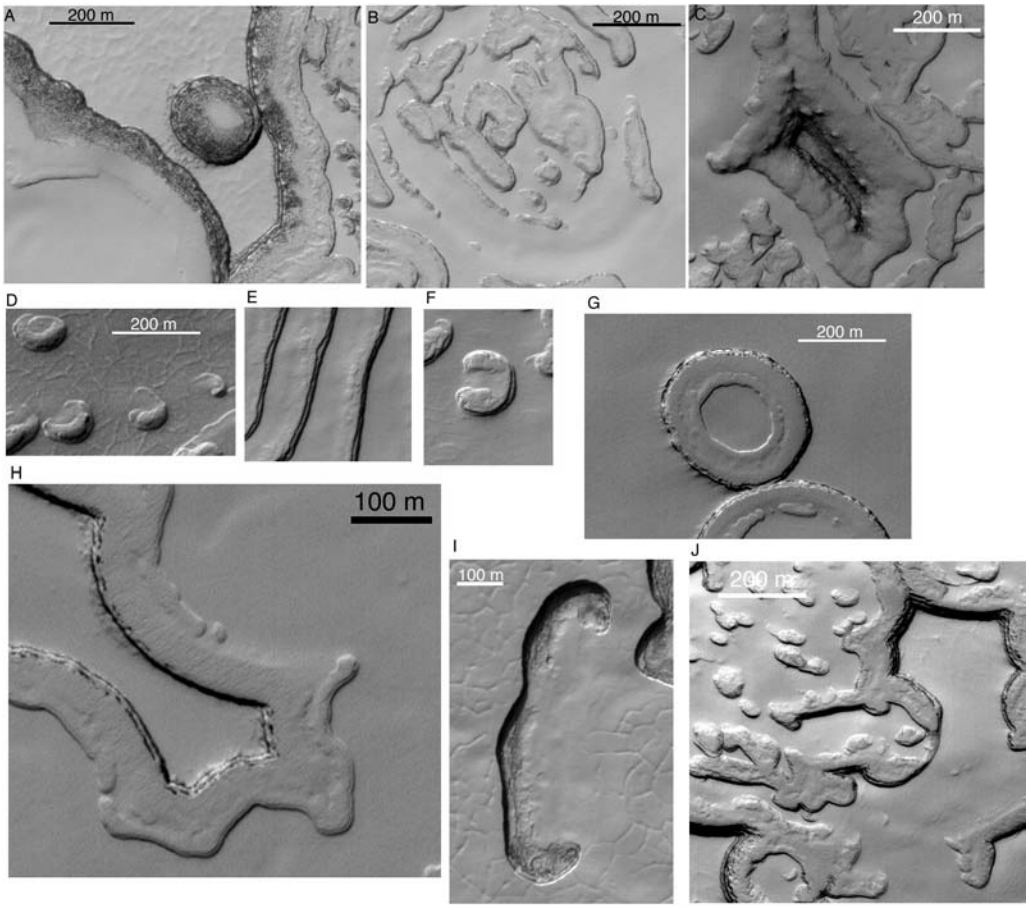

Figure 1a. Surface of thicker sprc unit, with polygonal troughs and darker patterned materials flanking slopes of 3-4 layers. Moat to the right. b). Erosion of thinner layers in places follows underlying topography, here part of a curving ridge in the lower left. Sun from lower right. c. Thinner unit eroded in moat from underlying topography. d. Depressions with fracture boundaries showing development sequence toward a curl depression. e. Fingerprint trough. f. Curl trough, showing interior ramp. g. Confined moats. h. Moat, showing textured lower surface, probably the main polar layered deposits. i. Linear depression and sag. j. "Escher" terrain with uncertain relation of upper and lower surfaces, probably generated in part by sag and collapse as in Fig. 1 i.

