CENTRAL PITS IN MARTIAN CRATERS: OCCURRENCE BY SUBSTRATE, EJECTA TYPE AND RIM DIAMETER. W. S. Hale, Dept. of Geol. Sci., Brown Univ. Providence, RI 02912.

Central pits are prominent morphologic features in many fresh complex impact craters on Mars (1-4). They occur either as summit pits atop central peaks or as central floor pits where no central peak is present (4). The presence of pits associated with or replacing central peaks has been attributed to the interaction of crater-forming processes with a substrate volatile component. Nearly adiabatic compression of the substrate by the impact shock front may be followed by explosive decompression of substrate volatiles associated with central peak emplacement (2) leading to pit formation. Pit distribution has therefore been suggested as a tool to discriminate between substrates with differing volatile content (2). However, early attempts to determine pit distributions produced conflicting results (2,3). Lobate ejecta deposits may also reflect incorporation of substrate volatile component (5), though recent experimental work suggests that atmospheric effects are more important (6). The purpose of this study is to determine central pit frequency as a function of substrate, ejecta type and rim diameter. Data for 990 fresh martian complex craters (diameter = 5-140 km) on 7 substrate types (6) covering 3.67×10^7 km^2 ($\approx$25%) of the martian surface has been derived from Viking Orbiter images and the U.S.G.S. geologic map series.

Substrate and Ejecta Dependence - Of the 990 craters in this study, 345 (35%) have pits, of which $\sim$ 60% are floor pits. Pits occur on all substrate types studied (Fig. 1) but are never the dominant central structure. Only on Cratered Plains units do pits (of all types) reach a frequency comparable to unpitted central peaks. Some variation occurs in frequency of summit pits versus floor pits as a function of substrate. Summit and floor pits are found in craters with all ejecta types (as defined in ref. 5), but do not dominate any single type (Fig. 2). Pit frequency increases with increasing complexity in fluidized ejecta from lobate to multi-lobate.

Rim Diameter Dependence - The distribution of central pits as a function of crater diameter (Drc) by 5 km bins is shown in Figure 3. Pits are not observed in craters with Drc > 63 km. Sufficient data exists to evaluate pit/Drc dependence for two substrate groups: plains units (ridged, smooth and rolling) of probable volcanic origin (6), and ancient cratered terrains. Pits are more common on plains units for Drc = 35-60 km than on ancient terrains for the same diameter range (Fig. 3). This high pit frequency is maintained to Drc > 60 km, (limit of plains unit data), while frequency on ancient terrains falls off rapidly for Drc > 60 km.

Discussion - The existence of a power-law relation between pit diameter and crater rim diameter (4) supports a link between pit formation and primary crater-forming processes (2). If pit formation does reflect interaction with a volatile substrate component, then the presence of pits on 7 different substrate types argues for such a component to be regionally extensive. The lack of strong correspondence between ejecta type and pit occurrence may reflect either differing volatile sources or differing processes for ejecta fluidization and pit formation.

Pit formation is diameter dependent, with no pits observed for Drc > 63 km. Craters with Drc = 63 km have present depths $\approx$ 2.5 km (7). This is a minimum depth to the base of a volatile component in the substrate that might contribute to pit formation. The depth of crater excavation and the source depth of material influenced by central structure formation exceeds this value (8). On Earth, the depth sampled by central uplift formation for for Drc = 63 km is $\sim$ 5.7 km (8). Thus the maximum depth of a volatile com-

ponent influencing pit formation is > 2.5 km. The variation in pit frequency as a function of substrate (Fig. 3) suggests that the depth and thickness of a volatile component may vary with substrate. This study is currently being expanded to include 100% of the martian surface.

