NEAR-INFRARED (1.3-4.0 μm) IMAGING SPECTROSCOPY OF MARS; James F. Bell (Planetary Geosciences Division, University of Hawaii, Honolulu 96822) and David A. Crisp (JPL/Caltech MS 169-237, Pasadena CA 91109).

Introduction: Many researchers have measured the near-infrared (near-IR) spectrum of Mars from groundbased and airborne telescopes over the past 35 years [*e.g.* 1-5]. In addition, Mariner 6 and 7 and more recently the Phobos-2 spacecraft have obtained near-IR spectral data of Mars [6-10]. These measurements have (a) shown that Mars has a very deep (≈ 80%) hydrated mineral absorption feature near 3.0 μm [1-7]; (b) provided some constraints on the abundance of certain atmospheric constituents and on limonite-like ferric oxides and oxyhydroxides on the martian surface [2-4]; and (c) shown that carbonates are not a spectrally important constituent of the optical surface of Mars [9,10]. All of these data have been spatially limited, however. In the case of the groundbased and airborne telescopic studies, the published spectra have been either for the whole disk of Mars or for very large regions (≈500-2500 km). The spacecraft data have been of higher spatial resolution, but of very limited spatial coverage. Recent advances in 2-dimensional infrared array detector technology are eliminating these spatial limitations, however, and imaging spectroscopy is becoming an increasingly more powerful tool in groundbased and spacecraft planetary astronomy. In this abstract we report preliminary results of the first groundbased near-IR imaging spectroscopy measurements of Mars, covering the entire western hemisphere of the planet at 50-100 km spatial resolution and 0.9-1.4% spectral resolution from 1.3-4.05 μm.

Data Set: We observed Mars with the ProtoCAM instrument on November 15-17 UT, 1990, at the NASA 3.0-m Infrared Telescope Facility at Mauna Kea Observatory. ProtoCAM has a 58X62 InSb array and 3 cooled CVFs sensitive from 1.3-5.8 μm. We obtained images of the entire martian disk in 58 colors from 1.3-2.5 μm (0.9% spectral resolution) and in 25 colors from 2.9-4.05 μm (1.4% spectral resolution). We were unable to take data beyond 4.05 μm due to increased thermal flux and subsequent detector saturation. Figure 1 shows a sample of 6 of the 83 colors obtained on November 15 UT. Mars was in late northern winter (L_s = 333°), had an angular size of 18 arcsec, and was at a phase angle of 12° (2 weeks before opposition). The data have undergone standard CCD-type data reduction, but have not yet been calibrated to reflectance or normal albedo.

Results: *(a) Surface Albedo.* Albedo features on Mars in the 1.3-3.5 μm region are nearly identical in form to those seen in the visible. Prominent features in Figure 1 include the dark regions Solis Lacus, Margaritifer Sinus, and Mare Acidalium. Bright regions include Tharsis and Chryse. Some evidence of the residual south polar cap can also be seen, especially near 1.5 μm and 2.5 μm. Bright/dark region contrast in the near-IR ranges from about 2.0 at 1.3-1.5 μm to a peak of 2.8 near 2.0 μm and then decreases to 2.0 again near 3.5 μm. Typical bright/dark values are 2.0-3.0 in the visible [11-13]. Only beyond ≈ 3.7 μm does the contrast begin to decrease significantly (bright/dark =1.3 at 4.0 μm) as the thermal flux from the martian surface increases.

(b) Polar Water Vapor/Ice. The presence of hydrated minerals and of water vapor/ice on Mars has been known spectroscopically for some time [3-7,14,15]. Figure 1, and the enlargement in Figure 2, provide the first groundbased imaging evidence of the distribution of atmospheric water on Mars. From 2.9-3.3 μm the polar region of Mars north of +50° is "cut off" due to absorption by H_2O. This effect is much weaker but also evident for the south pole. These regions of deeper H_2O absorption correspond with bright polar "hoods" seen in 0.4 μm images also obtained during this opposition [16]. Apparently, the water abundance at the north pole has increased as high altitude ice is advected toward the pole from lower latitudes. Further observations such as these during upcoming oppositions will be useful in monitoring the seasonal migration of martian atmospheric water.