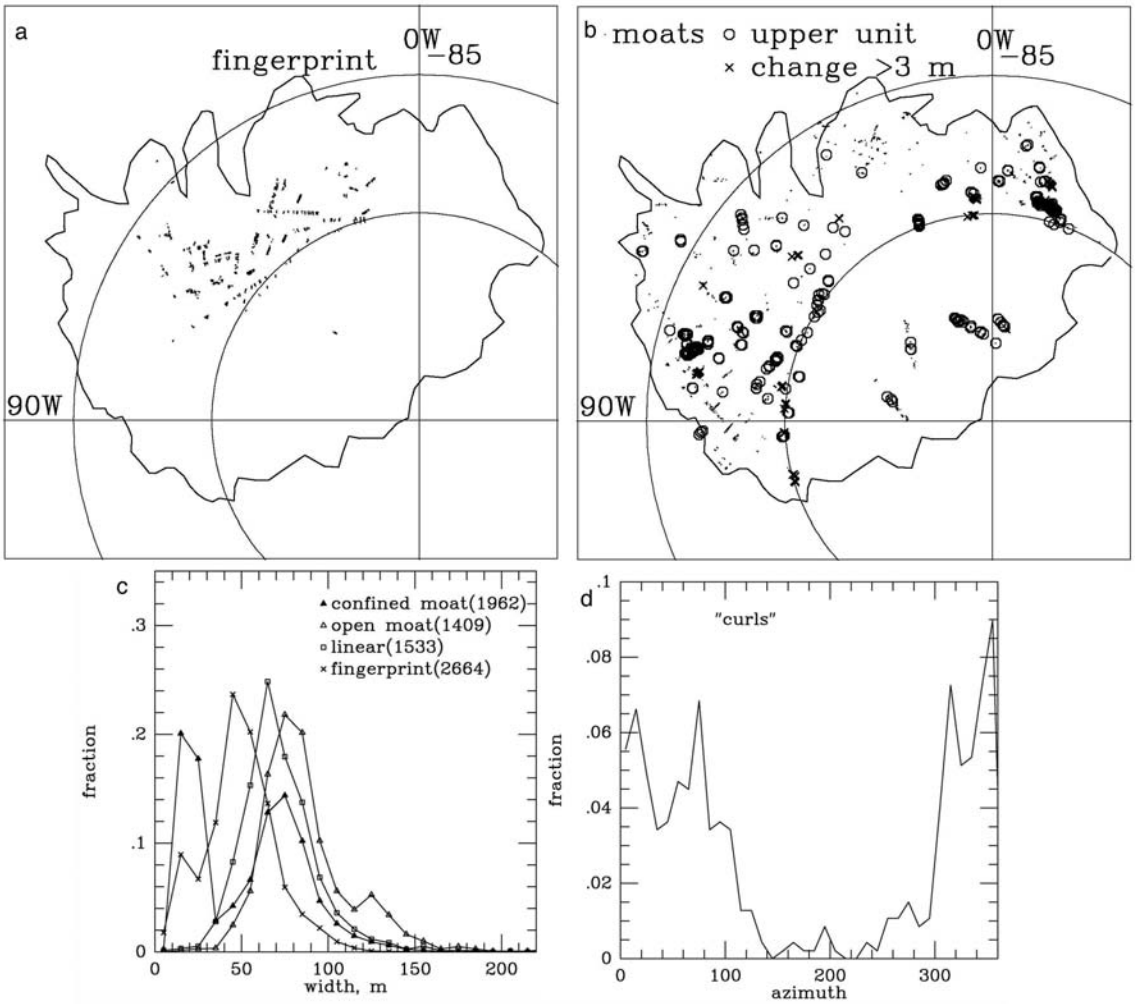

Figure 2. Some characteristics of the south polar residual cap erosional forms. a) Location of fingerprint terrain. b) Locations of upper surface of thick unit (circles), and most kinds of moats (small dots). Both forms are widespread over the sprc. Locations of changes measured in excess of 3 m in one Mars year shown by x's (Measured change is 6 m or more across walls or depressions; single distance is 3 m or more.) c) Widths of some depression types. Note the similarity of open and confined moats and linear depressions; slight distinction of the fingerprint depressions. d) Orientation, clockwise from north, of the curl depressions. The orientation would be to the left in Fig. 1f.