GEOMORPHOLOGICAL MAPPING OF THE HARGRAVES EJECTA AND POLYGONAL TERRAIN ASSOCIATED WITH THE CANDIDATE MARS 2020 LANDING SITE, NILI FOSSAE TROUGH.

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Introduction: The Nili Fossae are a set of concentric grabens to the northwest of Isidis Basin and north of Syrtis Major, and are believed to have formed due to crustal stresses following the Isidis Basin formation and infilling of Isidis Basin [1]. The Nili Fossae Trough (NFT) has been identified as a potential exploration site for NASA's Mars 2020 mission based on its mineral and geologic diversity [2]. NFT is the widest (average 25 km) and the longest (~600 km) of the grabens in this region. The landing ellipse (16 km x 14 km) is located approximately 145 km from the southern mouth of NFT (centred at 74^{o} 20'E, 21^{o}N) (Fig. 1). Previous work [3-5] revealed deposits containing alteration products such as phyllosilicates and carbonate minerals, as well as unaltered mafic materials. Additionally, approximately 50 km to the east of NFT is the 65 km diameter Hargraves Crater (Fig. 1); part of its ejecta blanket is found within the Trough and is included in the landing ellipse. It has been estimated [5] that the ballistic component of Hargraves ejecta may be derived from the first 3 km depth of target materials, while any melt-component in the ejecta may originate from deeper in the target (up to 7.2 km) [6]. However, due to the effects of ballistic sedimentation [7], the materials of the most distal portion of the ejecta blanket may be comprised of as much as 90% target surface materials entrained during ejecta emplacement [8].

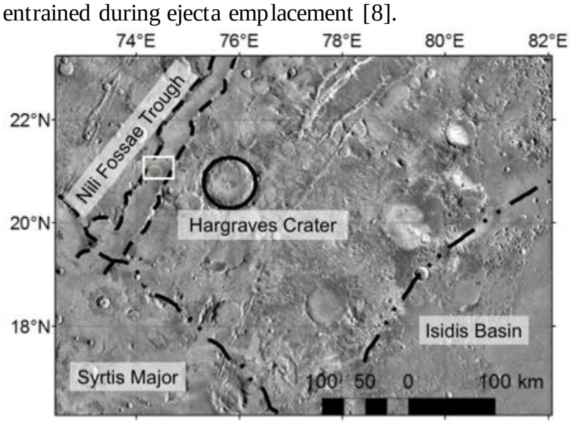


Fig. 1. THEMIS [9] daytime infrared mosaic image of the Nili Fossae Region. The study area, including the landing ellipse, is illustrated with a white box.

Here we present a detailed morphologic map (Fig. 2) of features in and around the landing ellipse, with emphasis on a portion of the western ejecta blanket of Hargraves Crater, located at the eastern margin of the Trough.

Methods: HiRISE (scale: ~25 cm/px) [10] and CTX (scale: ~6 m/px) [11] images from the Mars Reconnaissance Orbiter covering the landing ellipse and nearby areas within the bounds of the Trough were imported and projected as raster datasets into ArcMap, with the HiRISE images overlain on the CTX images to provide the highest resolution visible-image coverage. Features were defined as morphologic units based on these images on the basis of texture, tone, relief, and structure, and traced as vector polygon layers in ArcMap. Each feature or unit was symbolized with a different colour to illustrate their differences in morphology (Fig. 2) and aid in the determination of their relative stratigraphic relationships.

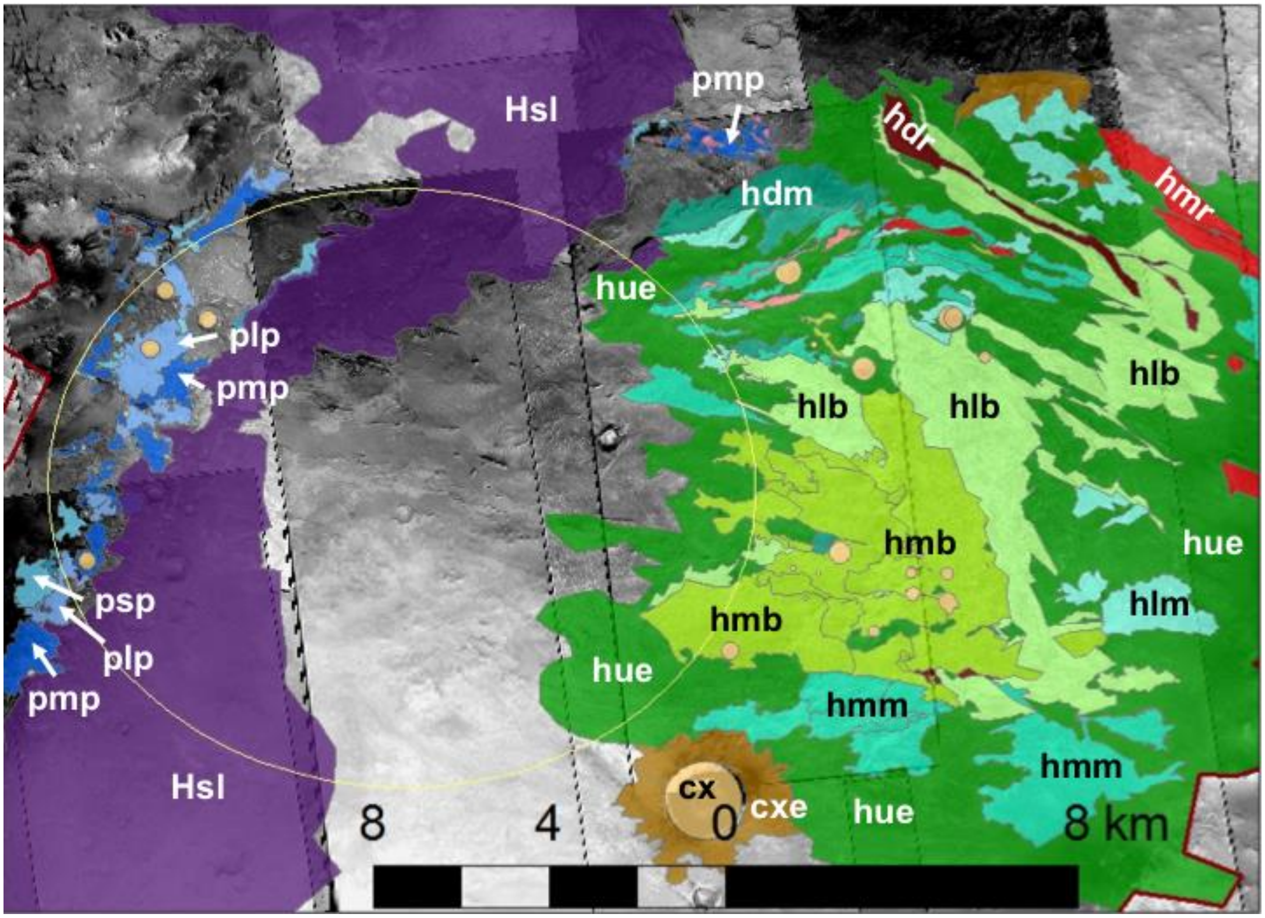
Results: We defined 22 different sub-units organized into two detailed map areas: the Hargraves ejecta blanket, and the polygonally textured surfaces (Fig. 2).

