LATE NOACHIAN DEVELOPMENT OF THE COPRATES RISE, MARS;
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The Coprates rise forms a 900-km-long, north- to northeast-trending ridge south of Coprates Chasma between long 56° and 60°. Radar [1] and stereophotogrammetric [2] data indicate that the rise is 2-4 km above a neighboring trough to the east. The break in slope between the rise and this trough is well defined topographically and in Viking images. In turn, the trough is bordered to the east at long 52° by a much gentler rise (relief <1 km). West of the Coprates rise, the terrain dips about 0.2° to roughly long 75°. The rise and flanking highs were previously interpreted to be tilted fault blocks formed by either Tharsis tectonism or an ancient impact [1, 3]. We report here results of a preliminary geologic investigation that documents Late Noachian growth of the Coprates rise as an asymmetric fold. More comprehensive work will lead to a mechanical analysis of the kinematic development of the rise.

Four west-northwest-trending "rift" zones (intensely faulted arches) spaced 150 to 200 km apart on higher parts of the rise are characterized by closely spaced normal faults and graben-and-horst structures (Nectaris Fossae) that are aligned with the rift zones. Locally, fault scarps bound rift valleys about 20 km across. Embayment by Upper Noachian materials and advanced surface and impact-crater degradation (see prominent 85-km-diameter, pre-Late Noachian crater {A} in Fig. 1) suggest that the rift zones are Early to Middle Noachian in age [4]. Two large massifs (not shown) about 50 km across in the northern rift zones appear channeled and faulted; the northern massif has a large, rimmed summit crater. These massifs may be ancient volcanoes [4]. Irregular massifs {B, C} also formed along the southern rift zones.

Interrift areas of the northern part of the Coprates rise are covered by a complex of flat-lying plains and gently sloping materials whose surfaces are locally marked by channels, degraded craters, lava flows, and north-trending wrinkle ridges and fault scarps. Ridged plains material embays and buries these materials and structures on both sides of the rise. Crater densities (where N(5) is the number of craters having rim diameters larger than 5 km per 10^6 km^2) for the ridged plains material (N(5)~200) indicate an age coincident with the Noachian/Hesperian boundary, whereas the interrift materials (which reflect the age of deformation) have a Late Noachian crater age (N(5)~300) [5].

South of lat 26° S., strata were upturned on both sides of the rise during the Late Noachian (prior to deposition of ridged plains material). On the northwest side, a patch of dissected crater-fill material {D} has been tilted toward the northwest and is embayed by a bed of ridged plains material {E}. That bed is overlain by one or two more beds {F}, seen in places on either side of the western part of the rift zone {G}. The apparent tilting indicates at least local, modest (hundreds of meters?) uplift of the Coprates rise and possibly some growth or uplift of the southern rift zone relative to the western plateau.

The sequence of upturned strata on the southeast side of the rise is much more clearly seen. We have identified as many as four or five layers in this sequence. These layers form prominent hogbacks having well-defined dip slopes {H}; a lava-flow origin is consistent with the layers' apparent resistance to erosion and association with the southern rift zone. Several sets of grooves, perhaps formed by erosion of joints, cut the strata. The grooves connect with sinuous channels {I} at their upper ends, indicating the runoff of ground water after uplift; lower channel reaches have been buried by

ridged plains material {J}. The upslope edge of the lowermost upturned layer forms a prominent (probably more than 100 m high), linear scarp {K} that may be the result of normal faulting. Another upturned bed {L} is exposed south of the massif at {C}. Following the apparent normal faulting and warping south of that massif, strata {M} were emplaced across the southwest end of the Coprates rise (some embay the upturned bed at {L}) and were later folded, faulted, and dissected. The deep sculpturing of the strata suggests that they are easily erodible (pyroclastic?) rocks. These deposits (and channels that cut them) apparently issued from the rift zone {G}.

We conclude that the Coprates rise formed during the Late Noachian by 2-4 km of asymmetric uplift (steeper on its east flank). The timing is inconsistent with an origin by an early impact, but it coincides in time with early Tharsis-centered radial faulting at Syria Planum (about 2,500 km west of the rise) [6]. The deformational history may be consistent with thrust faulting or buckling of the lithosphere. Tectonism was accompanied by volcanism, and such activity probably caused runoff of ground water.

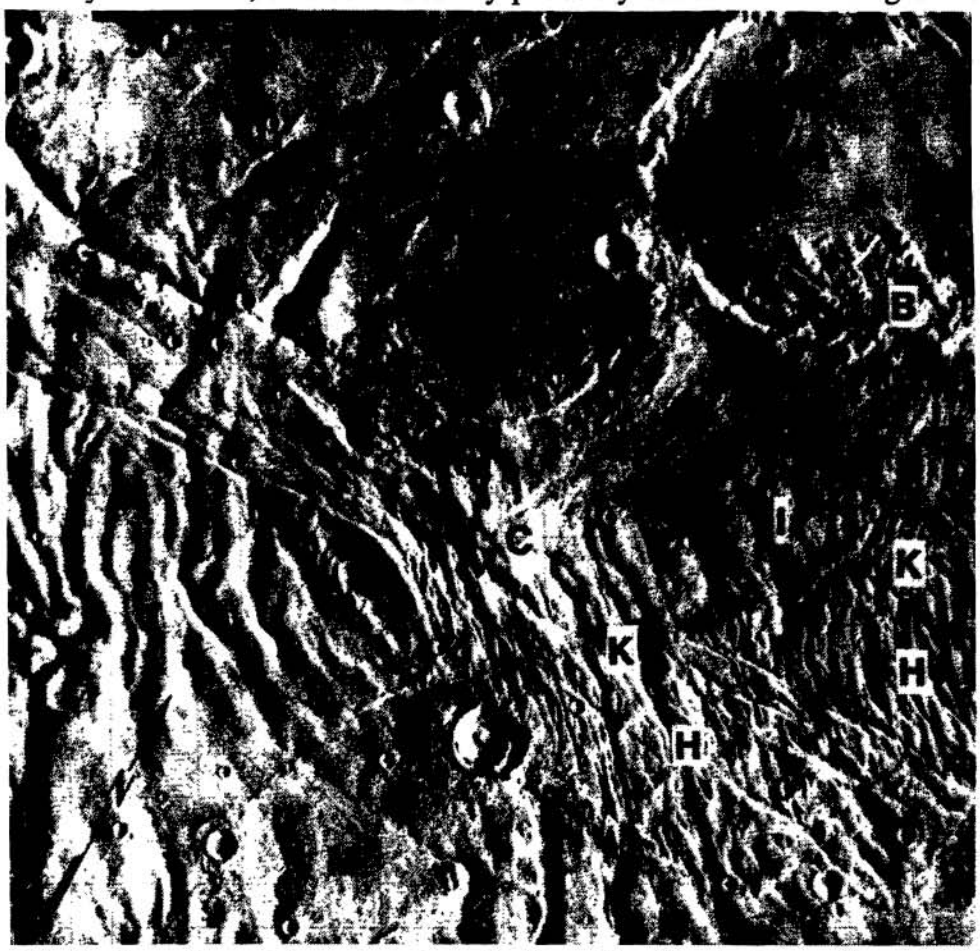

Figure 1. Part of southern Coprates rise. Letters identify features discussed in text. [Viking Orbiter image 610A42]

References Cited

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