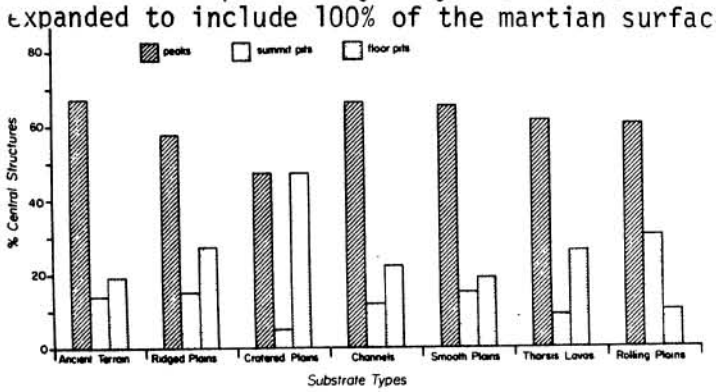

Figure 1

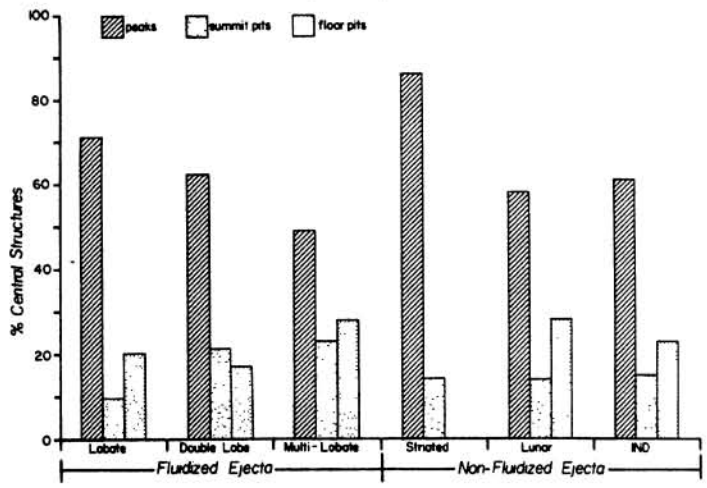

Figure 2

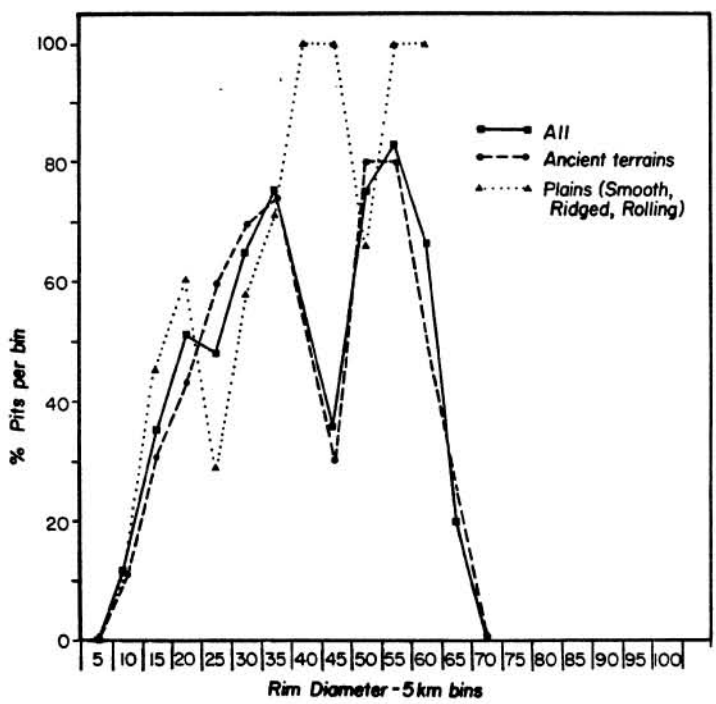

Figure 3

References: 1) Smith, E.I. (1976) Icarus 28, p. 543. 2) Wood, C.A. et al. (1978) PLPSC 9, P. 3691. 3) Hodges, C.A. et al. (1979) LPS XI, p. 450. 4) Hale, W.S. and Head, J.W. (1981) LPI Cont. 441, p. 104. 5) Mouginis-Mark, P. (1979) JGR 84, P. 8011. 6) Schultz, P. and Gault, D.E. (1979) JGR 84, p. 7669. 6) Scott, D.H. and Carr, M.H. (1978) U.S.G.S. Map I-1083. 7) Cintala, M.J. and Mouginis-Mark, P. (1980) GRL, p. 329. 8) Grieve, R.A.F. et al. (1981), PLPSC 12A, p. 37.