The Hargraves ejecta is characterized by relatively smooth light to dark-toned surfaces often manifesting as higher-standing sinuous ridges (hlr, hmr, hdr), light to medium-toned breccias (hlb and hmb) and a mix of these materials (hlm, hmm, hdm). Units hlb and hmb represent the majority of the exposed, high-relief surfaces. They are defined by their distinct texture of a lighter, irregular matrix containing darker-toned blocks or clasts ranging from the sub-pixel scale to hundreds of metres in diameter. The matrix is superimposed over a darker-toned material mapped as an undifferentiated ejecta unit (hue), and has been differentially eroded in places to reveal patches of this undifferentiated unit. In the northern part of this portion of the ejecta blanket, there are several sinuous ridges (hlr, hmr, hdr) that are interpreted to be more resistant to erosion than the surrounding breccias, as they are higher-standing and appear to be superposed over the lower-lying breccias.

The polygonal and fractured surfaces mapped in this study (units plp, pmp, pdp) consist of a lighter-toned surface separated into polygonal blocks ranging from ~1-6 m in size at their widest points, separated from each other by a network of irregular fractures no more than 1 m wide. In some areas, especially near the Hargraves ejecta blanket, this polygonal surface is associated with wider, sinuous fractures that appear to be intruding into the darker-toned country rock.

Discussion: Because such breccia deposits are rarely observed in high-resolution images of well-preserved craters that are comparable in size to Hargraves (*c.f.*, Mojave crater ejecta), we suggest that the ejecta blanket is eroded and well-exposed – likely the result of extensive erosion from aeolian processes. As such, this level of erosion offers us a unique opportunity to study the internal structure of an ejecta blanket, providing insights into the impact process. The smooth and sinous ridge forming unit may represent melt-bearing deposits, which offers unique preservation of biochemical signatures [12-14], and so this location is ideal for conducting *in situ* astrobiological investigations.

CRISM analysis [5] indicates that the polygonal surface found in this area may be hydrated and phyllosilicate-bearing. Studies of Toro Crater [15] and Holden Crater [16] revealed a strong correlation between areas that show a similar pattern of polygons and fractures as a replacement texture within what is interpreted to be the melt-bearing crater-fill deposits, and high relative levels of hydration. As phyllosilicates are often formed as aqueous alteration products and may be associated with polygonal textures [17], we hypothesize that the polygonal surfaces studied in this area may be the result of hydrothermal alteration.



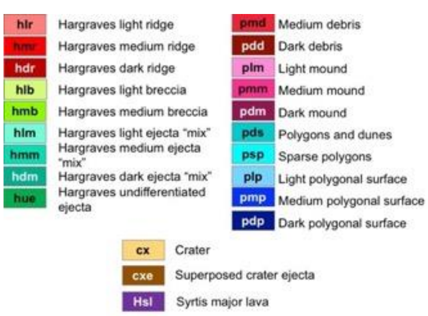


Fig. 2. Detailed morphological map of the Hargraves ejecta blanket (shades of green, teal, and red) and the polygonally-textured surfaces (shades of blue). The approximate extents of the Syrtis major lava, Hsl, [4,5] are coloured purple, while the planned landing ellipse is represented as a yellow elliptical outline.

Future Work: The main scientific inquiries to be addressed going forward include determining the mineralogical compositions of these morphological units through CRISM analysis; developing a stratigraphic model to illustrate the relationships between units; comparing the Hargraves ejecta blanket within the NFT to other places where it is exposed, as well as to similar craters such as Mojave; and completing more detailed mapping within the Trough itself, especially the Syrtis lavas and the full extents of the polygonally-textured surface, in order to determine the possible source of the hydrothermal alteration (i.e. its relation to events such as the Hargraves impact or Syrtis volcanism).

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