A REPORT ON MARTIAN ATMOSPHERIC WATER VAPOR NEAR OPPOSITION, 1969

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Abstract. Little variation in Martian atmospheric H_2O abundance was observed during three months prior to the 1969 opposition.

This report covers the dates February 10 through April 25, 1969. Twenty coudé spectroscopic plates of Mars in the λ 8200 water vapor band at a dispersion of 2 Å/mm were taken by Dr. Ronald Schorn and the author with the 82-inch telescope of the McDonald Observatory. The best 10 of these plates have been reduced to give an abundance of water vapor in the Martian atmosphere. Several were of sufficient density to allow reduction of partial widths of the spectrum; and, since a pole-to-pole orientation of the slit was used for most plates, this enables one to determine a water vapor abundance in both the northern and southern hemispheres. Plates number 6132 and 6150 were not taken with an image rotator, and the slit trailed from parallel to the equator to about 45° from the equator. These plates therefore give an abundance of water vapor for northern and southern equatorial regions.

The abundances were determined using a curve of growth for Voigt profiles with small *a* values (implying a small Doppler half-width). The line strengths, taken from a recent experimental determination by Farmer (1971) vary as a function of temperature; the temperature of 225 K used in this reduction was adopted from an earlier study of plate number 6132 by Schorn, Farmer, and Little (1969). A presssure of 6 mb was adopted because the water vapor should be found near the Martian surface. The effective airmass was estimated for each tracing. The estimates of airmass could cause errors of as much as $\pm 20\%$ in the derived abundance, but the errors in airmass should cause little change in the relative abundance difference between the northern and southern hemispheres.

Density tracings of all the plates and partial widths of spectra on the plates were made with the Grant microdensitometer at the Astronomy Department of the University of California at Los Angeles. Equivalent widths were reduced from the tracings by two means: (1) the characteristic curve of the emulsion was plotted and points on the line profile were reduced to intensity, and (2) the square-counts of the Martian water vapor lines were calibrated to equivalent widths by referring them to a plot of equivalent width versus square-count for solar lines on the same plate. The two processes gave similar results, so the first method was used to reduce most of the plates.

The Doppler shift during February and March of 1969 was greater than 0.40 Å, and the terrestrial water vapor contribution was small enough to allow a clear separation of the Martian component (Figure 1). During April the separation became more difficult to detect because of the declining Doppler shift and because the telluric

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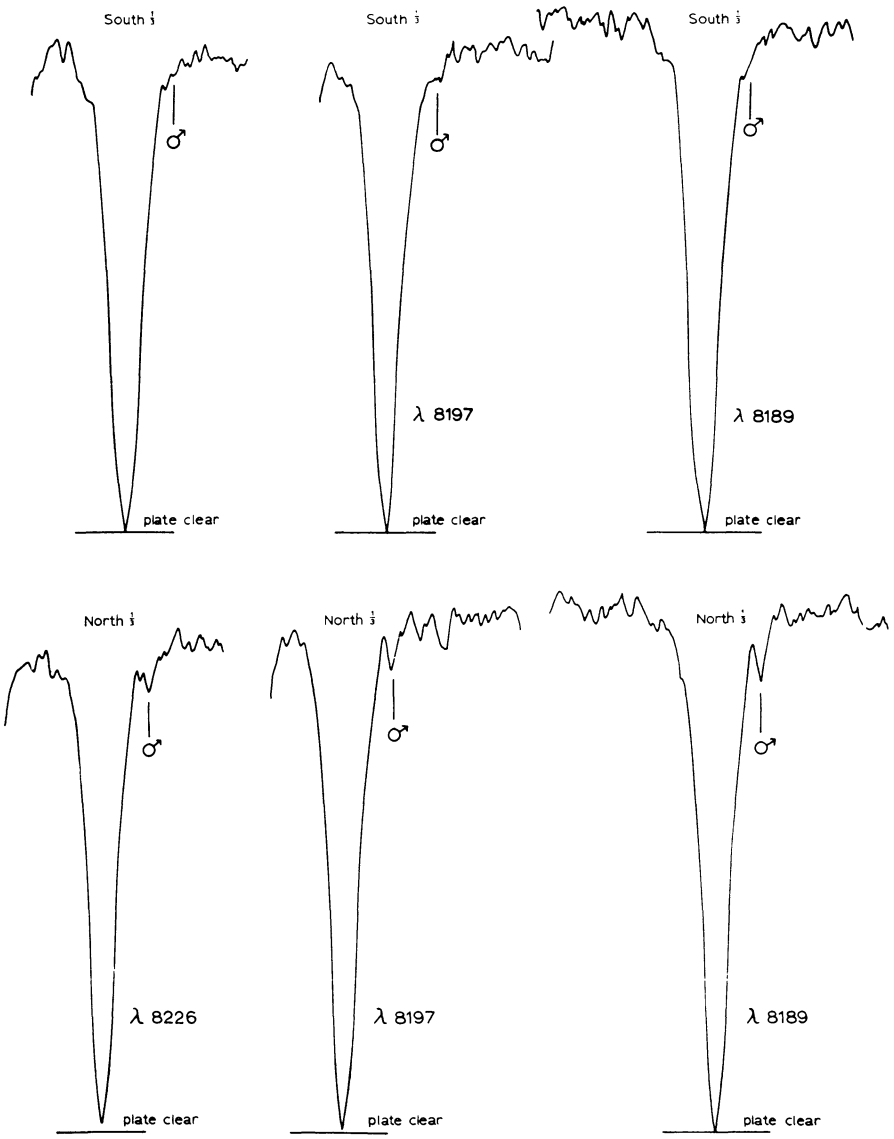

