CURVILINEAR RIDGES AND RELATED FEATURES IN SOUTHWEST CYDONIA MENSAE, MARS

by

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Figure 1 depicts a region in southwest Cydonia Mensae (32° lat., 17° lon.) just northwest of the lowland/upland boundary escarpment. The dominant morphologic features in the region are the clusters of large massifs and plateau outliers (Pl), knobby material (K), and smooth lowland plains (Ps). Surrounding the clusters and linking many isolated knobs is a system of curvilinear ridges and arcuate terrain boundaries which tend to separate the massifs and knobs from the smooth plains.

Curvilinear ridges are arcuate to nearly linear ridges that are smoother in plan than wrinkle ridges and show no apparent correlation with regional structural grain. They are typically 5-10km long but can range from as little as 2 or 3km to greater than 50km long. The widths vary from about 100m to as much as 2km. Ridge crests usually appear sharp to somewhat rounded. Changes in symmetry and width occur gradually along strike. Wrinkle ridge crests, in contrast, are often irregular, en echelon, and abruptly cross from one side of the ridge to the other along strike. Curvilinear ridges are most numerous within 100km of the lowland/upland boundary escarpment and are associated with massifs and knobby terrain. When enclosing clusters of massifs, they tend to do so with their concave sides facing the open plains.

Arcuate terrain boundaries are defined as arcuate boundaries between units of different apparent albedo or arcuate breaks in slope. When an arcuate terrain boundary separates units of different albedo, the unit with the lightest albedo is typically on the concave side of the boundary. There are two types of arcuate slope breaks: (A) The most common occur as low escarpments cut into adjacent topographically higher terrain by the lowland plains. In this case, the escarpment faces the concave (plainward) side of the arc. (B) Less commonly, they exhibit a low, sharp escarpment suggestive of a thin onlapping of the adjacent topographically higher material by the lowland plains material. In this case, the escarpment is on the convex side of the arc and faces upslope, away from the lowland plains. Arcuate breaks in slope may or may not be associated with an albedo change. All three of the above elements may occur along a single arcuate terrain boundary. Arcuate terrain boundaries display a plan and distribution relative to topography similar to the curvilinear ridges and may grade into them (figure 2). Those that are found downslope from the curvilinear ridges tend to be traceable over the longest distances (as much as 200km or more). Arcuate terrain boundaries, like the curvilinear ridges, are most common within 100km or so of the lowland/upland boundary.

Several terrestrial and lunar processes can produce ridge forms: (A) Volcanic ridge forms include intrusive dikes. Volcanic dikes intruding into a since-removed surface deposit have been suggested (1,2) as a possible explanation for the sinuous ridges in Argyre Basin (3), which share some morphological similarities with the curvilinear ridges of southwest Cydonia, though at a larger scale. Such ridges should exhibit some sort of structural control to their distribution, however. (B) At least two glacially derived terrestrial features - eskers and moraines - may be of similar scale and morphology to the martian curvilinear ridges. Both types of features require the presence of an extensive ice sheet within the northern plains and movement of material toward its margin. Movement of the ice over the now-exposed plains would likely have produced drumlin-like forms and other scour features. (C) Longitudinal dunes or sand ridges are common in the vast desert regions of Africa and Australia. Individual ridges are similar morphologically to those found on Mars. Terrestrial sand ridges, however, occur in parallel sets oriented with the dominant winds. The curvilinear ridges on Mars do not occur parallel to one another as a rule, and show no preferred alignment with local wind patterns. (D) Lacustrine and coastal ridge forms - spits, bars, and coastal barriers - may provide the best analogs for the curvilinear ridges. They are of similar scale to the curvilinear ridges and exhibit similar distributions relative to topography. Spits and bars form by longshore transport of sediment. Most bars form parallel to the coast, tending to close off re-entrants, or bays, or link offshore islands to the mainland or to one another. Spits are bars connected to the coast at one end. Their length, width and direction relative to the shore are dependent upon a number of interrelated factors: source, amount, and duration of sediment supply; strength, duration, and direction of the dominant swell; tidal range and currents (oceanic); and depth and slope of the lake or sea bottom (4,5). While most terrestrial spits are only a few kilometers long, some are known that are as much as 90km long (6). In terrestrial coastal regions with a gently sloping bottom profile and an abundant sediment supply, such as along the east coast of North America, large barrier islands have formed as a result of sea level rise since the last glaciation (7). Coastal barrier systems can be thousands of kilometers long.

