MOTTLED TERRAIN: A CONTINUING MARTIAN ENIGMA; D.H. Scott and J.R. Underwood, (1) U.S. Geological Survey, Flagstaff, Ariz. and (2) Kansas State University, Manhattan, Kansas

The northern lowlands of Mars are largely covered by plains materials that overall are mottled light and dark, a characteristic that is apparent on both Mariner and Viking images. The mottled terrain material (1) that makes up most of the northern lowlands is probably the most ambiguous material on all Martian images (2). Early studies, e.g., (3), used Mariner 9 images, which showed a hummocky, mottled surface encircling the planet between about lat 50° and 70° N. The Mariner pictures were degraded in this zone by atmospheric haze and high sun angles, which blurred them and produced high albedo contrasts; because significant morphologic variations were not recognized, the entire region was mapped as mottled plains material, a single geologic unit. Although image quality was poor, the mottling of the plains could be seen to result from albedo contrasts between numerous bright crater-ejecta blankets and dark intercrater plains material; also contributing to this effect were many dark-crested knobs, some having long, narrow, bright windstreaks or summit craters with bright interiors. The mottled plains were variously interpreted to consist of lava flows and knobby remnants of the highlands to the south (3), eolian and volcanic materials (4,5,6), ancient terrain and pedestal craters exhumed by wind erosion (7), eolian material cemented by permafrost (8), or volatile-rich deposits (9).

Debris mantles, suggested by (1) to have been derived from polar deposits, are distributed more or less symmetrically around the poles, extending as far as 30° toward the equator. These authors further suggested that the northern hemispheric mantle blankets the mottled plains and masks small (≤10-km diameter) craters on both young and old terrains.

I have described several geologic problems in the Martian northern plains, including that of the origin of the mottled material (2); I suggested that the plains "... may be an eroded remnant of the highlands that have survived a tectonic period of crustal separation caused by drifting or downfaulting followed by erosion."

The presence of lobate debris aprons, concentric crater fill, and terrain-softening poleward of lat 30° N. and S. suggested to (10) that topography in these regions has relaxed through quasi-viscous flow in ice-rich surface and near-surface materials. Support for this idea was provided by theoretical studies (11), which showed that ground ice should be present on Mars at middle and high latitudes. Dial (12) thought that permafrost and highly altered volcanic materials form the mottled plains.

Recent global geologic mapping of Mars (13,14,15), using high-resolution and high-quality Viking images, has subdivided the mottled terrain as originally mapped (3) into four members that constitute the Vastitas Borealis Formation of Late Hesperian age. The members intergrade and are largely distinguished by secondary morphologic characteristics, such as pronounced albedo contrasts, whorled patterns of ridges, knobby hills, and irregular troughs having polygonal outlines in places. Although the formation has been postulated to consist of lava flows, fluvial

deposits, and eolian materials within a permafrost zone (13), its surface is highly degraded, and the composition and origin of its component members remain uncertain.

Mapping problems still exist where image quality and resolution are adequate to determine textural characteristics of individual units but do not reveal the nature of their boundaries, stratigraphic relations, modes of formation, and processes responsible for their characteristic morphologies. The mottled plains material, as originally mapped and recently subdivided into members of the Vastitas Borealis Formation, continues to remain the most enigmatic geologic material in the northern hemisphere of Mars. Clarification of the origin of the mottled plains is critical, because this large, low, comparatively flat and unobstructed region may well provide the most suitable locations for successful landing and sample-return missions on Mars.

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