CONSTRAINTS ON DEGRADATION AT THE INSIGHT LANDING SITE, HOMESTEAD HOLLOW, FROM ROCK HEIGHTS AND SHAPES. J. A. Grant[1], S. A. Wilson[1], M. Golombek[2], A. Trussell[2,3], N. H. Warner[4], N. Williams[2], C. M. Weitz[5], H. Abarca[2], R. Deen[2], [1]NASM CEPS, Smithsonian Institution, 6th at Independence SW, Washington, DC, 20560, grantj@si.edu, [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [3]California Institute of Technology, Pasadena, CA, [4]SUNY Geneseo, Department of Geological Sciences, 1 College Circle, Geneseo, NY 14454, [5]Planetary Science Institute, 1700 East Fort Lowell, Tucson, AZ, 85719.

Introduction: The *InSight* mission (Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport) landed in western Elysium Planitia, Mars, at 4.502°N, 135.623°E on an Early Amazonian basaltic lava plain capped by ~3 m of impact-formed regolith derived from underlying bedrock [1-3]. The lander is in a degraded, ~400-700 Myr old, ~27 m-diameter, 0.3 m deep impact crater dubbed "*Homestead hollow*" [3-5] (**Figs. 1 and 2**). Prior evaluation of nearby craters in varying degradation states [5-6] indicates the hollow is 10-20% enlarged, was originally ~22-25 m-diameter, and had a 0.7 m high rim [5-6] (**Fig. 2**).

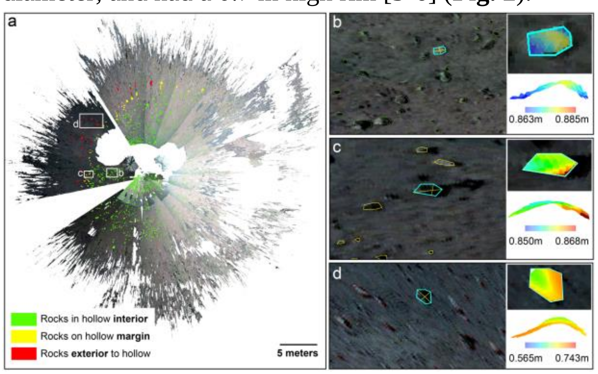

Fig. 1. a) Instrument Deployment Camera [IDC, 7-8] orthomosaic coverage of *Homestead hollow*. White gores are data gaps. Rock heights and shapes were measured in the hollow (green, 1,850 rocks), within ~1 meter of the NW hollow margin (yellow, 68 rocks), and on the NW exterior (red, 85 rocks,). Example mapped rocks: (**b**) interior; (**c**) margin; and (**d**) exterior. Locations of **b-d** shown in **a**. North to top.

Methods: We measured orthogonal dimensions of rocks >1 cm and >3 cm within 10 m of the lander from a panorama DEM and orthomosaic (**Fig. 1**) created from 283 stereo IDC images. Rock heights and three-dimensional shapes are used to assess the varying amount and number of processes degrading the hollow over time. Finally, we compare expected original ejecta thickness with exposed relief on exterior rocks whose bases remain partially embedded to understand how rock exposure may reflect deflation and hollow infilling.

Results: For rocks >1 cm, the statistical mean height from the exterior to the interior decreased from 6 cm (standard deviation or std 0.089), to 4 cm (std 0.079), to 1 cm (std 0.02). The height of rocks >3 cm decreases from 6 cm (std 0.089), to 4 cm (std 0.081), to 2 cm (std 0.033) from the exterior to the interior (**Fig. 3a and b**). For both >1 cm and >3 cm data sets, rock heights for the exterior, margin, and interior of the hollow are the shortest measured axis for 78%, 89-91%, and 97% of the rocks, respectively. The 10 tallest exterior rocks stand 23-30 cm in exposed relief (five largest are >28 cm in height), and 22% of the rocks are >10 cm tall. The 10 tallest margin rocks stand 4-33 cm in exposed relief (five largest are 25-34 cm in height), with 10% of the rocks >10 cm tall. The 10 tallest interior rocks stand 14-26 cm in exposed relief, but only 1-3% are >10 cm tall.

