POLYPHASE NOACHIAN TECTONISM OF THE MEMNONIA/AEOLIS REGION; EVIDENCE FOR GREATER PRE-THARSIS LITHOSPHERIC MOBILITY OF MARS, Randall D. Forsythe, Dept. Geog. and Ear. Sci., UNCC, Charlotte, NC 28223 and Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington D.C. 20560.

Contemporary summaries of planetary tectonics state there is no evidence of plate tectonics on Mars (1,2), no strike slip faults (3), and that a large percentage of the planets' tectonic features can be related in some fashion to the development of the Tharsis volcanic province (4,5). From this emerges the view of a Martian immobile lithosphere affected only by low strain contractional features, fractures, and graben systems. However, this view of Martian tectonics becomes much less tenable when consideration is given to a number of observations and inferences concerning Mars' ancient past(6).

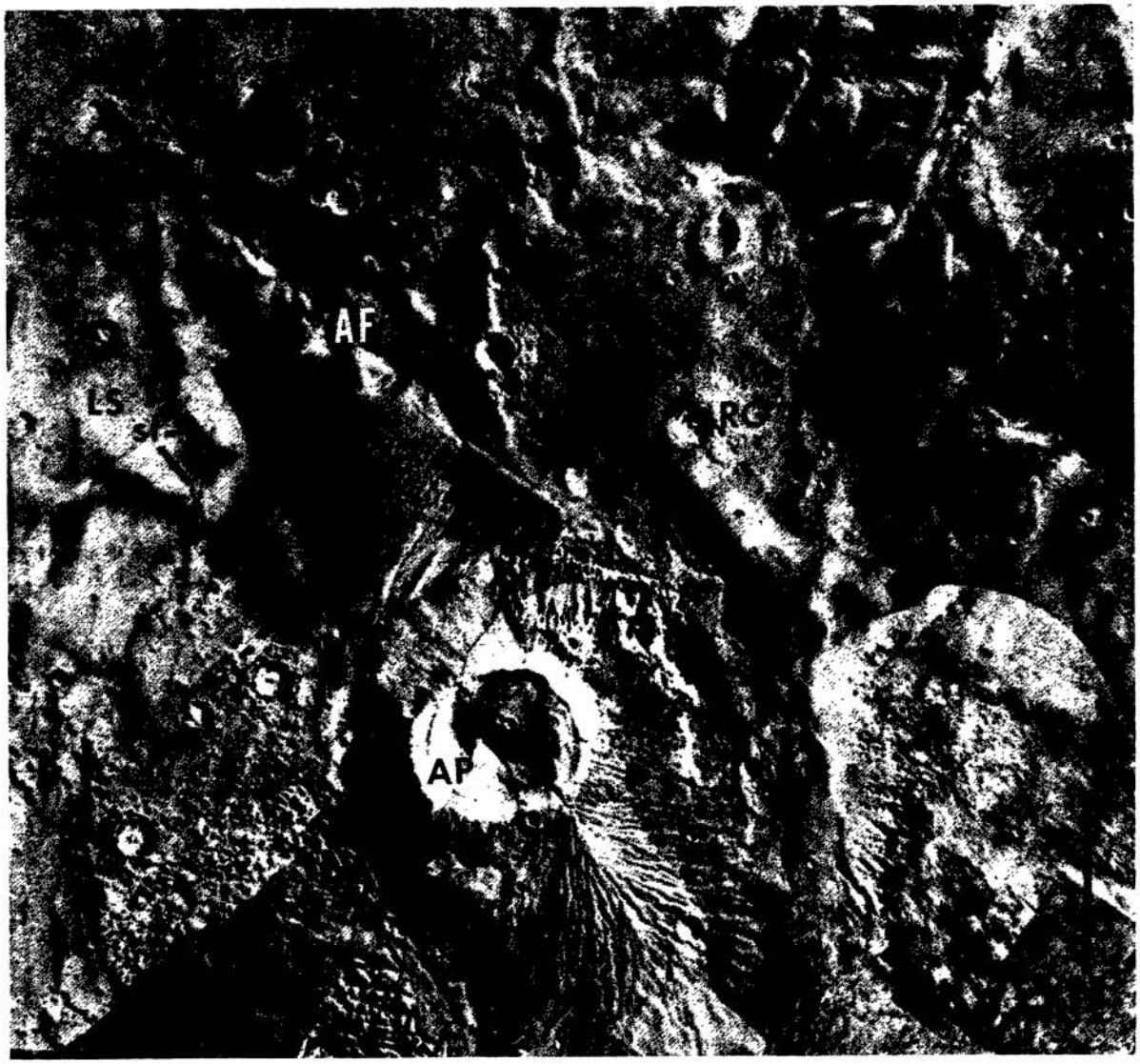
Noachian lobate scarps and wrinkle ridges. The Noachian highlands of the Memnonian-Aeolis area contain an array of N to NNE trending lobate scarps that have been argued to pre-date Tharsis-centered tectonism, and which are geometrically incongruous with such an interpretation(6). More detailed mapping (7,8) using Viking imagery has confirmed that at least locally these tectonic features predate outflow channel development in Mangala Valles, and are cut by the Tharsis radial 'fracture' swarm. Kinematically, the lobate scarps have previously been interpreted as normal faults, related either to early thermal stresses(6) or to a major Noachian impact basin (8). Two observations, however, suggest that these scarps are contractional features. First, they are replaced by wrinkle ridge morphologies of similar trend where they intersect major basins, and secondly, there are abundant sharply defined linear NNW-NW and NE-NNE trending offsets of the lobate scarps and wrinkle ridges that are identical in appearance to the strike-slip faults documented in the Valles Marinaris region (9). The wrinkle ridges and inferred strike-slip faults argue for a contractional origin for the lobate scarps.

