DESCRIPTION AND HYPOTHESES FOR LINEAR FEATURES, NORTHWEST ACIDALIA PLANITIA, MARS. F. J. Calef III and V. L. Sharpton, Geophysical Institute, University of Alaska, Fairbanks, AK, 99775, fred@gi.alaska.edu, buck.sharpton@gi.alaska.edu.

Introduction: Most dark linear features on Mars have been cataloged as dust devil trails [1]. While some of these features are unquestionably the result of dust devils, many others, such as those shown in Fig. 1, appear to be related to a different physical process [2]. We have conducted a quantitative and descriptive analysis of enigmatic dark linear features (LF after [2]) located within a large region of the Northern Hemisphere. Our initial results indicate that these features are not produced by dust devils and may be associated with seasonal phase changes of near-surface reservoirs of ground volatiles.

Previous Work: True dust devil trails (e.g., Fig. 2) generally possess several diagnostic characteristics. For instance, their widths vary significantly along track, and taper at the (distal?) end. Dust devils often show abrupt changes in direction and form cuspate or curvilinear trails that overlap in random criss-crossing patterns. The dark, sometimes bright, trails they create are caused by "surface disruption" as captured on MOC imagery [3]. Rifkin and Mustard [1], in their cataloguing of surface processes, recorded 230 images with "dark lineations" they related to dust devils, primarily in the northern hemisphere. Ormo [2] has found similar features in the Hellas Basin, but noted these features are characteristically different based primarily on their morphology. A number of MOC NA images depict LF, primarily in northern latitudes, that are distinctly different from classical dust devil trails.

Methodology: We surveyed a total of 1,366 MOC NA images (including all images up to mapping subphase M23), covering 40° to 80°W and 0° to 90°N. Of these 54 contained enigmatic LF as distinguished by characteristics obtained from our type examples located within image M0001362. These diagnostic characteristics are: high linearity (i.e., 'straight' appearance), multiple occurrences, consistent width over length, relatively consistently low albedo with decreases at LF intersections, and straight intersections. Image M0001362 was placed within a GIS and analyzed for quantitative and descriptive feature morphology, feature orientation using a rose diagram, and regional associations.

Observations: The LF are regionally associated with lower albedo areas in northwest Acidalia Planitia (Fig. 3). TES data [3] show signatures that have been associated with andesitic surfaces in this part of the Vastitas Borealis Formation [4]. All LF in our study region are found at the elevations between –2570m to -5165m and latitudes between 48ºN to 70ºN. Images display little relief and surfaces appear very young with few or no craters. Most images contained small elongate domed surface features in association with LF. These features are 20m ± 5m wide and completely cover most images. Some images display LF that appear offset and others with depth (Fig. 4). Using M0001362 as a diagnostic image, the following LF morphologies were noted: (1) the normalized difference between background and LF DN averaged 35%, (2) maximum LF length exceeded the image length at 6.6 km, the length of the smallest LF observed was 150m ± 20m, (3) LF widths range from 60m to 20m and vary along track by less than ± 10m, (4) intersections occur at orthogonal to sub-parallel angles, (5) LF form parallel and conjugate sets, and (6) concentration of features and intersections are observed in lower albedo areas. These morphologies are consistent with LF observed in the Hellas Basin [2].

Orientation Analysis: We derived orientation statistics for all LF in M0001362 using conventional spatial analysis techniques modified in the following manner: Because MOC NA images are much longer than wide, we had to eliminate directional bias introduced from this coverage. Therefore, lines were clipped to 1.5km radius circles (corresponding to the image width) in the northern and southern components of the image (Fig. 5a). A rose diagram was created showing the frequency of lines within 10º bins (Fig. 5b). There is a primary trend (70-250º) evident in the northern circle and two trends are observed in the southern circle (30-210º and 85-265º). Windstreaks from the WA context image M0001363 display a divergent orientation (105-285º). The dome-like features' short axis trends are approximately orthogonal to the general wind pattern from the WA image, suggesting that these features are not wind related either.

Discussion: Several hypotheses are possible for the process by which these LF are formed. Perhaps these are dust devil trails [3]. Though similar in appearance, their strict linearity, constant width and trend contradict the dust devil model. Some suggest these features represent plowmarks from ancient icebergs [6], however there are no obvious shallow depressions associated with the features in this study. Furthermore, as these features occur on very young martian surfaces, the quantity of both water and ice needed to satisfy this model is unrealistic. Others [2] have suggested that LF represent surface expressions of ground ice from their fracture-like pattern. There are similarities to periglacial features. Terrestrial ice-wedge polygons (Fig. 6) display striking linearity and appear in context with frost boils, a possible analog to the domal features typically associated with LF. Some LF have evidence of structural origins with horizontal offsets (Fig. 4), slight vertical displacements and apparent conjugate sets (Fig. 1).

Conclusion: Results of our analysis do not support previous interpretations that LF are generated from dust devils or other meteorological activity. Rather, fundamental characteristics of these features point to a structural origin, possibly through some periglacial-like process. While this process could be associated with phase changes and/or atmospheric discharge of H_2O ground ice, the role of CO_2 sublimation in generating surface deformation within porous sediments is not well constrained and cannot be ruled out with the present constraints. Such interchanges could be the accumulation of seasonal temperature variations, but may also record pronounced high-latitude temperature excursions associated with suggested 10^5-10^6 year obliquity variations [7 and references therein].

