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VALLES MARINERIS, MARS: ARE PIT CHAINS FORMED BY EROSION AND TROUGHS BY TECTONISM?; B.K. Lucchitta, R.A. Balser, and L.M. Bertolini, U.S. Geological Survey, Flagstaff, AZ 86001.

The origin of the Valles Marineris remains controversial. Erosional [1], tectonic [2], and hybrid processes [3] have been proposed. Erosional processes appeared attractive because a morphologic continuum was thought to exist from pit chains of probable erosional origin to larger troughs. Schultz [4], however, refuted the existence of this continuum. To clarify these contradictions, we compared the widths and depths of pit chains and troughs and found that the features do not form a continuum. Rather, results are consistent with the hypothesis that pit chains formed by surficial collapse and troughs by deeper seated and coherent failure.

We classified by inspection all pit chains and linear depressions in the Valles Marineris region into six morphologic categories: (1) pit chains (linear arrays of small pits), (2) floored chains (arrays of pit chains having flat or hummocky floors), (3) scalloped troughs (wider linear depressions with scalloped wall segments), (4) narrow troughs (depressions of intermediate width with straight wall segments), (5) wide troughs (broad, linear depressions), and (6) chaotic troughs (more irregular depressions displaying some channel morphologies). We drew topographic profiles across the classified depressions at each degree of longitude between long 45° and 90°, on the basis of 1:2,000,000-scale topographic maps of MC 18 NW [5] and 18 NE and SE (work in progress). For each profiled depression, we determined the erosional width between plateau margins, the depth from the surrounding plateau level to the deepest part, and the geologic unit (modified from Witbeck et al. [6]) exposed at the deepest point.

Depths and widths are shown in Figs. 1 and 2. Fig. 1 shows measurements of all troughs. Fig. 2 is the same but with omissions of three types: (1) chaotic troughs, which are genetically linked to outflow channels; (2) troughs east of long 61°, which are transitional to chaotic troughs; and (3) troughs whose maximum depth is not likely to reflect the approximate structural depth because of thick fill from landslides or interior deposits.

Results of the study, as deduced from the figures, are as follows:

1. Pit chains, floored chains, and scalloped troughs lie along a continuously ascending trend that suggests a common origin. Surficial erosional collapse into linear subsurface voids or tension cracks [3] is compatible with this observation. The limiting depths of about 4 km may be due to a discontinuity at that depth or to restricted size of the underlying voids.

2. Narrow and wide troughs form a continuum that suggests their formation by similar processes. The straight scarps bordering these troughs suggest control by faulting rather than surficial collapse.

3. A gap in data occurs at widths of 20-35 km, separating pit chains, floored chains, and scalloped troughs from narrow and wide troughs. Only two transitional points are located within this gap. The gap suggests an abrupt change in physical conditions or processes. Apparently, deep-seated, more coherent failure was activated for troughs wider than about 35 km.

4. Most troughs bottom out at 8-9 km regardless of width, perhaps implying a controlling discontinuity or limit in the amount of extension.

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DEPTH VS. WIDTH OF VALLES MARINERIS TROUGHS

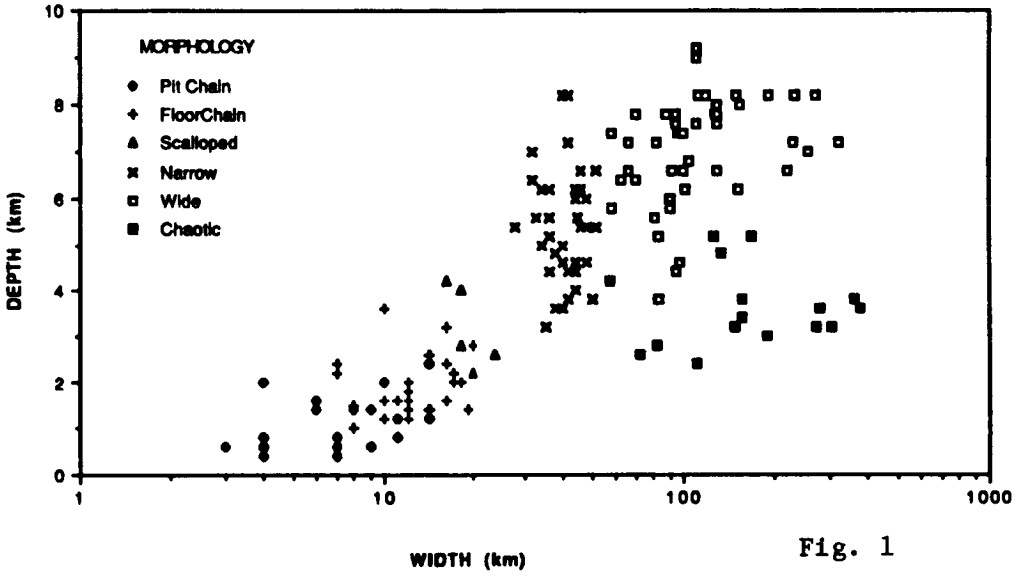

Fig. 1

DEPTH VS. WIDTH OF VALLES MARINERIS TROUGHS
FOR LONGITUDES>81 DEGREES

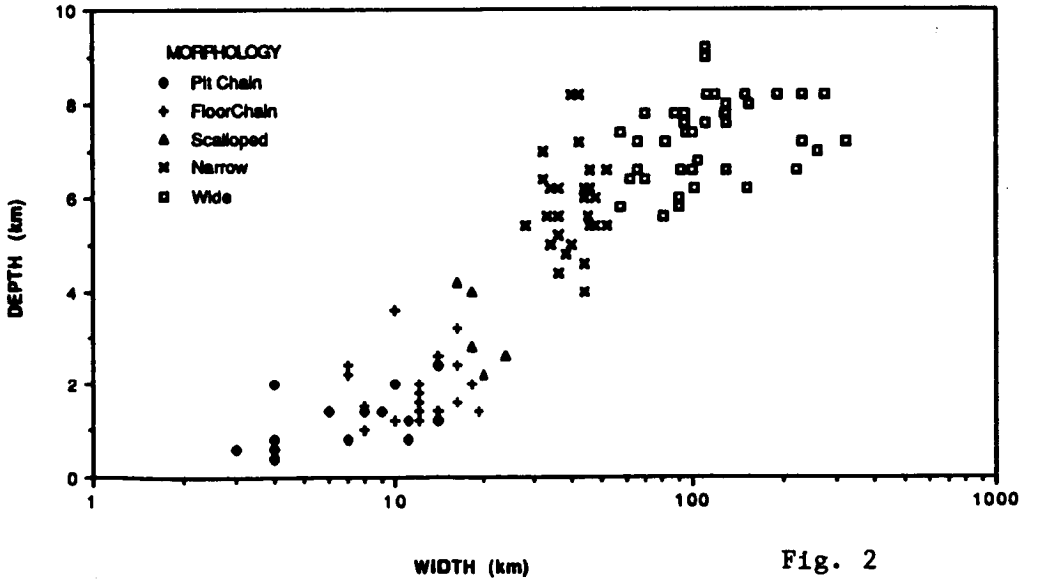

Fig. 2