Fig. 1. Density tracings from plate number 6147 of the northern (1b) and southern third of the planet Mars on March 27, 1969. The lines shown are λ 8189, λ 8197, and λ 8226 Å.

water vapor lines were broader. Plate number 6163 is the only good plate that was taken late in April. The error in equivalent width for an average individual line must be near ±50% on the better plates, and there is a possibility of spurious detection of lines on the poorer quality plates. The error of an abundance derived from 5 or 10 lines will be smaller than the error of any one line, so it is felt that the relative accuracy of the northern and southern hemisphere abundances is within ±20%. The uncertainty

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in the airmass estimates plus the equivalent width uncertainty means that the absolute abundance from any plate is probably uncertain by $\pm 50\%$.

The results are listed below in Table I. The derived abundances are subject to the

TABLE I

Water vapor abundance in microns

Plate no.	North polar	North equat.	Equat.	Whole plate	South equat.	South polar	Date
6094	43			32		24	2/10/69
6132		26			< 10		3/7/69
6146	40		33			30	3/27/69
6147	21		24			< 10	3/28/69
6149				46			3/29/69
6150		49			21		3/30/69
6152	39					< 10	4/1/69
6156				31			4/5/69
6159				33			4/7/69
6163	29		36			30	4/24/69

uncertainties described above. Figure 1 shows density tracings of the northern and southern one-third of Mars for plate number 6147 for lines λ 8189, λ 8197, and λ 8226. The presence of a Martian component in the northern tracing is easily seen, and the absence of any strong component in the southern tracing contrasts sharply with the northern tracing. Figures 2, 3, and 4 show the results from Table I plotted for the northern, equatorial (and whole plate), and southern abundances respectively.

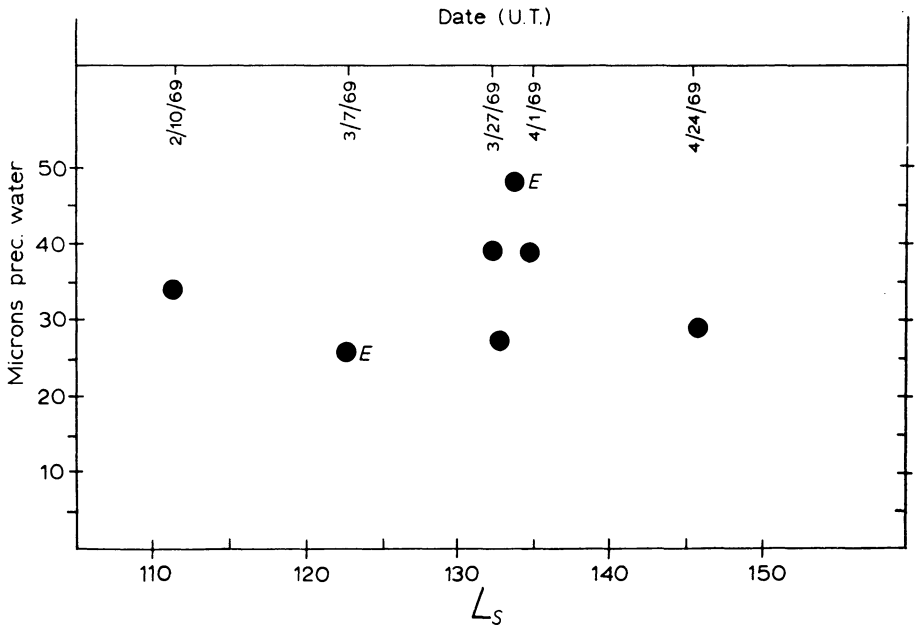

Fig. 2. Abundance of water in north polar region of Mars. The north equatorial results are indicated by an *E*.

