CHARACTERISTICS AND MODEL SIMULATIONS OF FLUVIAL INCISION IN PARANA BASIN.
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Introduction: MOLA and THEMIS data sets were used to define and quantitatively investigate the valley networks debouching into Parana Basin in Eastern Margaritifer Sinus, Mars. Realistic evaluation of various hypotheses for erosional processes responsible for observerd valley erosion are being simulated by MARSSIM, a landform evolution model. The overarching theme of this study is to compare geomorphic data with simulated models to evaluate the contrast in erosional style between the widespread, less channelized mid-Noachian erosion and the relatively limited, yet strongly focused erosion, fluvial, and otherwise, during the Noachian-Hesperian transition.

Background: The southern highlands record extensive fluvial erosion that occurred during the Noachian period [1]. The earlier Noachian period was characterized by widespread fluvial erosion of highlands and crater rims, deeply infilling crater floors and intercrater basins, but leaving few traces in currently visible contemporaneous drainage networks.

This older erosional regime is contrasted by evidence of 'late-stage' fluvial activity, occurring near the Noachian-Hesperian transition, found principally in the equatorial highlands. For example, along the southern rim of Isidis basin, sparse, arroyo-like trunk channels of valley networks sharply incise 50-350 m into what appear to be earlier, relatively planer upland surfaces interpreted to be Noachian fluvial basin deposits [2]. The depth of valley incision below established Noachian surfaces correlates strongly with the gradient and the total valley length, suggesting consistent regional hydrology. Estimated discharges within the channels estimated by channel dimensions and scaling to terrestrially based empirical relationships [3] imply either runoff directly from precipitation or rapid melting of accumulated snow, as suggested by [4]. Examples of this type of valley incision have been found on the Isidis rim, in the Ervos Valles region, and within Margaritifer Sinus [2] and appear to be fundamentally different than the fluvial environment characteristic of most of the earlier Noachian period.

Environmental conditions responsible for the enhanced late-stage fluvial erosion and deposition remain uncertain. One possibility is enhanced runoff relative to sediment yield, such as from snowmelt rather than rainfall. Another possibility is the development of a thick indurated duricrust layer over much of the highlands, which would enhance runoff, reduce sediment yields, and focus erosion within larger channels [2]. A third possibility is renewed erosion following a mantling episode [5].

Parana Basin: The Parana vallis system is a complete watershed-defined drainage network, possessing collecting tributaries and well-defined stem or trunk valleys. The location and orientation of the valleys are significantly influenced by Parana Basin [6]. A branching valley system deeply entrenched below the level of a broadly sloping upland surface forms the eastern rim of the ~330km basin. Preserved drainage densities in the Parana-Loire basin are among the highest on Mars [7] at 0.03-0.11 km/km^2. Post valley resurfacing may mask even higher drainage densities.

For this study the Parana Basin catchment was defined using MOLA PEDR data. Full resolution (~100m/pixel) daytime THEMIS IR images were mosaiced and coregistered with MOLA PEDR topographic data (Figure 1).

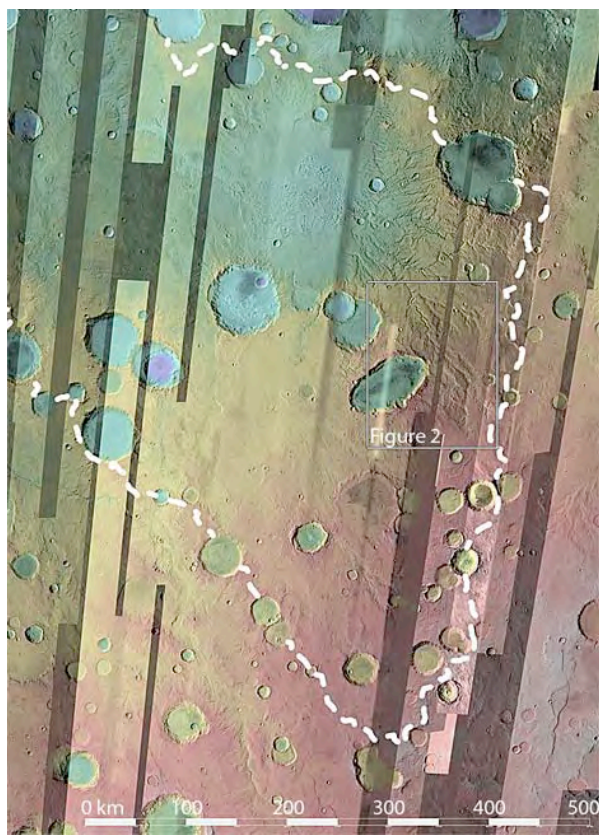

Figure 1: Parana Basin—Spanning 18.5 to 32.5 South and 342.5 to 353.0 East; roughly 529,200 km^2

