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Geology of the Insight Landing Site, Mars: Initial Results

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Introduction

The InSight spacecraft landed successfully on Mars on November 26, 2018 at 4.50°N, 135.62°E. A large number of color images from an arm-mounted camera, including stereo coverage at two resolutions of the instrument deployment workspace and panoramic image mosaics, provide information on the geology of the landing site. Such geologic characterization provides essential context for the analysis of data acquired by all InSight instruments.

1. Regional and Local Geology

InSight landed on Hesperian to Early Amazonian lava plains that have been processed by impact gardening and eolian erosion and transport since then [1]. The near surface is characterized by 1-10 m diameter impact craters [2] in various stages of degradation [3], partly associated with eolian bedforms. The minimum diameter of craters which produce rocky ejecta indicates a regolith thickness of a few meters [4]. The lander is located within a degraded crater, dubbed Homestead hollow, with a smooth surface adjacent to a slightly rougher terrain with rocky ejecta craters nearby. Homestead hollow has a diameter *(D)* of ~25 m, corresponding to a pristine depth *(d)* of ~3.8 m (d=0.15D [3]), and a present-day relief of ~0.8 m suggesting an infill from rim degradation and ~0.9 m to 1.2 m externally-derived eolian infill [4] of fine-grained material. Farther afield, bright circular patches suggest soil-filled craters are common. No bedrock has been observed.

2. Surface characteristics

The surface of Homestead hollow is made of smooth plains with low rock abundance (~2% [5]), and the resolvable particle size distribution is dominated by pebbles with slightly buried cobbles. Some pebbles and protrusions have what appear to be wind tails that extend radially away from the lander (Fig. 1). At least one rounded rock rolled across the surface creating divots and elongated depressions (Fig. 1). Post-landing HiRISE images show a dark spot centered on the lander. In the workspace nearest the lander, the surface appears scoured, with multi-millimeter-relief ridges and troughs that extend radially from the lander. These observations are consistent with the pulsed-descent motor exhaust removing surficial dust and granules to create the dark spot, as well as sculpting loose sand to create the scours and moving some pebbles. We measured clasts in the workspace area (Fig. 2a and 3) and found that cobble and pebble shape and form are equant to sub-equant and angular to sub-angular, respectively (Fig. 2b), consistent with an origin via fragmentation. Some of the clasts closest to the lander have a dark grey color and appear aphanitic, consistent with fine-grained, dark mafic rocks (basalts). Other clasts appear lighter in albedo as if covered by dust and/or weathering rinds. At least one rock appears fluted, suggesting eolian abrasion (ventifact).

3. Stratigraphy

Three 10-20 cm-deep pits excavated by the retrorockets beneath the lander provide clues to the near surface structure (Fig. 4). In one pit, the subsurface material is poorly sorted with pebbles and cobbles. Another pit has a steep slope (greater than the angle of repose) composed of small clasts and pebbles cemented in a finer-grained matrix (duricrust). Two footpads show evidence for slight sliding into place, creating a depression on one side and bulge in the direction of travel. These observations suggest a near surface stratigraphy of surficial dust over thin cohesionless sand, lying over a variable thickness (centimeters) duricrust, underlain by poorly sorted, cohesionless sand and clasts (Fig. 5) [6]. Orbital thermal inertia measurements are consistent with a surface dominated by sand-sized particles, consistent with the cohesionless fines and the low rock abundance.

In summary, the observations are consistent with a surface formed dominantly by impact, mass wasting, and eolian processes that created an impact-generated regolith composed dominantly of sand-sized particles with decreasing abundance of pebbles, cobbles and boulders (Fig. 6), consistent with expectations established from remote sensing data prior to landing.

