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Rock distributions at the InSight landing site and implications from fragmentation theory

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The Discovery mission InSight successfully landed in western Elysium Planitia on November 26, 2018. Dedicated to the study of the martian interior, the lander is located at 4.502°N/135.623°E (planetocentric co-ordinates) within a quasi-circular, shallow depression now known as Homestead hollow. This is a heavily modified and degraded crater, with a smooth surface. Rock populations near the lander are mostly pebble sized with few large rocks. Beyond the hollow, more cobble and boulder size rocks are present.

In this work, we present an analysis of the rock population statistics of areas nearby the lander by using images from both the lander-mounted Instrument Context Camera (ICC) and the robotic arm-mounted Instrument Deployment Camera (IDC). Four main areas were identified for characterizing the rock abundance: 1) a high rock abundance area to the west of the workspace, 2) the low rock abundance workspace area, 3) the instrument footprints, and 4) the far-field radiometer (RAD) spot on the rougher and rockier terrain to the north-west of the lander.

The distributions are analysed both in cumulative fractional area (CFA) covered by rocks and cumulative number of rocks per meter squared. The workspace area of the lander within the inner hollow is shown to have a low rock abundance due to dearth of rocks larger than 10 cm. The higher abundance area shows the transition of the hollow to the rockier field to the west of the lander, possibly mixed with a disturbed area of duricrust fragments. At diameters below 5 cm, the slope of the distribution increases and most closely resembles clast counts on the Gusev cratered plains from Spirit. These rock distributions and CFAs are similar to the 2-3% measured at the Phoenix landing site and below the 5-7% at the Spirit landing site for diameters >10 cm. This is consistent with expectations from average rock statistics of the entire landing E9 ellipse.

The overall distribution can be fitted using a negative binomial function from fragmentation theory. The main parameter of the model, the maturity index, is consistent with the Hesperian surface age of the E9 landing ellipse. Given the statistics from fragmentation theory, the observed population is therefore estimated to be the product of $\sim$3 impacts on average. Extrapolation of the model down to sub-cm clasts and further below to an upper limit for saltating grains indicates an overall population rich in sand-sized material, consistent with orbital thermal inertia measurements and the low rock abundance at the landing site.