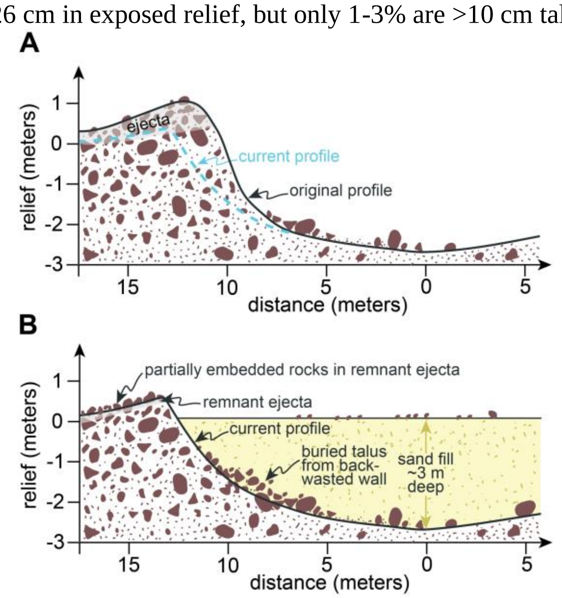

Fig. 2. Schematic cross-section through the original (A) and current (B) *Homestead hollow*. The cross-sections assume the hollow is a primary impact structure. The crater formed into a pre-existing regolith with few large rocks and abundant sand-sized fines [7, 9-10]. Aeolian deflation of most ejecta and downwind infilling of the crater accompanied by early mass-wasting caused the present muted expression.

The form factor [11] of *InSight* rocks in all areas appears more platy-to-bladed-to-elongate relative to basalt rocks at Lonar crater [12] and other terrestrial environments [13-14] (**Fig. 4**). A plot of rock shape based on various ratios of the axes [15-16] shows the *InSight* rocks appear more discoidal and bladed than terrestrial basalt rocks. Nevertheless, addition of 10 cm to rock heights outside the hollow to account for continued partially embedding in the originally ~40 cm-thick near-rim ejecta leads to a good match between the *InSight* and terrestrial rock shapes.

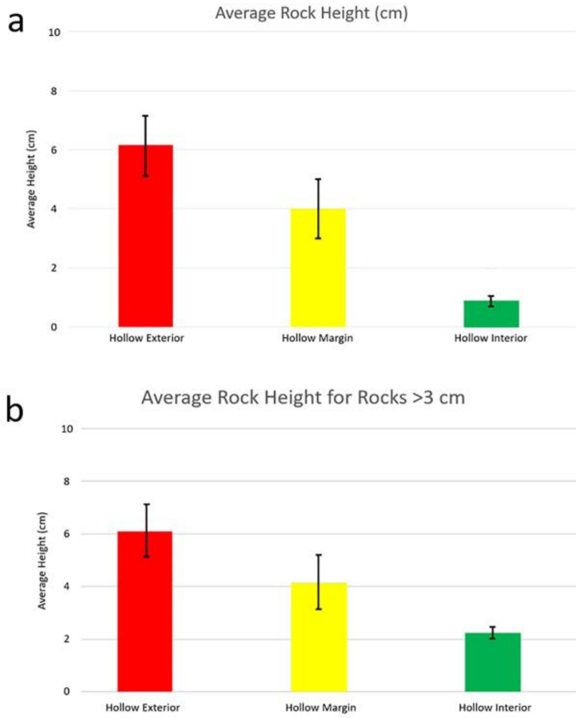

Figure 3. a) Average height of rocks >1 cm and **b**) >3 cm decreases from the exterior, to the margin, to the interior of *Homestead hollow* Bars are standard error.

