VARIABLE SUBSTRATES AND MORPHOLOGY OF MARTIAN VALLEY NETWORKS J. C. Cawley and R. P. Irwin III, Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, 6th St. at Independence Ave. SW, MRC 315, Washington DC 20013, cawleyj@si.edu, irwinr@si.edu.

Introduction: On Mars, as on Earth, the landscape includes a record of changes to surfaces and landforms by weathering and erosion. Many of the concepts of terrestrial geomorphology are transferable to martian terrain [1]. Base level control, channel nick points, channel width/depth/velocity relations, longitudinal gradient, terracing and calculations of sediment types and fluvial carrying capacity are applicable concepts.

The near-global Mars Reconnaissance Orbiter Context Camera imaging at 6 m/pixel [2] provides detailed perspective on valley networks. Here we report observations from northwestern Terra Cimmeria, where fluvial valleys are relatively well developed without periglacial modification [3].

The mapped geomorphic surfaces in this region have limited valley incision throughout and limited denudation except on escarpments, suggesting that any fluvial erosion was mostly below thresholds for transport of coarse-grained sediment. Apparently, most of the erosion occurred under low magnitude "hypo-fluvial" conditions that limited channeling and the grain sizes being eroded on the landscape [4].

Resistance to secondary erosion is a key characteristic, because lava flows and impact ejecta are not easily erodible, whereas fine-grained sedimentary deposits may be considerably more so. Martian channels cut differentially into various lithologies and sedimentary layers, including lags, duricrusts or other indurated or cemented layers. Differing lithologies have discernable surface spectral signatures [5]. Here, we discuss some preliminary geomorphic interpretations to better understand how early dissected highlands were resurfaced [6].

Mars Reconnaissance Orbiter Context Camera data show variable substrate resistance to erosion by water and wind: In the Viking and Mars Odyssey global image mosaics at 231 and 100 m/pixel, respectively, it was resolution which limited the mapping of tributary valleys. At 6 m/pixel, however, the mapping is limited by the scale of surface degradation of the physical landscape.

Some areas are visibly layered and/or terraced, apparently by differential erosion: Some fluvial valleys have one or more terrace, and in some cases, a nearby crater will reflect a terrace or bench at the equivalent level. This suggests the erosion of layered substrate rather than depositional terraces. The albedo and scale of roughness elements vary across these surfaces, suggesting compositional variability of the substrate. Some areas are scabby, consistent with susceptibility to aeolian deflation.

Basin fill often appears resistant, but deflated by wind: Many basins have resistant floor materials that retain small craters well, relative to the surrounding uplands [7]. This is consistent with indurated or cemented layers, lags, or duricrusts. These materials sometimes have sharply defined margins, with shallow edge-scouring separating them from adjacent crater walls. Some of these resistant deposits formed in open basins [8] with through-flowing valleys and relict paleochannels.

Sedimentary structures and paleochannels are evident: Sand deposits with transverse aeolian ridges obscure many valley floors, or expose an incised interior channel or an inverted channel. Cratering and shallow aeolian deflation of the landscape are widespread, such that the ancient runoff-producing surfaces are not preserved.

Physical and chemical weathering of basaltic impact glass, suevite breccias and basaltic regolith tend to produce clays, silica gels (or hyaline silica) and fine secondary particles. There are various styles and textures of basaltic weathering which are likely to have locally affected past runoff production, infiltration, deposition, and cementing of sediments, paucity of coarse-grained fluvial deposits, and ease or difficulty of later deflation.

Steeper slopes generally have more tributaries, and some slopes are fully dissected: The most densely dissected areas are relatively steep, high-relief slopes, including crater walls and uplifted escarpments, as well as some sidewalls of larger valleys [9].

Interfluvial areas have low slopes representing metastable erosional or depositional surfaces. These surfaces have subsequently been reworked by cratering and wind. Incised tributary confluences indicate where drainage on some of these surfaces increased above thresholds for channel forming.

Conclusions: Observations suggest that at presently resolvable levels, martian valley networks reflect geologic textures and substrate influences as well as topographic control.

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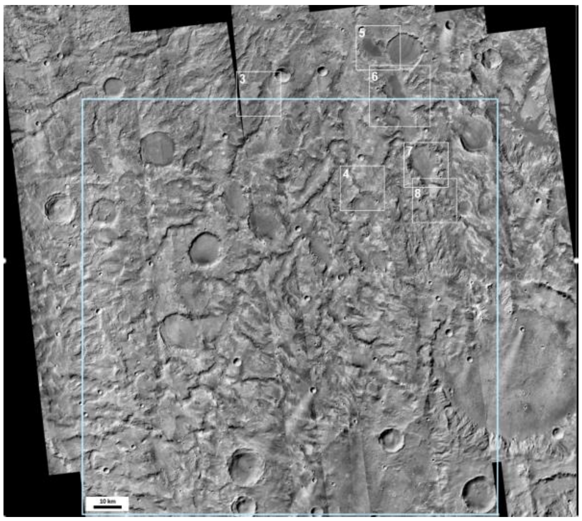
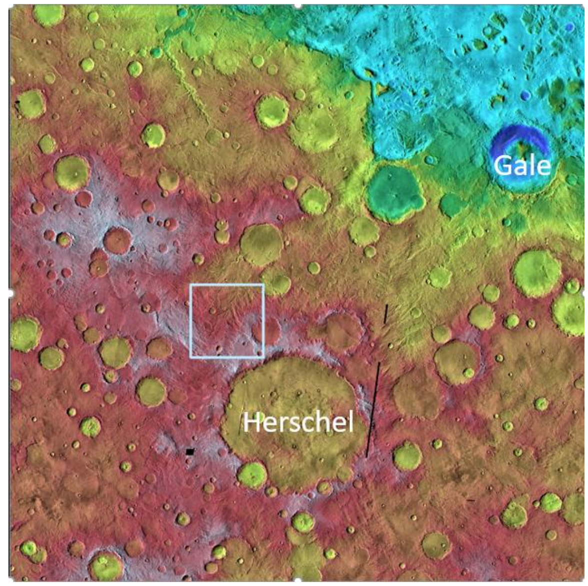
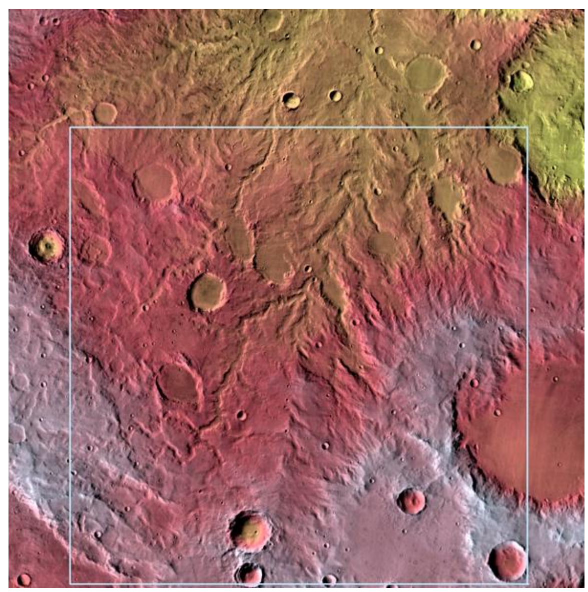


Composite Base Map of Terra Cimmeria, showing location of study areas.



Study area (box) locator, bounded by 0–20°S, 120–140°E. THEMIS daytime infrared mosaic colored with MOLA topography.



Study area boundary (box) is 9.70–12.23°S, 126.27–128.80°E in Terra Cimmeria, northwest of the 300 km Herschel crater.