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Variable Features in the Valles Marineris Region of Mars

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Transient phenomena on Mars have long been recognized in Mariner [1-5] and Viking [6,7] images as well as in decades of Earth-based telescopic observations [e.g., 8]. These events are of interest because of the information they present on currently active meteorological and geological processes. Changes in surface albedo patterns and atmospheric conditions can also affect the analysis and interpretation of image data based on spectral or morphological properties of geologic units on the surface.

Sources of secular variability include the occurrence of condensate clouds, fog, frost and haze, and the deposition or erosion of surfacial materials by eolian processes. Albedo pattern changes caused by the transportation of dust and sand raise a number of important geological issues. First, are the albedo variations caused by deposition or by erosion? The darkening of a specific region might be caused by either deposition of dark sands or by the removal of a previously deposited bright dust layer, for example. Second, are the processes driving these changes cyclic or episodic in nature? This is particularly relevant since a cyclic deposition mechanism is believed to be responsible for the formation of layered sedimentary deposits found in the equatorial canyons and at the poles of Mars. Finally, where are the sources and sinks of the materials being transported?

In the course of examining low resolution apoapsis images as part of a program of spectrophotometric mapping of the Valles Marineris and environs, we have noticed a number of transient phenomena which occurred during the Viking mission. Early morning images often show the canyons filled with fog which partially or completely obscures the underlying topography (e.g., VO image 620A63). Surface frost deposits in the region have been interpreted by Neukum [9], but reliable criteria for their identification in spacecraft images have yet to be established. Condensate clouds are best recognized from their appearance in multispectral composites (e.g. images 583A34, 38, and 40) or their often distinctive wave morphology in monochrome images (as in 762A88).

Localized dust cloud activity in the region to the west and south of Echus Chasma was described by Martin and James [10]. Marked changes in surface albedo have also been noted in this area; transient bright streaks, perhaps genetically related to the dust clouds [10], were interpreted as depositional in origin [11]. Figure 1 shows the Echus Chasma region at 4 different times during the Viking mission from 1976 to 1980, each acquired while Mars was near aphelion ($L_s = 36^o$ to 102^o). These images show the evolution of a distinctly linear bright streak to the southwest of Echus, and are consistent with the interpretation [10] of eolian deflation of a bright dust deposit.

A much larger scale albedo change occurred on the plains to the south of Eos Chasma. Figure 2 compares two image mosaics constructed from data obtained by Viking Orbiter 1 during orbits 544 (top, December 1977) and 1334 (bottom, February 1980). Each mosaic covers an area of about 1500 km by 700 km. An area of some 300000 km^2 was affected by the change, most of which occurred between January and April 1978 ($L_s = 40^o$ - 70^o, just before aphelion). On the basis of the limited Mariner 9 and Viking data available, the change is believed to be episodic in nature. Mariner 9 A-camera images (e.g. 05596748) show the region to appear in 1972 much as it did in 1977, prior to the change. Viking continued to observe the area for another full Martian year after the event, but the plains south of Eos remained dark.

The mechanism responsible for this albedo pattern change is currently under investigation. Generation and subsequent transportation and deposition of dark sands has been interpreted in the Valles [12], however the removal of a bright dust layer is more consistent with the rapid time period of the change (about 2 months) and with preliminary multispectral mapping results which suggest that the dark streak south of Eos and Coprates Chasmata is spectrally distinguishable from the dark saltating materials found elsewhere in the canyon system. If a layer of bright dust was removed to affect the albedo change, questions concerning how such micron-sized particles are mobilized by winds during a normally quiescent season (southern hemisphere Autumn) should be addressed.

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Figure 1: Variable features near Echus Chasma. Changes in albedo patterns (arrows) and dust/condensate cloud activity (C) discussed by Martin and James [10]. Images acquired by Viking Orbiter 1 during revolutions (1) 40, July 1976; (2) 583, January 1978; (3) 701, May 1978; (4) 1334, February 1980.