References: [1] Rifkin M. K. and Mustard J. F. (2001) *LPS XXXII*, no. 1698. [2] Ormo J. et al., *LPS XXXII*, no. 1517. [3] Edgett K. S. and Malin M. C., *LPS XXXI*, no. 1073. [4] Scott, D. H. and Tanaka, K. L. (1986) USGS Map I-1802-A. [5] Bandfield, J.L., V.E. Hamilton, and P.R. Christensen (2000) *Science*, *287*, 1626-1630. [6] Komatsu G., *LPS XXXI*, no. 1451. [7] Chappelow, J.E. and Sharpton, V.L., (2003) *LPS XXXIV*, no. 1418, *this volume*.

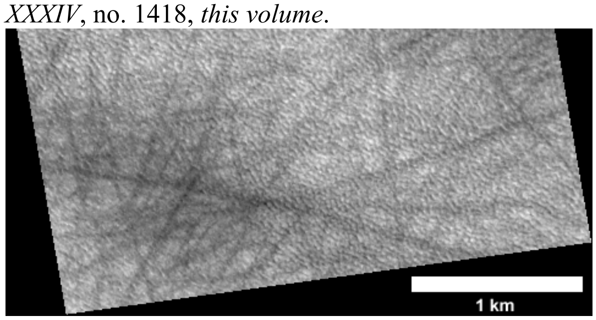

Figure 1. Section of MOC NA image M0001362 in northwest Acidalia Planitia. Note LF morphology and domal features.

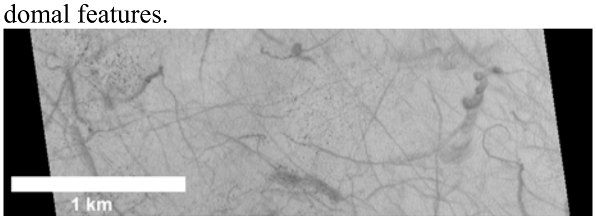

Figure 2. Section of MOC NA image M1003516 in Promethei Terra showing LF created by dust devils.

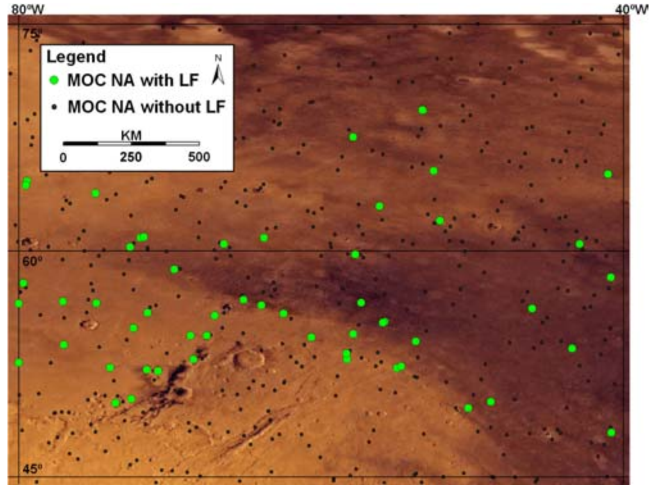

Figure 3. MOC NA image centroids with LF in the study area.

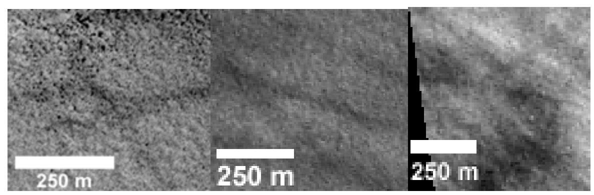

Figure 4. Possible horizontal offset (M0201131), vertical depth (M0301220, note illumination above and below LF) and truncated (M0200490) LF.

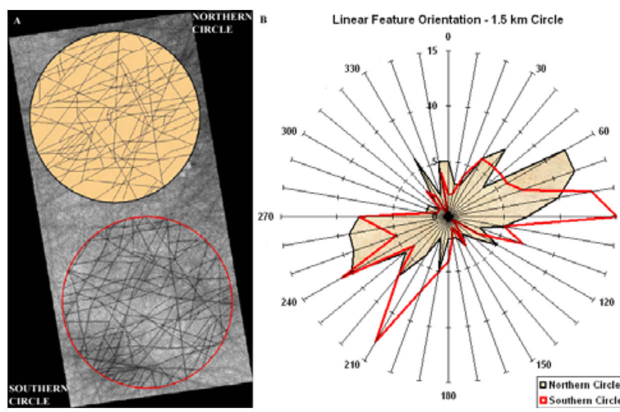

Figure 5a and 5b. 1.5km circles and rose diagram of LF trends in M0001362.

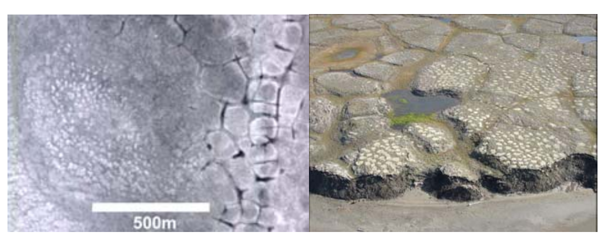

Figure 6. Vertical and oblique images of ice-wedge polygons and frost boils in Alaska. Photos: D. A. Walker, Alaska Geobotany Center.