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The InSight VBB Seismometer: From Signal and Noise to Internal Structure.

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The InSight Mission is one of three NASA down-selected projects in competition for the 2010 Discovery AO. The goal of SEIS (a very-broad-band (VBB) seismometer), the mission's core instrument, is to determine the interior structure and seismic activity of the planet. If selected by NASA in mid 2012, the mission will be launched in 2016 and will operate on the Martian surface during two earth years after landing.
We present modeling of both seismic amplitudes and seismic noise, in the later case by advance modeling of the interaction of the atmosphere with the Martian ground or seismic waves modeling fully taken into account the expected 3D structure of the crust, and use the later estimations to determine the detection threshold of the VBB seismometer. Both quakes and impacts are considered, and in the later case, impacts data and associated seismic responses of the Apollo seismic experiment are used to better model the seismic efficiency of the impacts and the associated source functions. For quakes, amplitudes of the core phases are estimated and discussed, as well as the dependence of signal amplitudes to attenuation and the associated importance of broad band seismology.

As only one seismic station is available, structure in-version will be performed using:
- Secondary seismic data which do not depend on the event location: e.g., free oscillation frequencies for the largest quakes constraining the interior down to 200 km and receiver functions constraining the crust-mantle discontinuity below the landing site ;
- Seismic impact data from impacts post-located by a Mars orbiter;
- Seismic data associated with events with more than 3 different wave arrival time determinations (for Vs in-version with constant Vp/Vs) or more than 4 (for full Vp, Vs inversions).

We estimate that about 35 events will be detected with both P and S waves (and for most R1-Lg surface waves) and about 10 with P, S and R1/R2/R3 surface waves and core phases (e.g., PcP, ScP) with high signal to noise ratio. For about half of the events the R2 surface wave will be also be detected, enabling an epicentral distance determination contaminated only by lateral variation, which can be corrected with 3D modeling. These events and associated seismic data set will allow the determination of seismic velocities down to 600 km to within $\pm$0.25 km/sec, enabling the first seismic model of another planet than Earth and exciting constrains in term of planetary formation and evolution