All valleys visible in the THEMIS data (yellow) set were mapped and and all valleys resolved by MOLA (white) were digitized in 3D space [lat, lon, alt] along their centerline as defined by their thalwegs (Figure 2). From these data, valley profiles where generated for central trunk valleys. Valley profiles are similar to those found on the Isidis rim [2]. They are broadly convex, stepped and irregular (Figure 3). Also, the depth of incision strongly correlates with gradient and valley length.

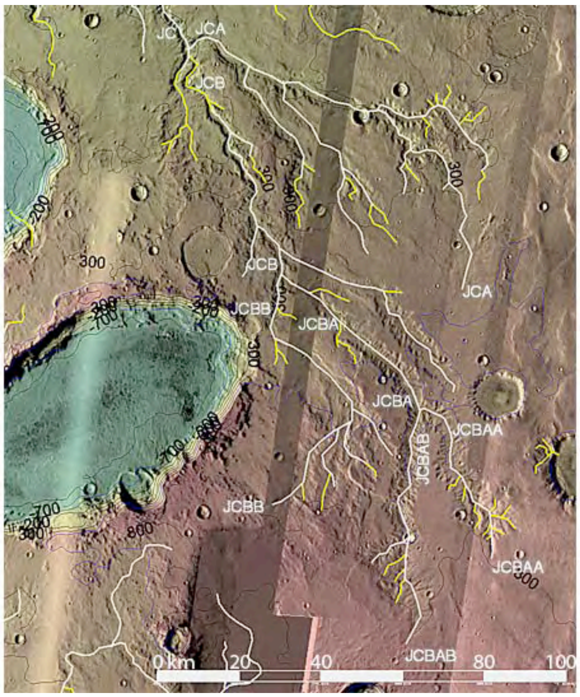

Figure 2: Insert within Fig. 1, Example Valley System

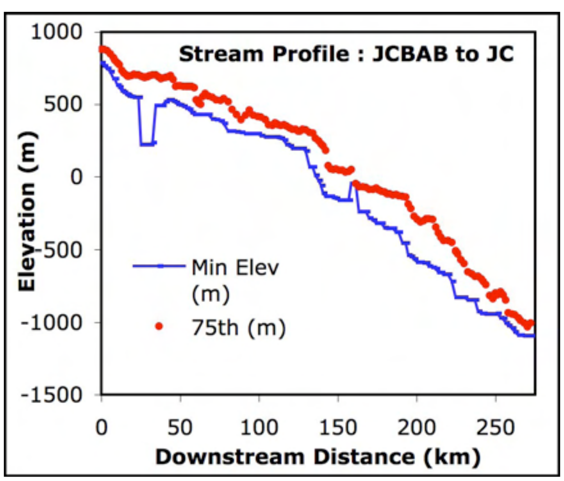

Figure 3: Valley profile of section JCBAB to JC of Fig. 2. The depth of incision correlates with gradient and valley length.

MARSSIM: The MARSSIM program simulates long-term landform evolution by weathering, mass-wasting, fluvial, eolian and lacustrine processes[*8-10*]. Our study of Parana Basin has led us to consider several hypothesis for late-stage incision including enhanced runoff, duricrusts, and mantling. We evaluated these alternative scenarios using MARSSIM simulations. An "original" topographic DEM for the region has been recreated from the present topography by conceptual infilling of extant valleys. Various scenarios for runoff and sediment yield, surface induration, and episodic mantling are then simulated starting from the artificial DEM and statistically compared in terms of pattern and depth of incision with the extant topography.

Concluding Remaks: There remains a number of uncertainties concerning fluvial activity within Parana Basin and throughout the southern highlands, including the fate of sediment delivered from the highlands to the northern lowlands and possible sediment interaction with putative seas and ice covers. The relationship between highland valley network formation to other events such as outflow channels, regional mantling episodes, high latitude ice-related formation, volcanic resurfacing, and oribital or impact induced climate excursions are potentially addressable using our approach. The convergence of observations that characterize the erosional style of actual landscapes and the results from landform evolution models imposes constraints on the environmental conditions present during valley formation and evolution.

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