THE GOLDSTONE MARS DATA: IS THERE REALLY EVIDENCE FOR MELTING? Zent, A. P., F. P. Fanale, Planetary Geosciences Division, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, HI. 96822; and L. E. Roth, Jet Propulsion Laboratory, Cal. Inst. Tech., Pasadena, CA. 91009.

The 1971 and 1973 Goldstone 12.6-cm radar coverage of Mars are separate data sets which include reflectivity as a function of latitude, longitude and season. The data are discontinuous, incomplete and irregularly spaced through independent variable space. It has been argued that secular reflectivity variations might be reflected in the data (1,2), and that those variations might be consistent with origin by subsurface melting (3,4). We are examining the reflectivity in both data sets to see if the subsurface melting model is compatible with the observations.

The reflectivity of the surface is a function of longitude, latitude, and (possibly) season. The subsurface melt volume, which we would like to predict and compare to reflectivity, is a function of insolation (i.e., latitude and season); surface thermal properties (latitude and longitude via Viking), and the depth and thermal properties of the putative brine. There are too many variables available to effectively evaluate melting models. We would like to remove latitude and longitude as variables, as they carry with them some idea of the surface thermal properties, which have been measured by Viking. Our first goal then is to find locations on the planet where reflectivity is a particularly strong function of season.

We chose two separate methods for this determination, one which is as rigorous as possible, and one which makes more allowances for the incomplete nature of the data set.

The data collection and calibration procedures have been reviewed (5), and an upper estimate of 5% in the uncertainty of the reflectivity measurements has been reported. In any event, the relative uncertainty in the reflectivity is expressed by the standard deviation calculated for each reflectivity solution in the data set. In order to establish greater confidence in our results, we excluded from analysis all reflectivities, ρ, for which $\sigma_\rho/\rho > 0.4$. We also excluded all reflectivity solutions that correspond to a calculated C-factor less than 500. Very low C-factors result from flat angular power spectra, whose peaks are difficult to fit with confidence.

We have attempted to analyze the experimental error, the variation in the data set not accounted for by differences between measured samples. We construct autocorrelograms of the reflectivity measurements in the 1971 and 1973 data sets (Figures 1 and 2). Collocated, simultaneous measurements should have a correlation of 1; to the degree that the extrapolated correlation coefficient at zero lag differs from 1, we have a measure of the experimental error. Correlations of ~0.95 at zero lag in both data sets indicate that the experimental errors, are less than ~ 10%. Given two separate estimates of the experimental error, we conclude that there is no *a priori* reason to discount reported reflectivity variations, provided the reported reflectivity increase is greater than 10% of the absolute value.

Our rigorous method of mapping reflectivity variation consisted simply of plotting all reflectivity pairs which overlap by greater than 50% of their resolution cells, and in which the later measurement exceeds the earlier by greater than 10%. The mapping was conducted for the 1971 and 1973 data separately. We find that there are broad regions, particularly in the 1971 data set, where reflectivity appears to increase by greater than 10% over the course of data acquisition. However, only in the region 120° - 125° W (southern Tharsis) do reflectivities appear to increase by greater than 10% in both 1971 and 1973. We find on closer examination of this region that average reflectivities in both years are less than 3%. This result is cause for concern, because we can find no realistic configuration which might cause such low reflectivities. Thermal analysis of the reflectivity increase, (which in the 1973 data takes place well after perihelion, when the surface heat balance is strongly negative), indicates that no combination in depth-eutectic space will produce an increase in melt volume during both years. As any postulated reconfiguration of the system would be completely *ad hoc,* we conclude that the Tharsis anomaly, if real, does not indicate the presence of a seasonal brine.

We attempted to map variations in the reflectivity over the course of each observing run more generally. We divided the area over which data was acquired into 144 3° x 5° resolution cells. Within each resolution cell, we calculated the value of a parameter $Z = \sqrt{N} \times R$ where N is the total number of reflectivity measurements in the resolution cell and R is the correlation coefficient of reflectivity v. time. Z is used only as a relative measure of our confidence that the data indicate a reflectivity increase. Two of the maps are shown in figures 3 and 4. In each data set there are 3 areas on the planet which might indicate a

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reflectivity increase. Two of those areas, Sinai Planum and the south rim of Valles Marinaris, repeat from year to year. Each year shows one peak that does not repeat.

