MAPPING OF LAYERED BEDROCK IN MARTIAN CRATERS: INSIGHTS IN TO CENTRAL UPLIFT FORMATION.

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Introduction: Central uplifts within complex impact craters expose faulted, rotated, and deformed deeply-seated bedrock from the subsurface and thus provide important insights with respect to the subsurface geology of planetary bodies [1,2] Details of the mechanics of central uplift formation, including weakening mechanisms, remain poorly constrained. In this study, three Martian complex craters with central uplifts exposing layered bedrock were selected for detailed mapping. The craters are all ~30 km in diameter, contain well-exposed bedrock, and are located in Hesperian ridged plains volcanic geological unit [3]. Here, we present the results of preliminary morphologic and structural mapping of these three unnamed Martian craters.

Data and Methods: The Mars Reconnaissance Orbiter (MRO) carrying the High Resolution Imaging Science Experiment (HiRISE) provides images and Digital Elevation Models (DEMs) with resolutions as high as ~0.25 and ~1.0 m/pixel, respectively [4]. HiRISE data can resolve small-scale features on central uplifts that allow detailed structural and morphological mapping.

HiRISE images as the base layer and ESRI ArcGIS and JMARS software were used to map the three craters in our study. Geological units were mapped by correlating similar unit morphologic characteristics. Mapping of structural features include dykes, faults, folds, and layer orientations. Morphologic and structural mapping is complete for the crater that exhibits the best exposure out of the three craters.

Results and Discussion:

Layered Bedrock. This morphological unit consists of darker-toned, lava layers alternating with lower-standing, weaker, lighter-toned, lower albedo, sedimentary or volcanogenic (possibly ash) layers [1-2, 5-6]. These layers are assumed to have been relatively flat-lying prior to impact. The layers are reported to have a mixture of strong spectral signatures of olivine and high calcium pyroxene; typical of basalts and consistent with a volcanigenic origin [6]. There are multiple exposures of bedrock that appears to have been fractured, folded, faulted, and uplifted into large megablocks that occurred during crater formation [2].

Folding and Faulting. The uplifted layered megablocks range from 100's to 1000's of metres in diameter and expose almost vertical overturned beds, consistent with the observations of Wulf et al. [7] at Martin crater. These blocks can sometimes be partially covered by impact melt and aeolian deposits. Radial folding of a few 100 metres in width and minor displacements of a 20 - 30 meters can be clearly seen within these large megablocks. The folding may be a series of faults referred to as a radial transpression ridge [8] consistent with high strain rates and the non-ductile behavior of rocks during an impact event.

The megablocks are clearly bounded by radial faults with larger displacements that contain a great deal of breccia.

Uplift of the blocks. All three of the crater's central features display varying elevations and diameters of uplift. This may be due to the influence of the target lithology and/or varying degrees of erosion to the surface. It is possible that the pre-existing layered volcanic and wrinkle ridges known to occur in this area cause pre-existing weakening within the target rock that allows these blocks to form. Also, one of the craters rests near a contact of older Noachian target lithology and the Hesperian volcanics, which also may contribute to the different size and exposure of the megablocks.

Breccia Dykes. Dykes within the three layered central uplifts exhibit displaced, tabular bodies, and are typically oriented approximately radially with respect to the centre of the crater. They crosscut the layered bedrock in all three of the selected layered central uplifts but are themselves offset by faults that are necessarily later. The dykes range from ~1 to 50 m in width and up to 1 km in length. Some well exposed dykes contain clasts in a smooth low albedo matrix, supporting the hypothesis that some may be breccia dykes.

Future Work: Future work in this study will measure strike and dip of the central uplifts using HiRISE DEM's, to further understand structural deformation. Mapping other craters with central uplift bedrock morphologies that include megabreccia and massive-fractured bedrock types will also be completed to see similarities and differences in regards to there formation and these target types [5, 9].

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