TIME VARIABLE SPECTRAL FEATURE AT APOLLINARIS PATERA, MARS.

Mark S. Robinson, Planetary Geosciences Division, University of Hawaii, 2525 Correa Road, Honolulu, HI, 96822; Milton O. Smith and John B. Adams, Department of Geological Sciences, University of Washington, Seattle, WA 98185.

Introduction

We identify and analyze a time variable spectral feature (spot) that occurs as two distinct patches on the northeast flanks of the martian volcano Apollinaris Patera (-8 lat, 186 lon) as shown in Fig. 1. This enigmatic spot is seen to wax and wane within the observations of the Mariner 9 and Viking missions and is distinct from other variable features reported in previous studies [1,2,3] because of its spectral characteristics and it is time variable on a scale of a few days. It is relatively bright across all the Viking Imaging System filters. Based on calibrated [4] Viking imaging data we investigate three possible origins for the spot; 1) compositional 2) photometric, and 3) cloud/meteorological.

Description of the Spot

The bright spot (Fig. 1) is seen in images from 5 of the 8 Viking orbits (Table 1) and not seen in the one Mariner 9 image (177A13). Other bright albedo features (bright unit) occur in the study area, but are not time variable. Within the observations of the Viking mission the spot, when it is seen, is relatively stable in shape and size. The spot is seen over a long time period (9/16/76 - 7/7/1980), is variable over a short time period (seen 2/16/1978, not seen 3/14/1978, seen 3/18/1978), and is not correlated with season (Ls). The spectral behavior of the spot from orbit 468S vs orbit 609A is quite unusual relative to the rest of region (from 468S to 609A there is a phase angle difference of 40). The Red vs Violet (Fig. 2) plot indicates the 3 units are relatively darker and redder at higher phase angle. The spot does darken at higher phase angle, but less than the surrounding area (Fig. 2). Most intriguing is its color shift relative to the rest of the area (Fig. 2). The violet radiance of the spot relative to the volcanics changes such that the spot has a lower radiance than the volcanics at lower phase and a higher radiance at higher phase.

Possible Explanations for the Spot

The multispectral images of the spot are all consistent with the same spectroscopic mixture model consisting of soil, rock and shade as proposed by Adams et al [5] from Viking lander multispectral images. Excluding shadows the volcano has nominal abundances of 80% soil and 20% rock. The spot, when present, is spectrally more soil like and when absent is more rock like. The minimum fractional change in areal abundance of the soil to cause the spot to appear in an image is 5% relative to the surrounding area. Analysis of spectral variation in other areas indicates other temporal compositional changes in soil/rock abundances for the different image acquisition times to be as high as 10%. Except for the spot, the dominant temporal variation is consistent with shading and shadowing caused by illumination and viewing geometry (e.g. phase/incidence angles). The relative lack of darkening of the spot versus the rest of the area as a function of increasing phase angle can be explained by a smoother surface (less shadow). These results are consistent with transport of an aeolian dust component which is spectrally similar to the soil endmember.

The possibility that the spot is the result of localized volatile release was considered but found to be inconsistent with the spectral mixture analysis. Similarly, the hypotheses that the spot is due to atmospheric changes is rejected because 1) the spot is of consistent size and shape over time 2) its spectral signature is much redder than observed clouds on Mars [6] and 3) it does not cast a shadow in low sun images. We are not able to suggest a physical cause to explain the brightening and reddening of the spot simply based on changes in lighting/viewing geometry.

Future Analysis

We are currently comparing our Viking Orbiter spectra of Apollinaris Patera with Earth based telescope spectra, Viking lander spectra, and laboratory spectra of analog materials to refine the nominal calibration of the Viking data. We are evaluating the calibration procedures and testing their effects on the observed spatial and temporal variations in composition in the Apollinaris Patera region to refine our models for the origin of this enigmatic feature and potentially tie it to the regional geology.

References

[1] Veverka, J. et al (1977) *JGR* 82 28 pp 4167-4187 **[2]** Briggs, G. et al (1977) *JGR* 82 28 pp 4121-4149 **[3]** Thomas, P., and Gierasch, P.J. (1985) *Science* 230, pp 175-177 **[4]** USGS Astrogeology (1987) *Planetary Image and Cartography System Manual.* **[5]** Adams, J. et al (1986) *JGR* 91 B8 pp 8098-8112 **[6]** McCord, T. B. et al (1982) *JGR* 87 B12, pp 10,129-10,148.

Figure 1. Digital mosaic of Apollinaris Patera from Viking orbit 088A. Black arrows indicate the time variable spot, white arrows indicate other bright features (not time variable) where spectra was measured , and letter v indicates locations where volcanic spectra were taken (see Fig. 2).

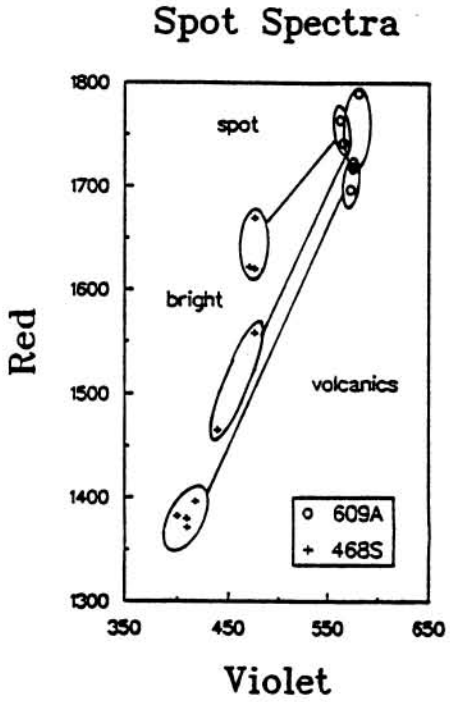

Figure 2. Spectral Behavior of three units (the spot, volcanics, and non-variable bright areas) in the Apollinaris Patera region. Lines between clusters indicate relative shift from low phase angle orbit (609A pha=28) to high phase angle orbit (468S pha=68). Each point represents an average of at least 9 pixels. Values are radiance units x 10,000.

ORBIT	EMA	INC	PHA	FIL	Ls	RES	SP
088A	44	38	82	C	123	192	Y
506A	09	38	39	VGR	359	585	N
609A	26	27	28	VCGR	48	835	Y
635A	23	79	94	R	59	250	N
639A	19	45	55	R	61	720	Y
646A	30	78	47	R	64	800	N
372S	42	48	83	R	86	233	B
468S	35	39	69	VBGRCmB	131	535	Y

Table 1. Viking Orbiter images covering Apollinaris Patera. EMA=emission angle, INC=incidence angle, PHA=phase angle, FIL=filter (V-violet, B-blue, G-green, R-red, C-clear, mB-minus blue) Ls=aerocentric longitude, RES=resolution m/pixel, SP=occurrence of bright spot (Y-yes, N-No, B-barely).