The arcuate terrain boundaries have two possible analogs: (A) Lunar mare flow fronts result from the interaction of vast volcanic floods and pre-existing terrain. One of the most striking features associated with the lunar maria are long, sinuous scarps which have been interpreted as flow fronts (8). Where individual flow fronts

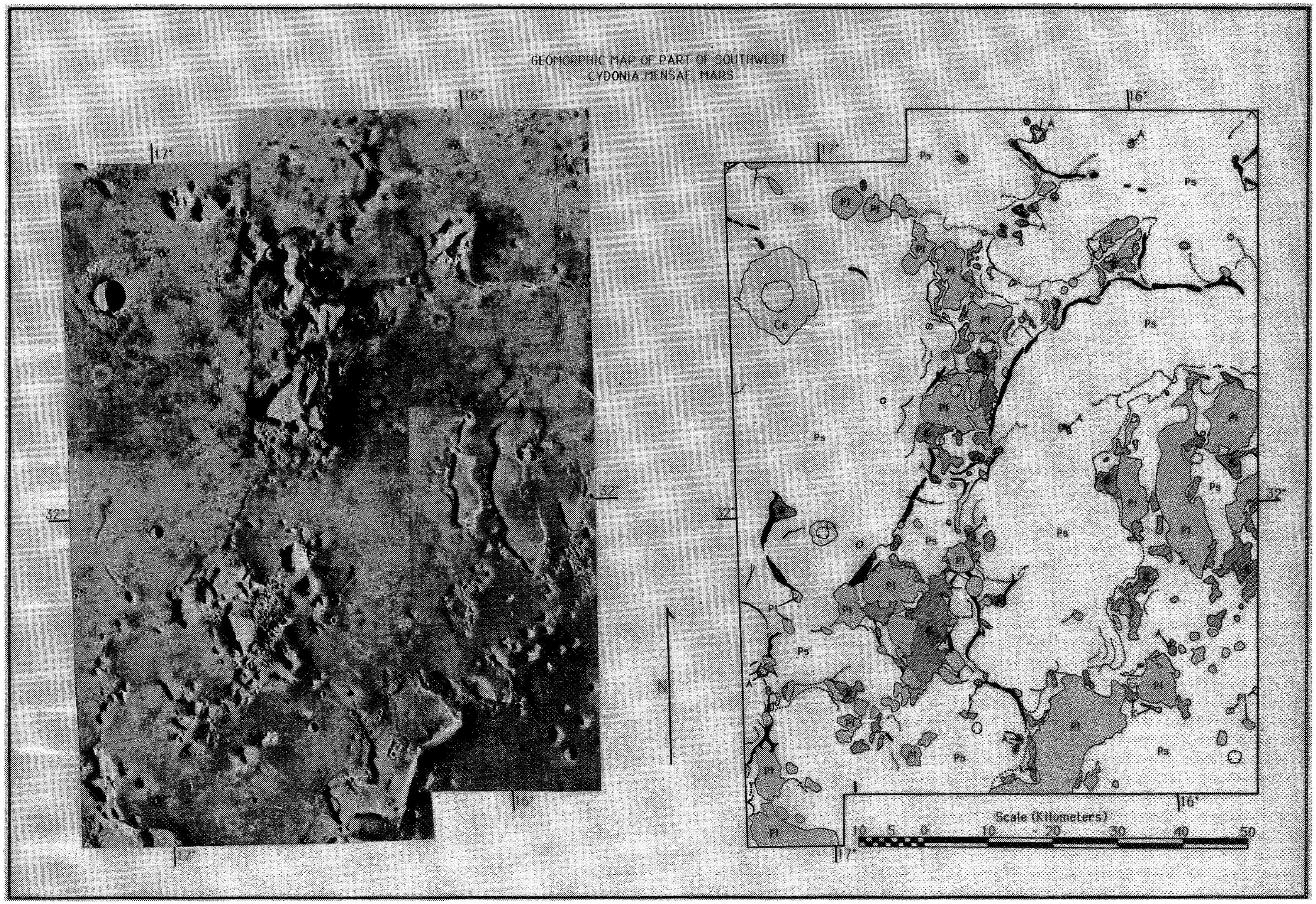

Figure 1: Principle geomorphic elements of part of Cydonia Mensae. (Pl), Plateau outliers and large massifs; (K), Knobby material; (A), flat-topped massif-encircling debris aprons; (Ps), Smooth plains; (Ce), Crater ejecta blanket; Curvilinear ridges indicated by solid black; Arcuate terrain boundaries indicated by dotted lines.

are not recognizable in the lunar maria, the flood lavas onlap pre-existing terrain in a topographically conformal fashion. This type of terrain boundary is also found in many places on Mars, but it is distinct from the morphology of the arcuate terrain boundaries found within the northern lowlands. Although onlapping of elevated terrain by lowland plains might be expected of lunar mare-type flood lavas, those boundaries exhibiting an escarpment cut into the elevated terrain would require the