Discussion: The rocks heights (**Fig. 3**) and shapes (**Fig. 4**) around and within *Homestead hollow* provide evidence regarding degradation over time that is consistent with processes inferred from prior studies [3-5]. Decreasing rock height from outside to within the hollow is consistent with greater exposure on the exterior due to deflation with subsequent downwind infilling of the hollow interior. Moreover, our observations, coupled with estimation of likely original ejecta properties and thickness, support deflation of 0.3 m from the ejecta at the current rim, up to 40 cm at the original rim, and decreasing amounts beyond the current rim. If 50% of the deflated sediment is transported into the hollow by prevailing wind (with the rest bypassing the hollow), the resultant contribution is close to the previously predicted 40% aeolian contribution [5-6]. Moreover, differences between observed versus expected [e.g., 12-14] rock shapes on the exterior of the hollow largely disappear when 10 cm is added to rock heights to account for embedding of rock bases in the remnant ejecta (**Fig. 4**).

Finally, we interpret continued exposure of mostly embedded ejecta rocks capping the hollow fill as consistent with prior estimates of only 4-10 m/Myr degradation over the past 300-600 Myr history of the hollow [5-6]. Our results suggest a significant fraction of deflated sediments bypassed the hollow via prevailing winds and may contribute to nearby bedforms and (or) regolith/soil formation. Because Hesperian to Amazonian regolith-mantled volcanic surfaces are widespread on Mars [17], our approach is a new tool for understanding local degradation history on the planet [18].

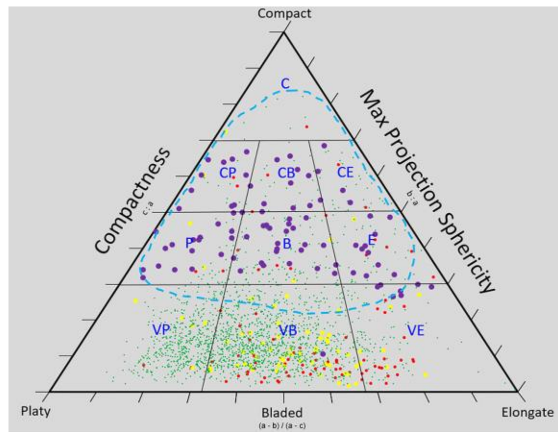

Fig. 4. Form factor (plotted using TRI-PLOT, see [11]) of basalt rocks within (green dots), around (yellow dots), and outside (red dots) the hollow differs from basalt rocks at Lonar crater [12] and other terrestrial environments [13-14] (blue dashed line). Each purple dot corresponds to a red dot, but with 10 cm added to the height. The purple dots indicate rock shapes at *InSight* are probably similar to the shape of basalt rocks in terrestrial environments.

References: [1] Banerdt, W. B., et al. (2020). Nat. Geosci., 13. [2] Golombek, M., et al. (2020). ESS, 7. [3] Golombek, M. P., et al. (2020). Nat. Comm, 11. [4] Grant, J. A., et al. (2020). JGR, 125. [5] Warner, N. H., et al. (2020). JGR, 125. [6] Sweeney, J., et al. (2018). JGR, 123, 2732. [7] Golombek, M. P., et al. (2021). ESS 8. [8] Maki, J., et al. (2018). Space Sci. Revs., 214. [9] Golombek, M. P., et al. (2018). 49th LPSC, #2319, LPI. [10] Golombek, M., et al. (2020). 51st LPSC, #2744, LPI. [11] Graham, D. J., & Midgley, N. G. (2000). Earth Surf. Proc. Land., 25. [12] Senthil Kumar, P., et al. (2014). JGR, 119. [13] Ehlmann, B. L., et al. (2008). JGR, 113. [14] Craddock, R. A., and Golombek, M. P. (2016). Icarus, 274, 50. [15] Zingg, T. (1935). Beitrage schotteranalyse, Schweizerische Mineralog. und Petrograph. Mitteilungen, 15. [16] Sneed, E. D., & Folk, R. L. (1958). J. Geology, 66, 114. [17] Tanaka, K., et al. (2014). Geol. Map of Mars, USGS Sci. Inv. Map 3292. [18] Grant, J. A., et al. (2021). ESS. https://doi.org/10.1029/2021EA001953.