MORPHOLOGICAL AND STRUCTURAL MAPPING OF MASSIVE-FRACTURED BEDROCK IN CRATER CENTRAL UPLIFTS ON MARS. B. D'Aoust[1], L. L. Tornabene[1], G. R. Osinski[1, 2] and A. S. McEwen[3], [1]Centre for Planetary Science and Exploration/Dept. Earth Sciences/Physics and Astronomy, University of Western Ontario, London, ON N6A 5B7, Canada, (bdaoust2@uwo.ca), [3]Lunar and Planetary Laboratory, University of Arizona, Tucson Arizona, USA.

Introduction: The central uplifts of complex Martian impact craters comprise uplifted outcrops of deep-seated bedrock, some of which may represent the early Martian crust. Exposures of primitive crustal materials in these uplifts can provide information about the petrogenetic and alteration history within the Martian crust. However, the study of Martian central uplifts is complicated by the fact that the bedrock can be draped and intruded by rocks formed during the impact process itself (e.g., impact melt). Furthermore, post-impact erosion and deposition (e.g., aeolian, volcanic, fluvio-lacustrine, etc.) from other processes occurring on Mars also have to be taken into account.

Three main types of parautochthonous (i.e., pre-exisiting crater-exposed) bedrock observed within complex impact craters on Mars include: layered, massive-fractured and brecciated bedrock [1-2]. The objective of this study is to carry out detailed geological and spectral mapping of complex impact craters exposing the massive-fractured type of bedrock, starting with the morphological and structural mapping of the crater Alga. The goal is to use these maps to provide a synthesis of the various data sets used to construct these maps towards an improved understanding of the geologic history of Mars and the impact process, particularly the formation of central uplifts.

Background: Included in the Crater-Exposed Bedrock (CEB) database compiled by Tornabene et al. [1-2], Alga (333.3º E, 24.3º S) is a ~19 km diameter complex impact crater located within the outer rings of Ladon Basin just east of the Margaritifer-Uzboi Valles system [3]. The target materials may be comprised of the ejecta of the Argyre basin [3]. However, Alga Crater is also located within both the Ladon impact basin and Chekalin Crater, a larger complex impact crater, as such implications of these landforms are suggested to contribute to the target materials from which Alga sampled. The 200 m high [3] central uplift contains very good exposures of fractured-massive bedrock and breccias. Spectral analyses by Skok et al. [3] found moderate-Fe pyroxenes enriched in low-Ca as well as fayalitic olivine. They divided the terrain at Alga into four geological units: (1) a light-toned olivine-bearing unit; (2) a pyroxene-bearing bedrock unit; (3) a light-toned pyroxene unit observed on the crater floor; and (4) a fine-grained deposit, interpreted to be impact melt rock.

Methods: The detailed morphological and structural mapping of Alga will be performed through the ESRI ArcGIS software using Mars Reconnaissance Orbiter (MRO) High Resolution Science Experiment (HiRISE) orthoimages at 30 cm/pixel [4], and Context Camera (CTX) visible images at 6m/pixel [5], which provides a regional context of the surrounding geology. A HiRISE Digital Terrain Model (DTM) was derived from HiRISE stereo images PSP_007573_1555 and PSP_007929_1555, and covers most of Alga's central uplift at 1.00 m/pixel resolution. The HiRISE images were georectified using a script created by Trent Hare from the U.S. Geological Survey (USGS) which overrides the JP2 projection for a more accurate one [6]. Overall, all the images are tied to Mars Orbiter Laser Altimeter (MOLA) as a base map starting with the coarsest resolution data sets and moving to progressively higher resolution.

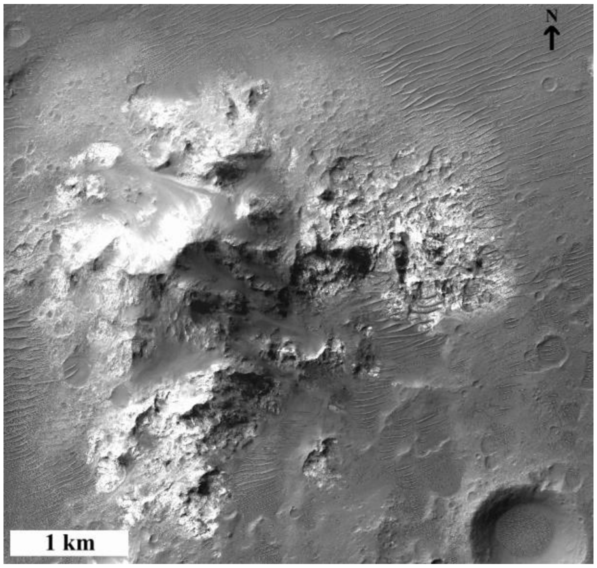


Figure 1: Digital Terrain Model (DTM) of Alga's central uplift created in ArcScene. HiRISE orthoimage PSP_007573_1555 is draped over DTM.

Results: The geological units described below are based on the morphological and textural characteristics observed in the central uplift of Alga. Figure 2 illustrates a digitized area located within the light-toned pyroxene-bearing unit identified by Skok et al. [3].