(c) Variations in CO and mineralogy. Another advantage of imaging spectroscopy is its ability to depict compositional variations in a spatially coherent form. For example, in order to investigate spectral variability on Mars associated with the 2.33 μm CO absorption [17,18] we registered (by cylindrical map projection) and ratioed two Mars images at 2.31 and 2.33 μm. In the resulting ratio image (Figure 3), bright regions correspond to more absorption at 2.33 μm (by 5-15%) than gray or black regions. More importantly, the bright regions do not form a random pattern: instead they directly correlate with lower altitude topographic and geologic features such as Valles Marineris. Further study of diagnostic ratio images such as these and intercomparisons with Mariner, Viking, and Phobos 2 geologic and topographic maps may allow us to distinguish between variations in atmospheric components and in surface mineralogy.

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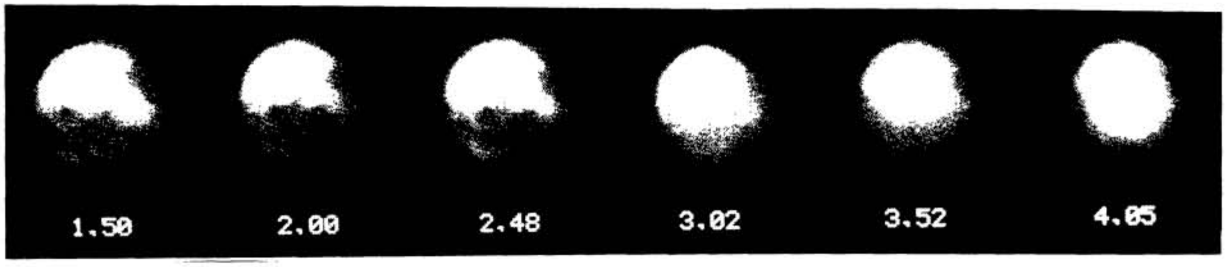

Figure 1: Mars in 6 of the 83 colors we obtained in our imaging spectrometer data set (wavelengths in microns).

