THE GALE CRATER MOUND IN A REGIONAL GEOLOGIC SETTING: COMPARISON STUDY OF WIND EROSION IN GALE CRATER AND WITHIN A 1000 KM RADIUS.

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Introduction: Gale is a Late Noachian/Early Hesperian impact crater located on the dichotomy boundary separating the southern highlands and the northern lowlands of Mars [1,2]. NASA's Curiosity Rover is currently exploring Gale, searching for evidence of habitability early in Mars history. With an approximate diameter of 155 km, and a ~ 5 km central mound informally titled Mt. Sharp, Gale represents a region of geologic interest due to the abundance of knowledge that can be derived, through its sedimentary deposits, pertaining to the environmental evolution of Mars [2][Fig. 1]. This study was undertaken to compare wind erosional features in Gale Crater and within sediments in a 1000 km radial area. The ultimate objective of this comparison was to determine if or how Gale relates to the surrounding region.

Large scale aeolian erosional features called yardangs are a proxy for prevailing wind direction over an extended period of time. Thomson et al. [1] mapped several yardang units in the Lower Mound (LM) and Upper Mound (UM) of Gale, and similar features have been noted in studies of the Medusae Fossae Formation (MFF) near the dichotomy boundary [3, 4]. The MFF is comprised of three members: upper, middle, and lower [5]. Only the latter two members are located within 1000 km of Gale [Fig. 2]. The MFF is thought to be Hesperian-Amazonian in age and formed from volcanic ash [4,6]. It contains the largest concentration of yardangs on Mars [7]. Yardangs are valuable tools for correlation studies of Gale and the surrounding regional geology.

Methodologies: Wind directions of yardangs inside and outside of Gale were mapped using the Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) mosaic in Mars - Google Earth [Fig. 1]. Geologic map units of Thomson et al. [1] were used to define mound boundaries of the interior of Gale. Image overlays were created to correlate Thomson et al.'s units with mapped yardang units inside the crater.

Lower and middle members of the MFF were outlined in Mars - Google Earth. Formation extent was taken from U.S. Geological Survey map I-1802-B [8]. Images from the High Resolution Imaging Science Experiment (HiRISE) website were used, in several locations, to identify yardangs within the MFF and to determine yardang orientations on a finer scale.

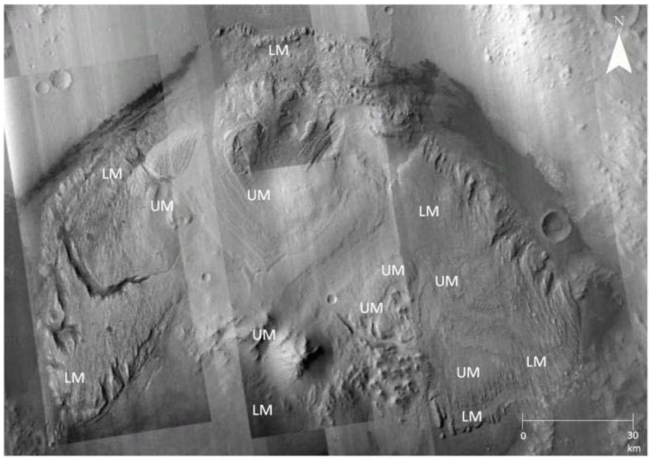

Fig.1. CTX mosaic of Gale crater with lower mound (LM) and upper mound (UM) unit labels.

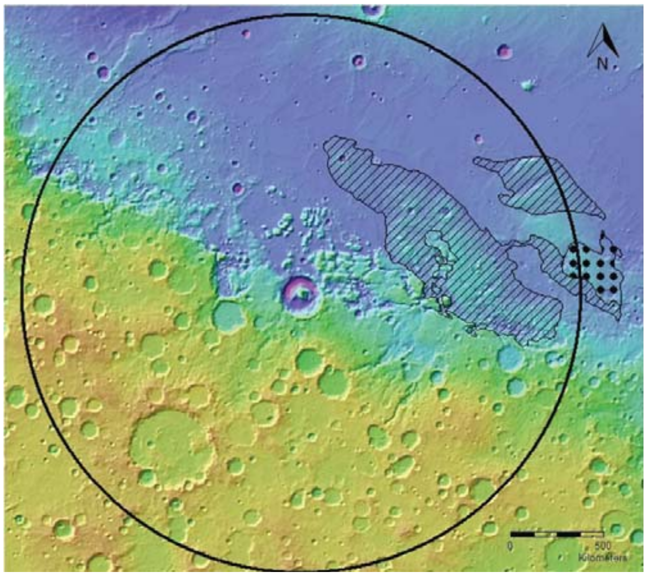

Fig.2. Image of Gale Crater from the Mars Orbiter Laser Altimeter (MOLA) dataset prepared by the U.S. Geological Survey with lower member (lines) and middle member (dots) MFF units outside of Gale. Black circle represents 1000 km radius.