Peaks 1 and 1': At 70 - 75° W, 14 - 17° S. The south rim of Valles Marinaris. There are no overlapping pairs which show reflectivity increase, but several closely spaced scans. The 1973 reflectivity increase again occurs long after the surface heat balance becomes negative. Thermal analysis indicates that no depth-eutectic configuration will satisfy both the 1971 and 1973 increase simultaneously.

Peaks 2 and 2': The famous "Solis Lacus Radar Anomaly" 85- 95° W, 14 - 17° S. Western Sinai Planum. At least one overlapping scan in 1973 shows a reflectivity increase of almost 50%. Several closely spaced scans are consistent with a 50% increase. Again, however the 1973 increase occurs between L_s 280 and 295°, at a time when the surface is rapidly cooling. This case is particularly difficult to reconcile with melt production because a 50% increase in reflectivity would require an increase of 10 vol. % throughout the volume being sensed (6) during a period in which the top 50 cm of the regolith are cooling. Again, we find no simultaneous solution for both years.

Peaks 3 and 4: Peak 4 is the previously mentioned "Tharsis" anomaly; we will not discuss it further. Peak 3 occurs in the 1971 data only, at 320 - 325° W. The absence of a peak in the plot of the 1973 data cannot be attributed to a lack of data; there is no reflectivity change in that longitude band in the 1973 data. We continue to investigate this region.

It is not possible to preclude the possibility of subsurface melting on Mars, based upon our examination of the data thus far. Comparison with models of the subsurface thermal regime indicates that, while there is evidence for secular reflectivity variations in the Mars radar data, those variations are not consistent with the anticipated pattern of melt production in the martian subsurface.

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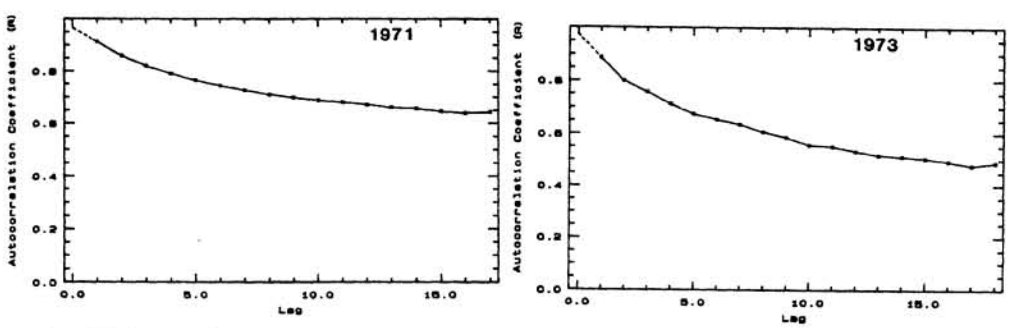
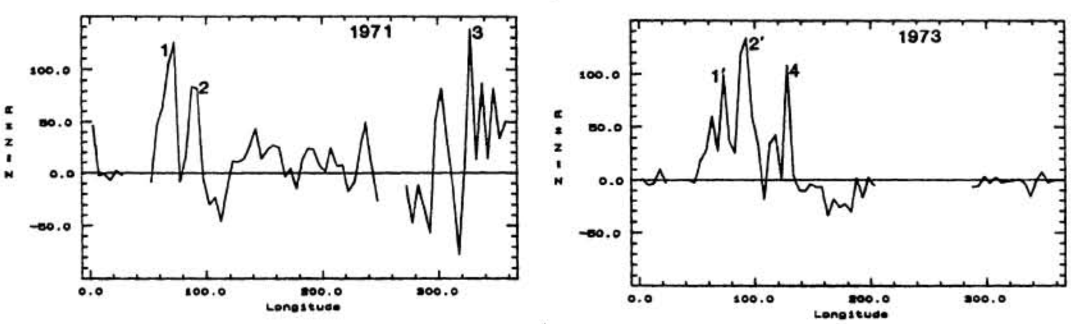


Figures 1 and 2: Autocorrelograms of the 1971 and 1973 data. They indicate that experimental error is less than 10% for both data sets, and that more than half of the variance in the data is present at scales larger than 2.5° (15 lags).



Figures 3 and 4: Map of N measurements per 3 by 5° box times R the correlation of reflectivity with time within each box. the latitude range is 14 - 17° S. The peaks are discussed in the text.

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