THE ROLE OF FLUVIAL PROCESSES IN HIGHLANDS CLASTIC BEDROCK FORMATION.
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Introduction: The Martian cratered highlands contains the planet’s oldest terrain [1]. This region was heavily resurfaced by fluvial, cryogenic, volcanic, impact and aeolian processes [2]. The relative contributions of these processes have implications for the evolution of the Martian interior, surface, and atmosphere during the planet’s first billion years. While the chronology and extent of resurfacing processes have been well-documented [e.g. 3], the distribution and origin of intact resurfacing products are less well understood.

Exposed, intact resurfacing products may be identified by their thermal inertia (TI), a thermophysical property effectively related to grain size and induration. At km-scales unconsolidated regolith materials generally exhibit $TI < 300 \text{ J m}^2 \text{s}^{-1/2}$ (thermal inertia units, or TIU). Highlands intercrater basins host expansive regions of $TI > 325$ TIU corresponding to large exposures of rugged, mechanically competent materials (‘bedrock plains’) at the 6 m/px imaging scale of the Mars Reconnaissance Orbiter Context Camera (CTX) [4]. Bedrock-dominant surfaces show sharp thermophysical and morphological boundaries with the surrounding regolith- or dust-dominant surfaces.

We recently produced a map of bedrock-dominant regions within the Martian cratered highlands (Fig. 1) [5]. During map production, we performed morphological assessments to help determine bedrock lithology and origins. Our observations show ample evidence for a clastic origin of many intercrater bedrock plains. In addition, they indicate that many clastic plains experienced fluvial deposit on and/or modification.

Morphological Assessment: Our morphological assessment of bedrock plains materials used CTX imagery to analyze surface texture and crater retention as proxies for lithology. Clastic lithologies are more likely to rapidly erode, leading to poor crater retention and wind-sculpted surface features such as yardangs. Bedrock plains with low crater retention and highly-developed erosional features are identified as possibly clastic in origin. To further constrain these observations, we catalogued process-related landforms, the presence and style of layering within bedrock materials, and stratigraphic relationships between bedrock plains and the surrounding low thermal inertia materials. We found that 34 of our 139 mapped bedrock plains contain landforms that are plausibly related to fluvial processes.

Bedrock Materials With Dendritic Outcrops: Many bedrock plains are located within intercrater basins at the confluence of incised highlands valley networks. Some incised valley networks contain exposures of bedrock materials near their terminus. In these cases, bedrock materials are found up to 100 m above the modern surface of the bedrock plain (Fig. 2a). This topographic relationship suggests bedrock materials originated from material transported via incised valley networks, rather than later flood volcanism within the basin that began to reoccupy the incised valleys.

Nine intercrater bedrock plains contain tonally-distinct bedrock materials with a dendritic outcrop pattern (Fig. 2b). These surfaces show narrow outcrops converging on an axis oriented towards the center of the intercrater basin. These materials commonly display moderate to high erosional susceptibility, suggesting that they are composed of clastic materials. These materials appear to fall within a stratigraphic succession of bedrock materials, rather than resulting from later surface modification.

Sinuous Ridges: Twenty-three bedrock plains host sinuous ridge systems. The morphology and context of

Figure 1. Map of bedrock-dominant surfaces in the Martian cratered highlands. This map outlines bedrock plains determined using a TES-derived thermal inertia threshold >325 TIU and THEMIS radiance morphology. This map displays TES albedo over MOLA shaded elevation, bounded between 50 degrees latitude.
Figure 2. Examples of bedrock with dendritic outcrops. A1) THEMIS regional context image showing a bedrock plain in Tyr-
rhena Terra (white outline) and surrounding highlands plateau (black outline). A2) CTX mosaic showing bedrock plains material
occupying a sinuous path at the base of a major incised highlands valley network. B) Bedrock materials in Terra Cimmeria.

Sinuous ridge systems varies between bedrock plains. In some bedrock plains, sinuous ridges exist as short
segments near the base of incised highlands valley networks (Figure 3a). HiRISE imagery of these sinu-
ous ridges shows that these ridges are tonally layered (Figure 3b). In other bedrock plains, sinuous ridge
systems exist as winding, broken segments within relatively low-gradient regions (Figure 3c). HiRISE im-
agery of one bedrock plain with broken sinuous ridge segments shows tonally-layered bedrock materials with
high erosional susceptibility. (Figure 3d). These observations may indicate significant fluvial input into
intercrater bedrock plains.

Light-Toned Material with Sinuous Outcrop Patterns: Some Terra Cimmeria bedrock plains con-
tain small outcrops of light-toned surfaces. These mate-
rials, which have a sinuous outcrop pattern, are inset
within a broader (200-300 m wide), several km long of
texturally-featureless materials (Figure 4a). Available
HiRISE imagery of the light-toned materials shows that
they have a coarse (10-20 m scale) polygonal texture
(Figure 4b). The broader, texturally-featureless mate-
rials appear to form a thin (5-10 m thickness) capping
unit that overlies the light-toned material. Both the
light-toned material and the capping unit appear to be
frangible. It is unclear whether these materials form part
of a stratigraphic sequence within bedrock plains mate-
rials, or represent later modification and deposition.


Acknowledgements: This work was funded by
NASA MDAP NNX14AM26G. Image analysis was
performed using JMARS and HiView.