Results: Yardangs are positioned parallel to the prevailing wind direction [9]. This information was used to determine feature orientation inside and outside of Gale.

Aeolian Erosion Inside Gale. The UM exhibited small scale yardangs with diverse orientations (N-S, NE-SW, and NW-SE) [Fig. 3]. In contrast, the larger yardangs of the LM exhibited a more consistent nearly N-S orientation, suggesting a N-S prevailing wind during their formation. [Fig. 3].

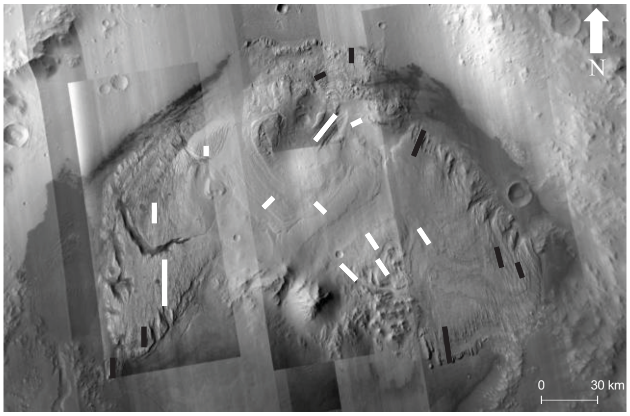

Fig.3. Wind directions (determined form yardang orientations) of LM (black) and UM (white) overlain on

Aeolian Erosion Outside Gale: Yardangs outside of Gale were predominantly located to the northeast, in the northern plains units, and along the dichotomy boundary. Yardang orientations included NW-SE, NE-SW, N-S, and E-W. The lower member of the MFF contained the majority of yardangs with a prevailing NW-SE orientation [Fig. 4]. The middle member of the MFF within 1000 km of Gale contained significantly fewer yardangs with a prevailing orientation of NW-SE. These observations suggest a predominant NW-SE eroding wind over the course of MFF erosion history.

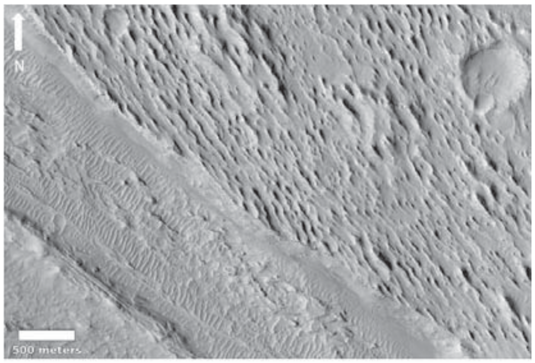

Fig.4. NW-SE oriented yardangs located in the lower member of the MFF (HiRISE: ESP_028717_1795).

Discussion/Conclusion:

Differences in wind directions deduced from yardang orientations in the lower and upper mounds indicate changes in prevailing wind direction over the course of Gale's history. This suggests a significant gap in erosion of the lower and upper mounds. It is possible this shift is related to an overall global climatic change.

Given that the presence of an erosional unconformity separating the LM and UM is indicative of a break in Gale's depositional sequence, wind direction findings further support the idea of a two part history for the crater [1].

Yardangs within the MFF outside of Gale (lower and middle members) exhibit orientations most closely related to the UM of Gale and suggest a varied wind regime history dominated by NW-SE winds.

The age of UM sediments is unknown [1]. However, they may have been deposited at the same time as MFF material, possibly during the Amazonian [2]. Similar orientations of UM and MFF yardangs outside of Gale suggest a potential correlation in sediment erosion history.

Future investigations should focus on correltation of sediment origin through compositional analyses of yardangs inside and outside of Gale. Discoveries of the Curiosity Rover, currently en route to Mt. Sharp, will aid in a more comprehensive understanding of Gale's past.

References: [1] Thomson et al. (2011) *Icarus,* 214, 413-432. [2] Milliken et al. (2010) *GRL,* 37, L040201. [3] Kerber and Head (2010) *Icarus* 206*,* 669-684. [4] Irwin R.P., Watters, T.R., Howard, A.D., and Zimbelman J.R. (2004) *JGR*, 109, E09011. [5] Mandt K.E., de Silva, S.L., Zimbelman, J.R. (2008) *JGR*, 113, E12011. [6] Zimbelman J. R. and Scheidt S. P. (2012) *Science, 336,* 1683. [7] Bridges et al. (2007) *GRL*, 34, L23205. [8] Greeley R. and Guest J.E. (1985) *USGS* I-1802-B. [9] Greely R. and Iversen J.D. (1985) Cambridge University Press, 333 p.