**SEISMIC WIND NOISE COUPLING THROUGH MARS' REGOLITH: IMPLICATIONS FOR THE INSIGHT NASA DISCOVERY MISSION.** N. A. Teanby[1], J. Taylor[1], J. Wookey[1], and W. T. Pike[2], [1]School of Earth Sciences, University of Bristol, Bristol, BS8 1RJ, UK (n.teanby@bristol.ac.uk), [2]Electrical and Electronic Engineering, Imperial College, London, UK.

**Introduction:** One of the final frontiers in solar system research is the probing of planetary interiors. Constraints on the interiors of terrestrial planets other than Earth are currently limited to globally averaged properties such as moment of inertia and large scale gravitational moments [1,2]. Therefore, derivation of internal structure is non unique, with multiple - and often very different - internal models being equally consistent with the available data. This limits the constraints we can place on core size and other internal planetary boundaries and prevents us from understanding the detail of early planet formation and differentiation. NASA's InSight Discovery mission [3] aims to address these deficiencies. InSight's main science payloads comprise a broadband and short period seismometer, a heat probe, and precision radio tracking. Together, these instruments will revolutionise our understanding of Mars' interior.

Here we focus on the seismometer elements. A key mission requirement is the minimization of environmental seismic noise so that even the smallest marsquakes can be studied. To this end a wind and thermal shield will be deployed over the seismometers to provide some measure of isolation from Mars' large diurnal temperature variation and surface winds. This shield will be especially important at dusk/dawn, when the rate of thermal change and wind speeds are highest. However, it is expected that an attenuated version of the noise generated by wind-induced shield vibrations will be transmitted through the martian regolith to the instruments. It is this attenuation that we aim to quantify in this study – enabling the measurement and deployment strategy to be optimised.

**Methods:** We used a selection of Mars surface analogues including laboratory and field settings with surfaces ranging from fine sand to coarse gravel. A scale model of the InSight seismometer tripod and wind shield tripod were instrumented with commercial short period (frequencies >1 Hz) seismometers. This makes our results particularly relevant to the micro-seismometer, which covers these short periods [4]. Figure 1 shows an initial test deployment in coarse gravel. Both horizontal and vertical component instruments were used, which are most relevant to S and P wave detection respectively. Vibrations were applied to the wind shield to simulate wind-induced noise and the vibration amplitudes recorded on both shield and instrument platforms. By comparing the relative amplitude of the signals as a function of frequency, the regolith attenuation factor was determined. Both aligned and anti-aligned shield-seismometer tripod configurations were investigated to determine the optimum configuration.

Figure 1: Preliminary test rig designed to represent the InSight seismometer tripod (small inner tripod) and wind and thermal shield (large outer tripod). Upper left blue/red wired block is an impulsive noise source used to mimic wind noise on the wind shield. Both tripods are in an inline configuration in this test. Preliminary test bed comprises coarse gravel over a fine grained substrate. Further tests will be presented using a modified sensor rig and more realistic surface types.

**Results:** Figure 2 shows simulated impulsive wind signals recorded by Sensor SM-6 4.5 Hz vertical geophones located on the wind shield and seismometer tripod. These preliminary results were taken in coarse gravel with the seismometer and wind shield tripods aligned. The noise induced on the shield tripod is significantly reduced by transmission though even a few centimeters of gravel to around 5% of its original value (approximately -30dB attenuation). These preliminary results are very encouraging and suggest any regolith-transmitted wind noise will be significantly reduced.

Comparison of in-line and anti-aligned tripod configurations did not produce significantly different attenuations at this preliminary stage – although this will be investigated further in subsequent experiments. Also, note that coarse gravel is sub-optimal for simulation of martian surface conditions and further results will be presented for a more realistic suite of possible surface environments.

**Discussion:** Preliminary investigations of regolith wind noise coupling into a martian seismometer are encouraging and show that:

i) Only around 5% of the wind shield vibrations are transmitted to the seismometer though the regolith. This means that wind induced noise will be significantly reduced. Further reduction may be possible using band pass or band reject filters designed to eliminate the natural frequency of the shield for a given wind speed.

ii) Orientation of the shield with respect to the seismometer appears to be non-critical. This is important if confirmed as it removes a potentially restrictive constraint on the surface deployment – greatly simplifying operations with the InSight robot arm.

These preliminary results will be confirmed with further laboratory and field tests using a wide range of surface types. The frequency dependence of these inferences will also be investigated.

**References:** [1] Lognonne P. (2005) *Annu. Rev. Earth Planet. Sci., 33,* 571-604. [2] Teanby N. A. and Bowles N. E. (2010) *A&G, 51,* 2.22-2.25. [3] Banerdt W. B., et al (2012) *43rd LPSC, 43,* 1659. [4] Pike W. T. et al (2005) *36th LPSC, 36*, 2002.

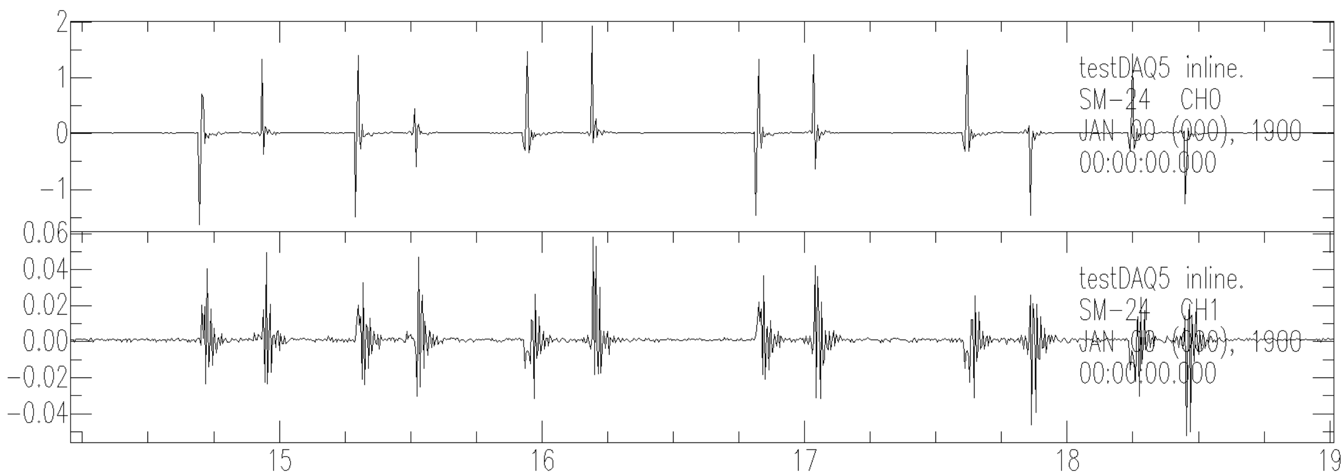


Figure 2: Seismograms recorded from a noise generation setup using the configuration in Figure 1. Axes are time in seconds (x) against relative velocity in volts (y). Upper plot shows the unattenuated signal recorded on the wind shield tripod and lower plot shows the recording on the inner tripod after transmission through the regolith simulant. Pulse heights are reduced by a factor of 20, indicating that wind noise will be significantly reduced by the regolith before it is picked up by the seismometers