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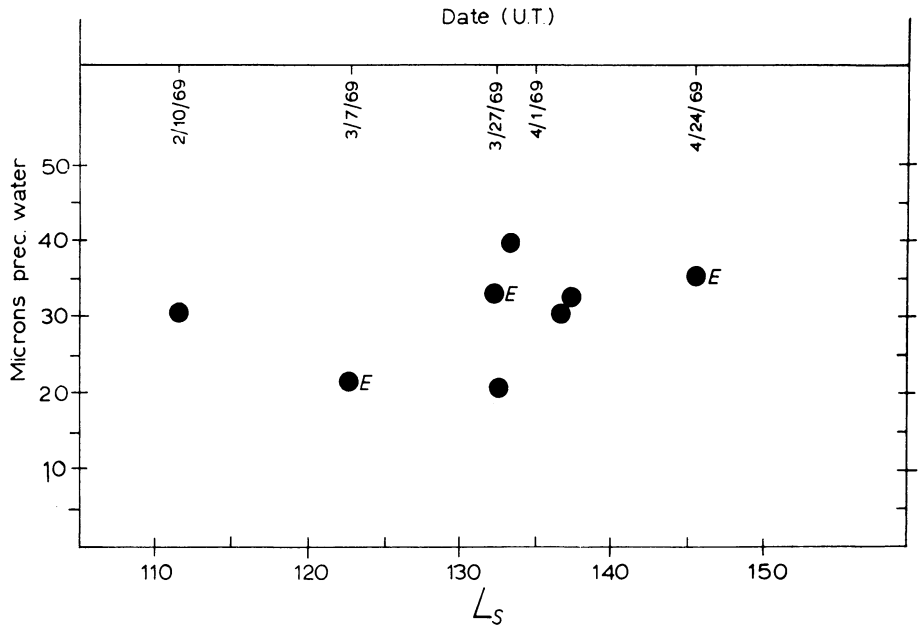

Fig. 3. Abundance of water on the whole disc of Mars. If the abundance is only for the equatorial region, this is indicated by an *E*.

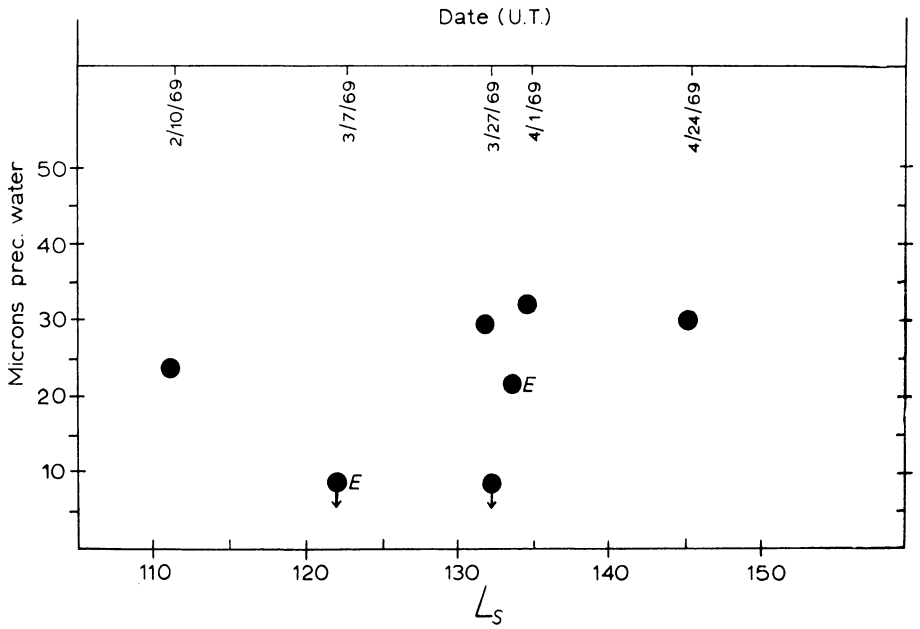

Fig. 4. Abundance of water in south polar regions of Mars. The south equatorial regions are indicated by an *E*.

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Considering the errors involved it appears that not much evidence exists for a variation of Martian water vapor abundance during the time span under study. The results of Owen (1969) in late February support this conclusion as do those of Tull given earlier in this conference. There is a definite predominance of water vapor in the northern hemisphere of Mars during this time in agreement with Tull's report.

Several good plates of the water vapor region have been recently obtained at McDonald Observatory with both the 82-inch and 107-inch telescopes. None of these plates show any trace of Martian water vapor upon visual inspection. The Doppler shift is not great, but it is felt that lines with an equivalent width corresponding to an abundance of 15 μ would have been seen had they been present. The Martian water vapor has apparently disappeared or decreased during opposition.

Acknowledgments

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