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Insight landing site: stratigraphy of the regolith beneath the lander and in its surroundings, and implications for formation processes.

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On November 26, 2018, the InSight lander touched down within Homestead hollow, a subdued and filled depression on Late Hesperian, highly cratered volcanic plains of western Elysium Planitia, Mars. Both using the lander-mounted Instrument Context Camera (ICC) and the robotic arm-mounted Instrument Deployment Camera (IDC), the terrain surrounding and beneath the lander was imaged, showing a a smooth, sandy surface with additional >cm scale clasts, ranging from pebbles to very few cobbles. Close to the lander, pebbles and cobbles show two distinct types of materials: dark-toned, grey aphanitic one probably corresponding to a basaltic composition, and light-toned one with unknown composition and origin. The particles display a variety of shapes, from sharp angular edges to sub-angular ones, partly associated with wind-erosion features (ventifacts). Some particles are partially buried, showing that sedimentary processes are or were active after their deposition (i.e. sedimentation or aeolian erosion is very efficient at present-day).

The texture and near surface structure of regolith have been exposed by landing rocket-induced excavations under the lander, showing a variety of clast sizes, arrangements and texture at horizontal meter-scale (distance between lander feet). From these observations, stratigraphic sequences are proposed as following from top to bottom: i) a cm-scale thick layer consisting of light-toned, cohesionless, <mm-scale grain sizes ranging from clay to fine sand. It was partially removed by the rocket blast as shown by cm-scale erosive streaks and divots around the lander [6,7]; ii) a mm-to cm scale thick, light-toned layer, consisting of indurated material “duricrust”, easily fragmented in flat polygons by lander feet. This duricrust shows lateral variations of textures, from fine-grained (i.e. <mm scale) to coarse-grained material (i.e. composed of poorly-sorted, angular to sub-rounded clasts, ranging from granule to cobbles with a majority of pebbles contained in fine-grained cement; iii) a cm-scale thick, cohesionless, granular material comprised of either dark-toned sand or poorly sorted material with sub-angular, dark-toned pebbles showing a weakly developed sub-horizontal planar layering, containing in a fine-grained matrix.

This stratigraphic succession is quite similar to the other Martian landing sites, notably if compared to the regolith in Gusev crater which consists of similar Hesperian volcanic host material: There is a cohesive duricrust near the sub-surface. It differs by a greater thickness (cm-scale).

This stratigraphic succession suggests that several processes modified the Late Hesperian/Early Amazonian lava flows of western Elysium Planitia into this clastic regolith during the last 3 billion years: impact gardening as the origin of clasts; aeolian erosion, transport and sedimentation, filling impact craters and intercrater plains, though the small excavations do not display sand cross-bedding; weathering as clast shape modification and the cementation to form duricrust.