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Mars Polar Volatiles: Topographic and Geologic Setting

MARS POLAR RESEARCH - STATUS REPORT

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We report here on the first nine months of a nominally three-year planned effort to better elucidate the geological and topographic setting of the Martian polar volatiles. Our planned focus is on exploiting the combined Mariner 9 and Viking polar image sets and, possibly, also selected parts of the infrared emission data sets.

Most of the initial effort was directed on quantitative evaluation of the Mariner 9 imaging data set and acquisition of the necessary software for its processing at Caltech. Specifically, we accomplished the following:

1. Data Set

We acquired and copied all the Mariner 9 imaging data sets available through JPL and created a local Mariner 9 image library. Using the hard-copy at the JPL regional image library, we identified 171 A-frames and 114 B-frames with frost, ranging in L_s 290° to 360°. Resolution of the B-frames ranged from approximately 70 to 200 meters per pixel. These polar frames were transferred to individual A- and B-frame tapes for ease of handling.

2. SEDR

We acquired the best available Mariner 9 Supplementary Experiment Data Record and checked the accuracy of the image footprints on the surface of Mars by direct comparison with the USGS airbrush map. We verified that the surface locations of the footprints are within the $\pm 1^{\circ}$ error nominally attributed to the data, and that the NORAZ angle (solar pointing angle) was generally within the $\pm 2^{\circ}$ nominal limit, also. On this basis we concluded that the SEDR can be used directly within these kinds of accuracies, especially for geometric projection.

3. Dark Current

We investigated, estimated, removed, and verified the dark current, especially through use of sequences of frames that moved off the planet. We determined that the dark current could be corrected to within about 1/2 DN in time and to approximately 1 DN across the field, except near the "hot" corners. Thus, the dark current was determined to be well-behaved and correctable and less of a problem than with the Viking data.

4. Residual Image

Residual image is, on the other hand, a serious limitation to the photometric usefulness of the Mariner 9 imaging data. The phenomenon is difficult to evaluate and was not successfully modeled by us or, apparently, in the original experiment descriptions. Brute force tracking of the residual image effect in sample sequences of both A- and B-frames indicated that in properly exposed frames the residual image ranges from about 6% to 16% of the brightness of the previous frame. Unfortunately,

this effect is difficult to correct to better than ±5% with much confidence.

5. Vidicon Response Function

The "shading" and light transfer functions of both cameras were investigated by using the images of the planet during the time it was heavily covered by the dust storm on Revolution 3. Overlapping sequences of A-frames with nested B-frames provide an ideal data set that permits the shading correction and light transfers to be determined reasonably accurately. Thus, adequate in-flight data exist to model the response of the vidicon sensor itself.

6. Atmospheric Scattering

The magnitude of the atmospheric scattering was examined by tracing the brightness profiles of the frames across the terminator. Atmospheric scattering is apparent but appears to be well behaved and correctable, perhaps down to the same level as the dark current, at least where high altitude clouds or other special phenomena are not encountered.

A preliminary review of Viking south polar images was also conducted by KEH and LAS in Flagstaff. The use of these three-color sets to extract surface color information seems encouraging in the equatorial areas. However, no data, as of this writing, are available from the polar area to demonstrate that that technique can be applied in the polar regions as well. More generally, it is apparent that the Mariner 9 B-frames provide the highest resolution of the south polar region for either mission, along with the good temporal coverage with the A-frames. The Mariner 9 (1971-72) data set thus constitutes the best single representation of the residual south polar cap. These data are nicely supplemented by the Viking Orbiter 2 data six years later (1977-78). The Viking Orbiter north polar data are quite abundant and of good resolution and, thus, constitute the prime data set for study of the north polar area.

The previously reported differences between the timing of the south polar retreat in the Viking observations compared to Mariner 9 were confirmed in this investigation. However, within the Mariner 9 south p· ar data there clearly are persistent reflectivity variations in the frost. Some, such as bright regions which develop near the margins late in the retreat, may be speculated to be associated with fresh reforming water frost. Others, such as bright homogeneous regions in the central region of the cap are less easily explained by the simple published models of frost formation and disappearance.