Detecting, discriminating, locating and characterizing Marsquakes with the SEIS InSight experiment

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A key goal of the NASA InSight mission to Mars is the detection, discrimination, location and characterization of Marsquakes. InSight landed on Mars on November 26, 2018, and the SEIS seismometer package was deployed on the surface over Christmas. Over its nomination mission duration of one martian year, SEIS is expected to register a few global events of magnitude larger than 4 and a few tens of events at local and regional distances of smaller magnitudes, in addition to a few impacts.

We have calibrated single-station procedures for: the discrimination of non-seismic pulses, by correlating with measurements of pressure, wind and magnetic anomalies; the discrimination of possible meteoritic impacts, by depth estimation (using depth phases such as pP and sP) and spectral analysis; event location based on the use of differential travel-times of body waves and surface waves, and of multiple Rayleigh and Love-wave orbits; accounting for both aleatoric (i.e. picking error) and epistemic (i.e. phase identification and model uncertaienty) uncertainties; event quantification and characterization, including magnitude assessment with a new suite of Martian magnitudes and moment-tensor inversion; the iterative refinement of the model suite and event locations.

These procedures have been tested in blind tests and operation readiness tests using realistic Mars conditions and we expect confirmation and calibration as part of the Marsquake Service operations, using data recorded on Mars, in conjunction with the Mars Structural Service (MSS).