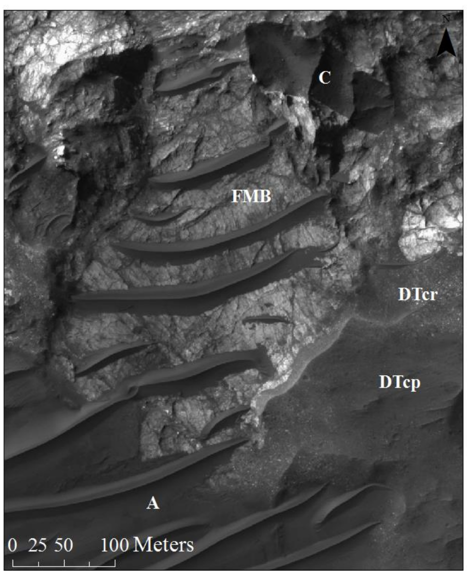
This portion of the uplift is unique in that it represents a type locality and encompasses most of the main morphologic units observed in the central uplift of Alga.

Fractured and Massive Bedrock (FMB). This massive and fractured light-toned unit is consistent with other uplifts bearing this texture across Mars [3-7]. This unit comprises most of the southern and eastern areas of the crater floor of Alga where pyroxene-bearing outcrops are well-exposed and brecciated. Fractures are common within this unit. CRISM data indicates spectral signatures of a moderately high-Fe, low-Ca pyroxene. Figure 2 illustrates a small area within this light-toned pyroxene-bearing unit.

Dark-toned unit (DT). This generally smooth clast-rich to clast-free dark-toned unit is prominent on the northwestern downsloping wall of the central uplift and covers the northern, southern and eastern flanks of the central uplift where it is clast-free. At the crater floor, it contains metre-sized clasts. Based on previous observations [e.g., 2], this unit is consistent with impact melt-bearing deposits with a varying clast content. Both clast-rich (DTcr – Unit 2) and clast-poor facies (DTcp – Unit 2) are observed within the area and shown in Figure 2.

Aeolian Bedforms (A). This post-impact depositional unit occurs in depressions and/or lower elevations. It is interpreted and clearly illustrates discrete aeolian bedforms that are formed by saltation [8].

Dark Clasts within FMB unit (C). Various large-sized, dark-toned clasts appear to occur within the massive-fractured bedrock unit. A large clast is shown in Figure 2.



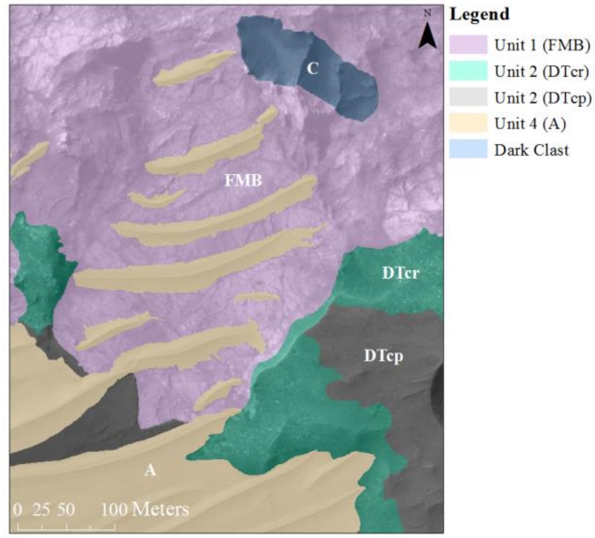


Figure 2: (a) HiRISE RED orthoimage of small area located within the light-toned pyroxene unit on the eastern floor of Alga's central uplift. (b) Digitized polygon shapefiles showing *FMB*, *DT*, *A*, and *C* previously defined geological units.

Discussion: The central uplift of Alga is very well exposed and provides an insight into the nature of massive bedrock component of the Martian crust, as it has been noted in other craters [1-2]. Impact melt rocks are common draping the central uplifts of many Martian impact craters [e.g., 2-9]. As such, high-resolution imagery is critical in order to ground-truth observations made with other lower-resolution instruments, including spectroscopic determinations of the composition (e.g., CRISM) of these distinctive morphologic units.

References: [1] Tornabene L. L. et al. (2010) *41st LPSC*, Abstract #1737. [2] Tornabene L. L. et al. (2014) *8th International Conference on Mars*. [3] Skok J. R. et al. (2012) *J. Geophys. Res.*, 177, E00J18. [4] McEwen A. S. et al. (2007) *J. Geophys. Res.*,112, doi: 10.1029/2005JE002605. [5] Malin M. C. et al. (2007), *J. Geophys. Res*., doi:10.1029/2006JE00280. [6] Hare T. Available from: ftp://pdsimage2.wr.usgs.gov/pub/pigpen/Perl/arcmap9_fixjp2.pl [7] Tornabene L. L. et al. (2012) *3rd Early Mars*, Abstract #7069. [8] Carr M. H. (2006) *Cambridge University Press.* [9] Marzo G. A. et al. (2010) *Icarus, 208, 667–683.*