unlikely erosion of the elevated material by the lavas. (B) Terrestrial shorelines on gently sloping terrain can produce similar morphologies that might be visible at medium to high resolution Viking Orbiter image scales. These include such features as beach ridges and cuspate and zetaform shorelines. Beach ridges are constructional features that may be several meters in height, tens of meters in width, and hundreds of meters to kilometers in length (9). The cuspate or zetaform plan of many coastlines, which may have both constructional and erosional elements, is a result of wave refraction and is a function of the dominant swell direction, the bottom topography, and the resistance of the coastal material to wave erosion.

References:

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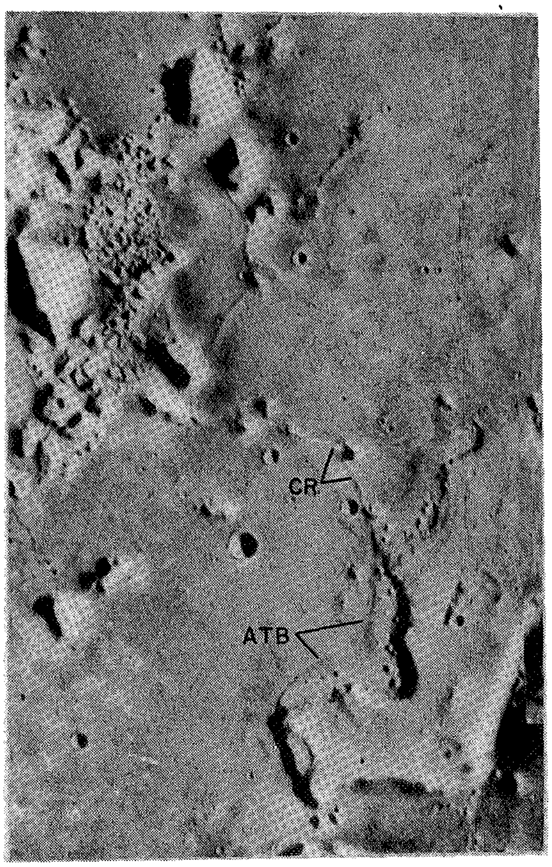

Figure 2: Magnified view of area along south edge of figure 1. Arcuate break in slope (ATB; erosional?) at base of plateau remnant at lower right grades smoothly into curvilinear ridge (CR; constructional?). Other arcuate terrain boundaries and curvilinear ridges can also be seen in this view. A cluster of large massifs and knobby material can be seen at upper left.