InSight at Mars – seismicity and meteorite strikes

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NASA's InSight mission (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) landed on Mars' surface on 26th November 2018 (Banerdt et al., 2020). This geophysical laboratory now sits on Elysium Planitia, a smooth, flat plain close to Mars' equator where InSight placed the first seismometer on the Martian surface. The InSight mission aims to study the planet's interior. One of its scientific payloads is the SEIS (Seismic Experiment for Interior Structure), a three-component very broad band seismometer (VBB) has been measuring seismic activity on Mars for about a year (Lognonné et al., 2020) and has recorded over 300 Marsquakes (Giardini et al., 2020).

About 1.1 m away from SEIS, a heat flow and physical properties package (HP^3) was deployed and began hammering a probe into the subsurface to measure the heat coming from Mars' interior and to reveal the planet's thermal history. The probe, which uses a self-propelling hammering mechanism, has generated thousands of seismic signals, very similar to a controlled active seismic source. The seismic hammering signals can be used to analyse the shallow subsurface and shed new light on the elastic properties of the Martian regolith.

One of possible natural seismic sources on Mars could come from meteoroid strikes (Daubar et al., 2020, *in review*). To aid such impact analysis, we used the Desert Fireball Network in Australia (Howie et al., 2017), a continental scale facility for observing meteoroids in the Earth's atmosphere, to understand seismic responses to these phenomena on Earth to inform and develop our understanding on Mars. The DFN has observed and calculated orbits for over 1100 meteoroids, some of which are large enough to drop meteorites on the ground. Our preliminary search for signals in the Australian National Seismograph Network data revealed at least a dozen candidates for which the atmospheric shock waves are likely recorded. The highest peaks in acceleration are in the vertical direction as is expected from an atmospheric source. These are either created from the blast wave following a fragmentation event, or from the Mach cone generated by the hypersonic trajectory of the meteoroid. While it is complicated to make parallels between Mars' and Earth' atmosphere because of significantly different densities and chemical composition that alters the propagation of seismic waves, this may not matter too much given that the airburst altitude of most meteors on the Earth corresponds to the near surface on Mars. Even so, our preliminary work investigates the physics of meteor fragmentation that can aid understanding of the seismic source creation coming from meteoroid encountering both Earth and Mars.