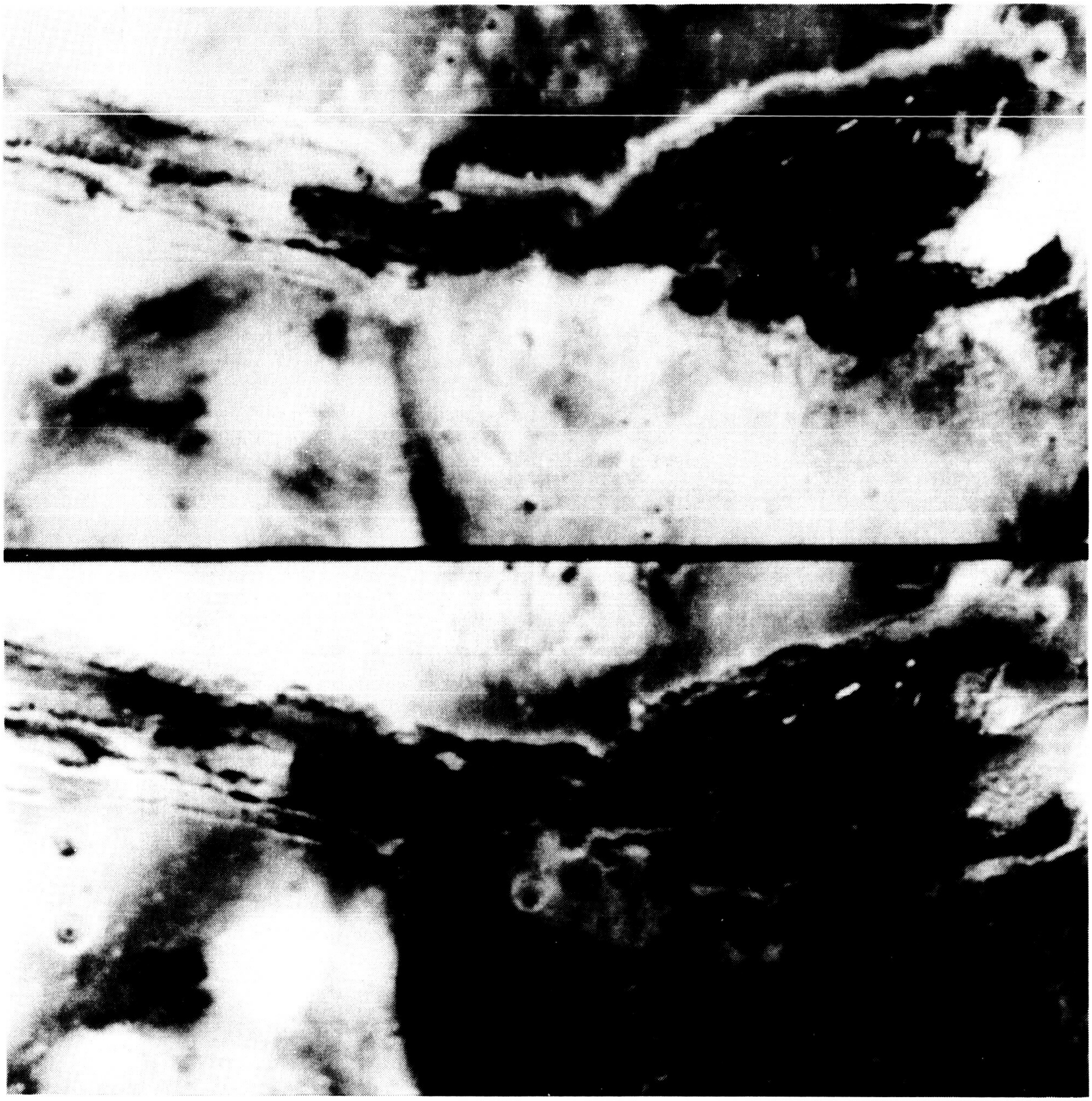

Figure 2: A large scale albedo change on the plains south of Eos Chasma. Each image mosaic covers approximately 1500 km by 700 km. Top: VO 1 orbit 544, December 1977. The dark spot near the north rim of Coprates Chasma is the shadow of Phobos. Bottom: VO 1 orbit 1334, February 1980. The area affected by the change is close to 300,000 km^2.

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