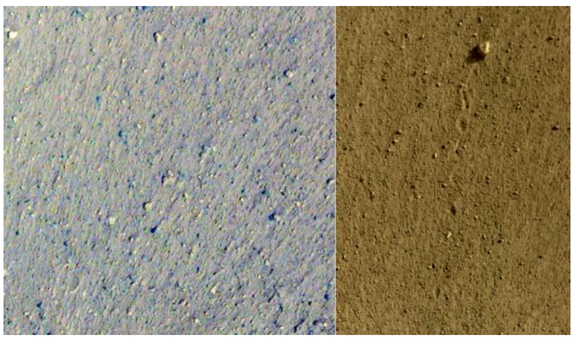

Figure 1: *(left)* Detail of the workspace, showing a radially scoured surface (lander to the lower left) and particles with wind tails. *(right)* Particle displaced by retrorocket blast.

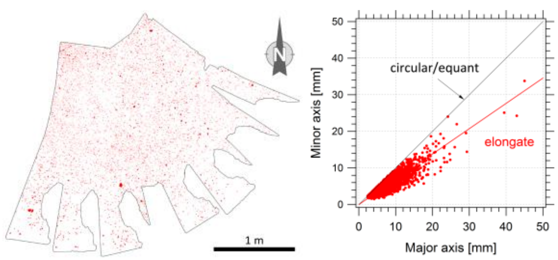

Figure 2: *(a, left)* Part of the workspace with mapped clasts (N=8252; area=5.339 m^2). *(b, right)* Diagram showing cast shape (equant to sub-equant).

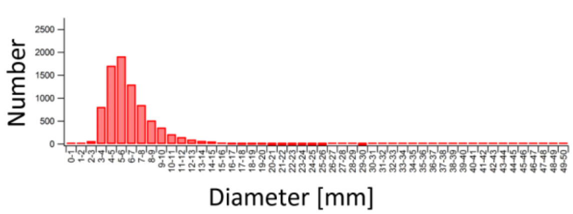

Figure 3: Particle sizes over the measured diameter range (range= 2 mm to 54 mm; mean=5.96 mm).

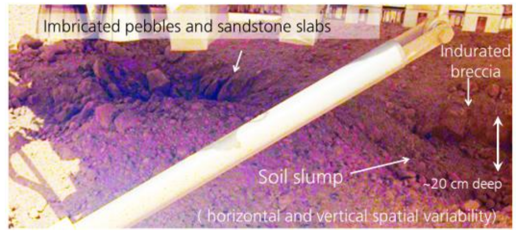

Figure 4: Area beneath the lander with struts, retrorockets, and excavated pits (10-20 cm deep). Steep pit walls (> angle of repose) indicate cemented duricrust.

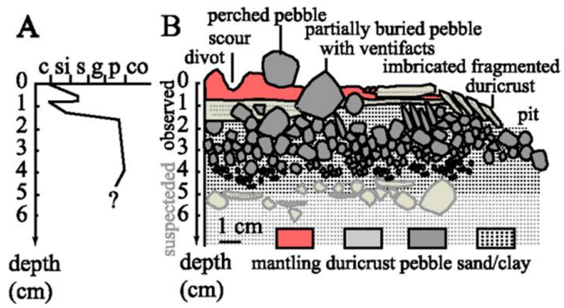

Figure 5: A. Dominant granulometry (c: clay, si: silt, s: sand, g: granule, p: pebble, co: cobble). B. Idealized very near-surface cross-section of regolith beneath and in surroundings of InSight lander.

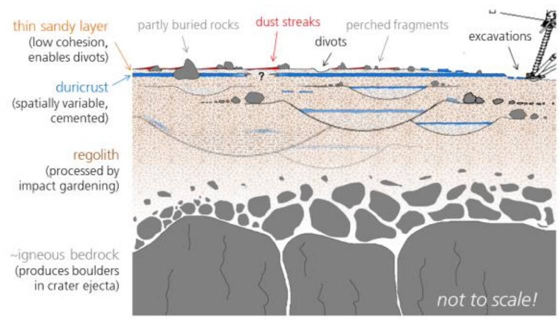

Figure 6: Idealized cross-section of surface and regolith down to the bedrock (=Hesperian to Early-Amazonian lava flows). Duricrust may have formed at different times in the past and was constantly disrupted by new impacts.

References

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