Transcurrent faults. Work in the western equatorial dichotomy boundary zone argued for the Gordii Dorsum escarpment to represent a lithospheric scale left-lateral transcurrent fault of Noachian age; perhaps indicating greater lithospheric mobility in the ancient past(10). Current analysis of the western equatorial zone has led to the discovery of an additional fault of a probable transcurrent character, here called the Apollinaris fault zone. The fault, like the Gordii Dorsum appears to have fine scale fault sculpture controlled by 2 sets of low angle oblique-trending secondary faults. Also apparent, are several oblique-trending bulges and ridges and an adjacent rhombic-shaped, and fault-limited, depression (rhomb graben?). Finally, adjacent to the rhomb 'graben' is a conspicuous array of regularly spaced assymetric warps that appear truncated and displaced in a left-lateral sense along the edges of the graben structure. The combined set of structures are restricted to what has previously been mapped as Amazonian age materials(11), but are alternatively interpreted as exhumed Noachian units(12). The combined set of structures, can be modelled an with an E-W oriented horizontal maximum compressive stress regime, with the Apollinaris fault zone (>300 km length) representing a major lithospheric-scale left-lateral shear zone like the Gordii Dorsum. Topographic profiles indicate that the NNW to NW trending transcurrent faults of this unique equatorial province (approx. 2500x500 km) parallel large scale trough/swell structures with wavelengths of 375 km and amplitudes between 1 and 3 km. To the west, south, and east highland materials in the immediate vicinity of the Apollinaris fault zone have lobate scarps and wrinkle ridges with 'strike-slip' faults of inferred left-lateral character sub-parallel to the Gordii Dorsum and Apollinaris fault zones.

Polyphase deformed Noachian 'Basement.' Finally, an analysis of the marginal Noachian zone to the south of the dichotomy boundary reveals a number of lines of evidence for erosional resurfacing of a previously deformed(polyphase) basement complex. Here erosional resurfacing in the intercrater plains has etched the surface traces of cross-cutting linear and curvi-linear penetrative fabrics. The fabrics (typically with NW and NE sets represented) have controlled crater basin shapes likely by a combination of primary syncratering excavation, the secondary post-excavation collapse of crater walls, and by later tertiary erosional processes. The fabrics have also controlled dendritic tributary systems within the Noachian intercrater plain areas, as well as the development of outflow channels near the dichotomy boundary. Large craters near the dichotomy boundary reveal internal walls with at least two orientations of fabrics that are seen penetrating at least to the base of crater walls with >1 km relief. Do the fabrics represent bedding, cleavages, or foliations? In one outflow channel (Viking 443S13) erosion reveals the edges of a series of resistant west dipping layers.

Noachian (Pre-Tharsis) Tectonics of Mars: Forsythe, R.D.

Viewed collectively the Noachian data set argues for at least two, if not three, phases of regional tectonism prior to Tharsis development. Penetrative fabrics and upturned layers, appear to be regionally present but largely masked by the highland 'regolith'. Where exposed, however, they provide tantalizing opportunities to gain a glimpse of what appears to be a very different, and more tectonically active phase of Mars' history. The N-S lobate scarps and NW trending transcurrent faults were superimposed on this polyphase deformed basement probably during the late Noachian. Preliminary analysis suggests E-W shortening strains >7.5 % that affected an area >3000 km x 1500 km. This appear larger than that inferred for the circum-Tharsis ridge structures(12) and may reflect a trend towards increasing stabilization (13).



Photomosaic of the Apollinaris Patera region (7S,187W; Approx. scale: 1cm=37 km) AP: Caldera wall of Apollinaris Patera, AF: Apollinaris fault zone (inferred left-lateral transcurrent fault), RG: rhomb 'graben', NAW: northern array of asymmetric 'warps' in the Medusa Fossa Fm., SAW: southern area of warps in the Medusa Fossa Fm., sf: NW-trending offsets of lobate scarps (small strike-slip faults).

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