

USING HIGH SPECTRAL RESOLUTION SPECTROPHOTOMETRY TO STUDY BROAD MINERAL ABSORPTION FEATURES ON MARS; D. L. Blaney and D. Crisp, Jet Propulsion Laboratory, California Institute of Technology, MS183-501, 4800 Oak Grove Drive, Pasadena, Ca 91109.

Traditionally telescopic measurements of mineralogic absorption features have been made using relatively low to moderate ($R=30-300$) spectral resolution. Mineralogic absorption features tend to be broad so high resolution spectroscopy ($R>10,000$) does not provide significant additional compositional information. Low to moderate resolution spectroscopy allows an observer to obtain data over a wide wavelength range (hundreds to thousands of wavenumbers) compared to the several wavenumber intervals that are collected using high resolution spectrometers. However, spectrophotometry at high resolution has major advantages over lower resolution spectroscopy in situations that are applicable to studies of the Martian surface, i.e. at wavelengths where relatively weak surface absorption features and atmospheric gas absorption features both occur.

The nature of weak absorption features can be easily identified at wavelengths at or near regions where atmospheric absorptions also occur using high resolution spectrophotometry. At high resolution, individual atmospheric lines can be resolved removing any ambiguity about whether a feature is caused by an atmospheric gas or by a mineralogic feature. This is applicable in the 4 - 5 μm region where there is absorption, emission, and scattering by atmospheric CO_2 (4.3 and 4.8 μm), CO (4.6 μm), and water vapor (> 4.8 μm).

A weak absorption feature (5-10% band depth) has been observed near 4.5 μm and has not been reproduced in models by atmospheric gases [1,2,3]. Sulfate minerals have strong absorptions around 4.5 μm caused by the $2\nu_3$ overtone of the sulfate fundamental [4]. The observed feature however, does not match the measured spectra of known terrestrial sulfate minerals [1,2,3] so the identification of this feature remains tentative. Analysis of this absorption feature's band depth and shape is problematic because it lies on the wing of the 4.3 μm CO_2 band. The continuum is defined not only by the albedo outside the absorption band but also by the atmosphere.

In addition to the problems encountered in the study of a mineralogic absorption feature in the wings of an atmospheric band, analysis is further complicated because the measured light includes similar contributions from reflected solar radiation and emitted thermal radiation. Thermal masking of mineralogic absorption features may occur. Even strong surface albedo features near 4.5 μm will not produce deep spectral features because reductions in the reflected solar flux are almost completely compensated by increases in the emitted thermal flux (Kirchoff's Law) at high temperatures ($T \sim 270$ K). At slightly lower temperatures ($T \sim 250$ K), thermal emission tends to subdue surface absorption features making them more difficult to detect [2,3]. Therefore, a technique

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which separates atmospheric gas absorptions from albedo changes caused by mineralogy would be useful in better understanding the optical properties of both the surface and the atmosphere.

High spectral resolution spectroscopy answers this need. Rather than covering a broad wavelength range, several limited wavelength regions are selected to address specific questions about a known absorption feature. These wavelength regions must be selected carefully using not only lower resolution spectra of the absorption feature but also detailed knowledge of the line structure of the atmospheric gases. At high resolution, individual atmospheric gas lines are resolved, eliminating doubt about whether it is a gas or mineralogic absorption. The continuum produced by surface absorption between the lines is well defined and the atmospheric gas portion of the spectra is distinct. The small windows of transparency between the lines provide direct information about the mineralogy of the absorbers. Atmospheric modeling is also easier as individual line strengths of different gases can be measured in the spectra.

References: [1]. Blaney, D.B. and T.B. McCord, submitted to *J. Geophys Res.* 1992. [2]. D. Crisp and D.L. Blaney, *MSATT Meeting*, Boulder, Co, Sept. 1991. [3]. Blaney, D.L., and D. Crisp, *Bulletin of the American Astronomical Society*, Vol.23, No.3, p 1183, (1991). [4]. V. Farmer (ed.) *Mineralogical Soc. of London Monograph 4*, London England, 427, 1974.