RELATION BETWEEN GULLYING AND CRATER DEGRADATION IN THE MARTIAN UPLANDS; D. E. Wilhelms and R. J. Baldwin, U.S. Geological Survey (MS-946), Menlo Park, CA 94025

Degraded deposits apparently are superposed on much of the ancient cratered basement of Mars. Their many styles of modification (chaos, knobs, frets, fretted channels, gullies, "outflow" channels, etc.) indicate that their coherence was lost when a cementing material was removed. That this material was ice is suggested by the probable fluid-flow origin of the gullies and other channels [1-8]. As part of a study of the lithology, thickness, and spatial and stratigraphic variation of the upland deposits [9], we here summarize a study of crater degradation directed mainly at elucidation of the gullies (a term we prefer for these small, clustered channels [1] to such common synonyms as "valley networks" and "runoff channels" [4-7]).

We investigated the relation between degree of crater degradation and extent of gullying in two regions that have distinct geologic styles (Fig. 1). MC-22 NE (region 1 of [9]) is densely gullied and appears deeply buried by gullied deposits, whereas MC-16 SW is an almost ungullied region in which parts of ancient basins seem relatively well exposed. Crater size-frequency curves confirm these qualitative impressions (Fig. 1). MC-16 SW has more total craters than MC-22 NE, as would be expected if MC-16 SW has fewer deposits thick enough to bury craters. Furthermore, fresh (relatively unmodified) craters are far more numerous, and intermediate (softened but exposed) craters somewhat less numerous, in MC-16 SW than in MC-22 NE; intermediate craters smaller than 20 km in diameter are particularly sparse in MC-16 SW. These differences indicate that the almost ungullied region MC-16 SW has undergone less degradation of all kinds than MC-22 NE. The degradation in MC-16 SW may also have ceased before that in MC-22 NE, although the effects of age are hard to distinguish from those of degree of degradation. Thus, gullying seems to require the presence of a thick upland deposit.

Gully formation has recently been ascribed to interaction with ground ice of hot springs that originated from the impact melts of ancient craters [10]. We agree that lateral variations in gully density [2,5,9] suggest that the gullying has an internal and not an atmospheric cause [10]; however, our observations contradict the conclusions of [10]. (a) The most numerous craters in such gullied regions as MC-22 NE are those whose ejecta is buried by gullied deposits; because impact heating normally affects only preimpact materials, this stratigraphic relation would require either that the hot springs persisted for an unreasonably long time or that all the craters and deposits formed in a geologic instant. (b) The total number of craters is inversely, not directly, proportional to the density of gullies in each area. (c) Early impacts could not lead to the area-to-area variations in numbers of gullied fresh craters. (d) Although some gullies originate near craters [4, p. 136], most show no such relation but rather occur in broad intercrater tracts [4, p. 137]. Thus, the mechanism proposed by [10] is unlikely to be a major cause of gullying.

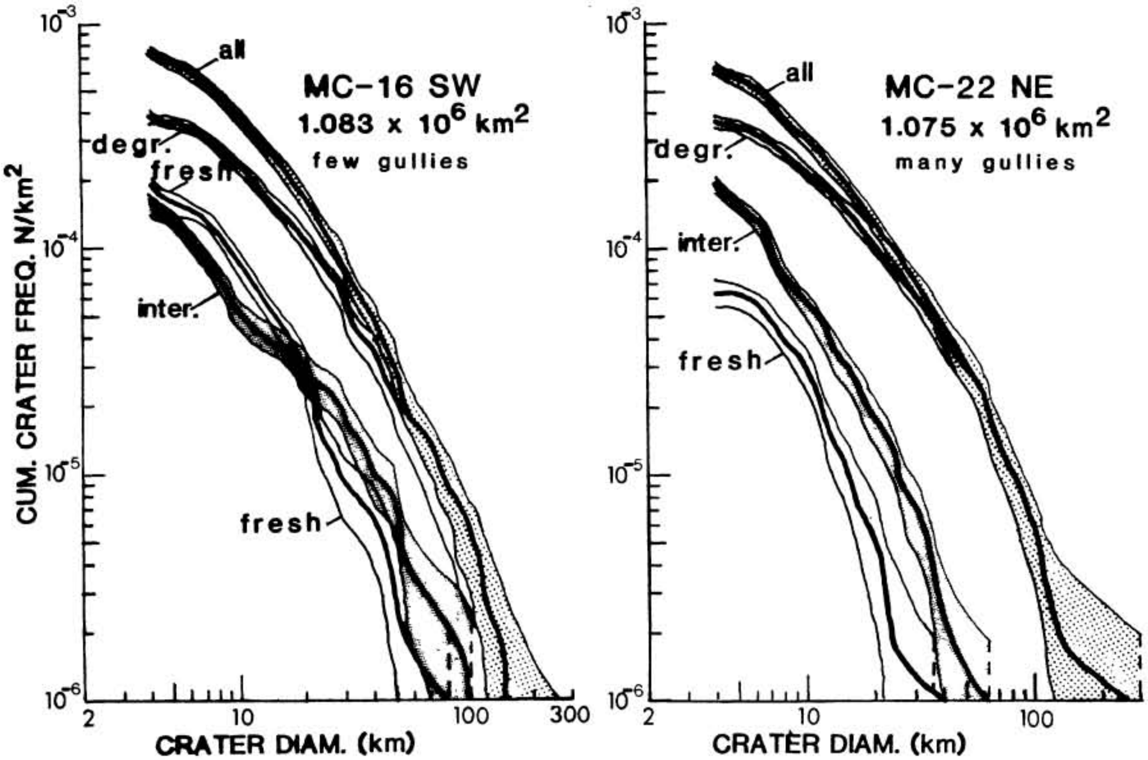

Fig. 1. Cumulative size-frequency distributions of three degradational classes of Martian craters ≥ 4 km in diameter. Fresh, ejecta and secondary craters appear unmodified at the scale of photographs in the mosaics; intermediate, ejecta visible but gullied or otherwise modified; degraded, no visible ejecta except immediate rim flank. Solid lines connect data points; envelopes connect end points of 1-sigma error bars.

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