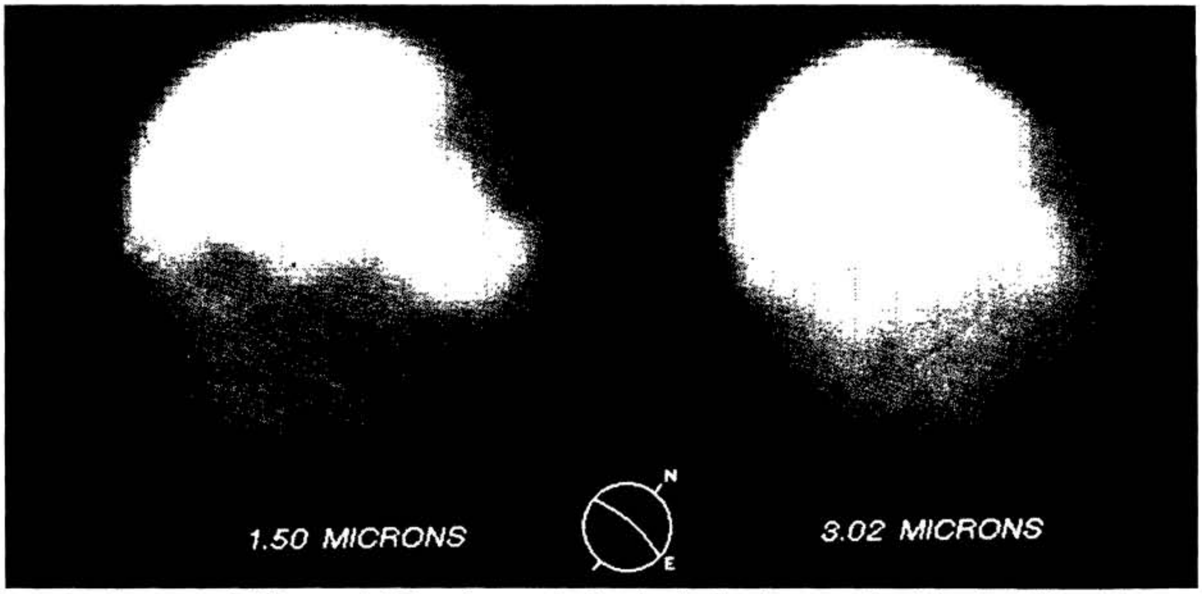

Figure 2: Enlargement of 1.50 μm and 3.02 μm images, showing, for the first time, groundbased imaging evidence of atmospheric water at the martian poles. Reflected solar radiation northward of +50° and southward of ≈ -80° is completely absorbed at 3.02 μm. This effect is much stronger in the north because of seasonal poleward advection of high altitude water ice (Ls=333°) [cf. 15].

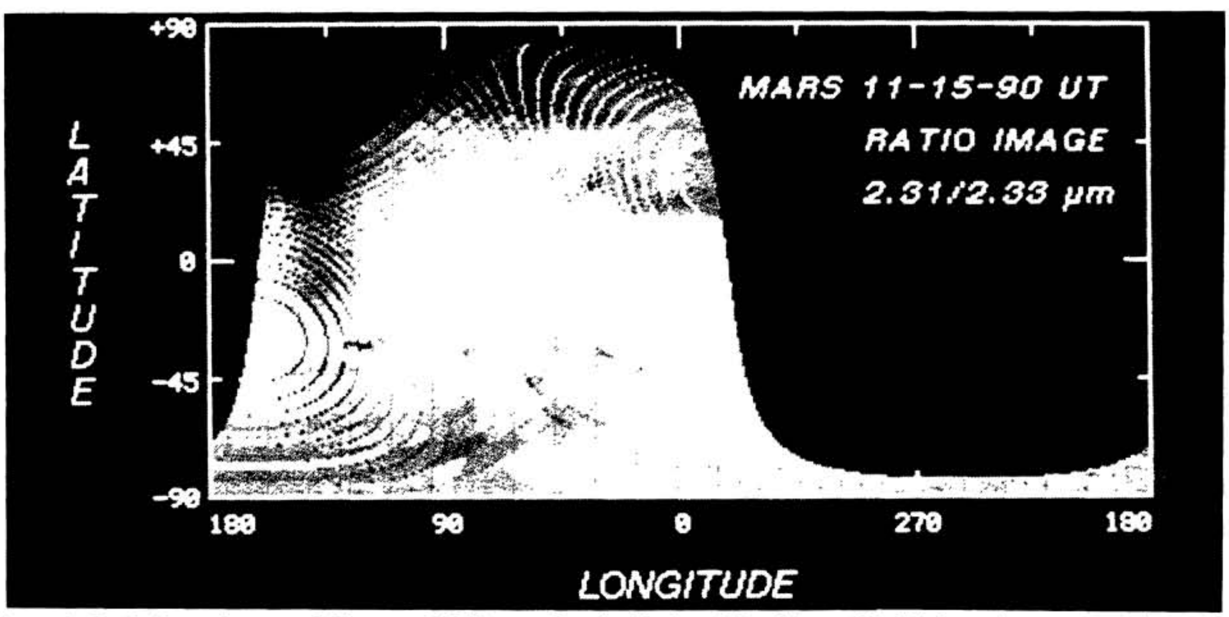

Figure 3: Ratio image between 2.31 μm and 2.33 μm. Stretch: black = 0.8, white = 1.2. Bright regions correspond to more absorption at 2.33 μm, interpreted here as greater CO abundance. These bright regions are highly correlated with topographic and geologic features such as Valles Marineris (labeled "b"), Ganges Chasma ("d"), Tempe Fossae ("c") and Argyre ("e"). The Tharsis plateau is at "a". The circular bands are an artifact of the map projection routine.