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H/V spectral ratios at the InSight landing site using ambient noise and Marsquake records

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The InSight mission landed on Mars on November 26th, 2018 and its seismometer, the Seismic Experiment for Interior Structure (SEIS), has recorded continuous Martian seismic data since February 2019, consisting of mainly ambient seismic noise but also hundreds of seismic events.

We used the SEIS data to study the horizontal-to-vertical spectral ratios from both the ambient seismic noise (nHV) and the seismic events (eHV), for frequencies above 0.6 Hz, in order to get further constraints on the first tens of meters at the Insight landing site. The nHV curve was obtained by using data segments of 50 s over more than 400 Sols. The preferred nHV curve is observed during the northern spring and summer at low wind levels and it is a mostly flat curve with a prominent trough around ~2.4 Hz. Outside of these time periods, the nHV curve is contaminated with artificial peaks likely related to lander modes. On the other hand, the eHV curve was created using 336 seismic events with quality either A, B or C, as defined by the Marsquake Service. For each seismic event, we computed the signal-to-noise ratio (SNR) at each frequency and only frequencies with SNR>3 were used to obtain the final eHV curve. In addition to the 2.4 Hz trough, the final eHV curve shows a strong peak around 8 Hz, which is not observed from the ambient noise data possibly due to a lack of seismic energy in this frequency band able to excite it.

A preliminary inversion of the eHV curve, considering the fundamental mode of the Rayleigh wave only, shows that the 2.4 Hz trough and the 8 Hz peak can be explained by a shear-wave velocity model increasing from the surface to a depth of 5-8 m (likely the boundary between the regolith and coarse ejecta), in good agreement with previous analysis based on compliance observations, hammering measurements and satellite images. At this depth, a discontinuity leading to a higher

velocity layer is observed, which is followed by a deeper low-velocity layer about 20 m thick. The modeling assuming body waves only or a full diffuse seismic wavefield is currently under investigation.