



InSight Mission Status and Recent Results

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and the InSight Science Team

17 April, 2020

- The InSight spacecraft is just now finishing its 493rd sol on Mars and is operating almost flawlessly.
- All the instruments are operating 24.6/7, as well as or better than designed, with the exception of the HP³ mole.
 - SEIS is measuring motions ~10x better than its design requirement.
 - The mole is mechanically sound, but unexpected soil conditions have thus far prevented it from reaching its planned depth.
- All data is being released through the PDS within 3-6 months of acquisition. Raw images are released within minutes of receipt on the ground.
 - Currently, roughly 60% of this data and >90% of our commands are being relayed through Odyssey.

- The HP³ was deployed to the surface in mid-February 2019 and immediately began penetration.
- A depth of 35 cm was reached relatively rapidly (within a few hundred strokes); repeated subsequent hammering (~9000 strokes) resulted in no measurable further progress.
- We have subsequently concluded that the mole has lost sufficient hull friction to maintain downward progress due to unexpected soil conditions.
 - Loosely cemented, porous duricrust >15 cm thick
- We developed and tested a recovery plan to using the robotic arm, first to increase the hull friction, and later to provide downward force to the back of the mole.

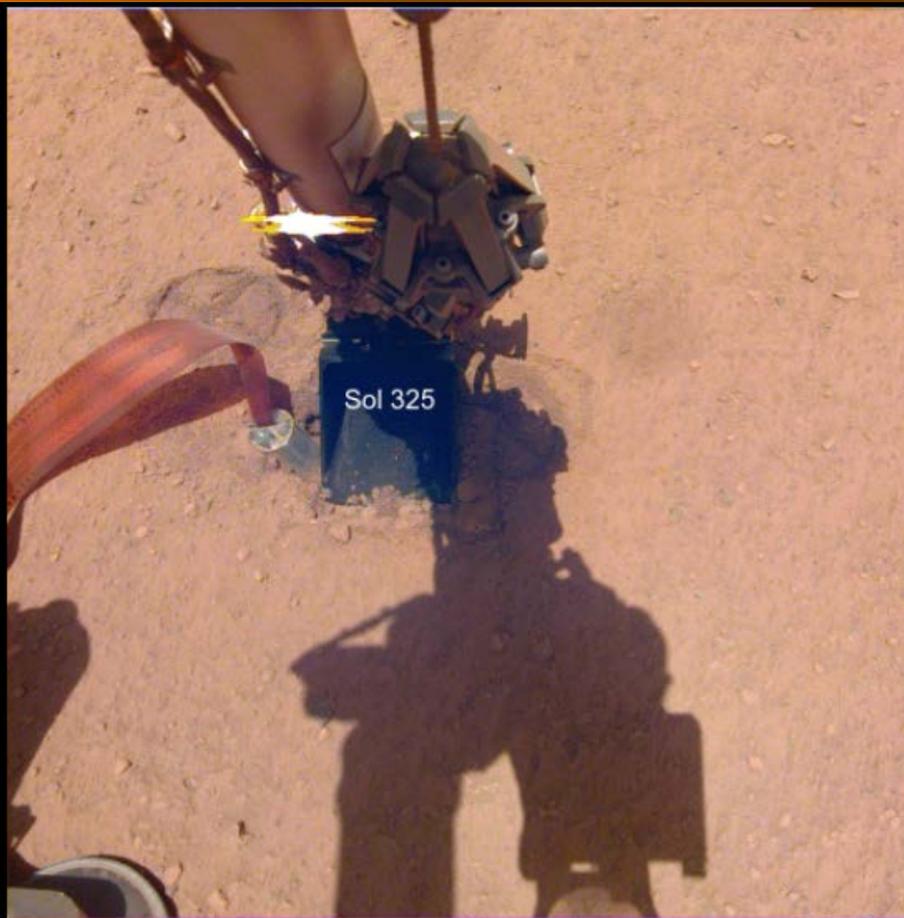


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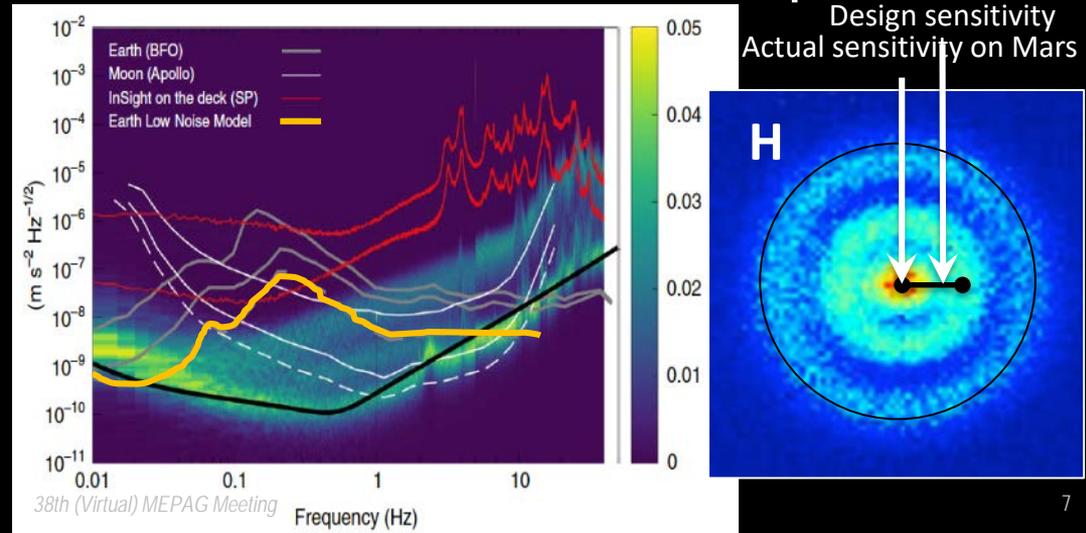
Getting into position on Mars – sol 427



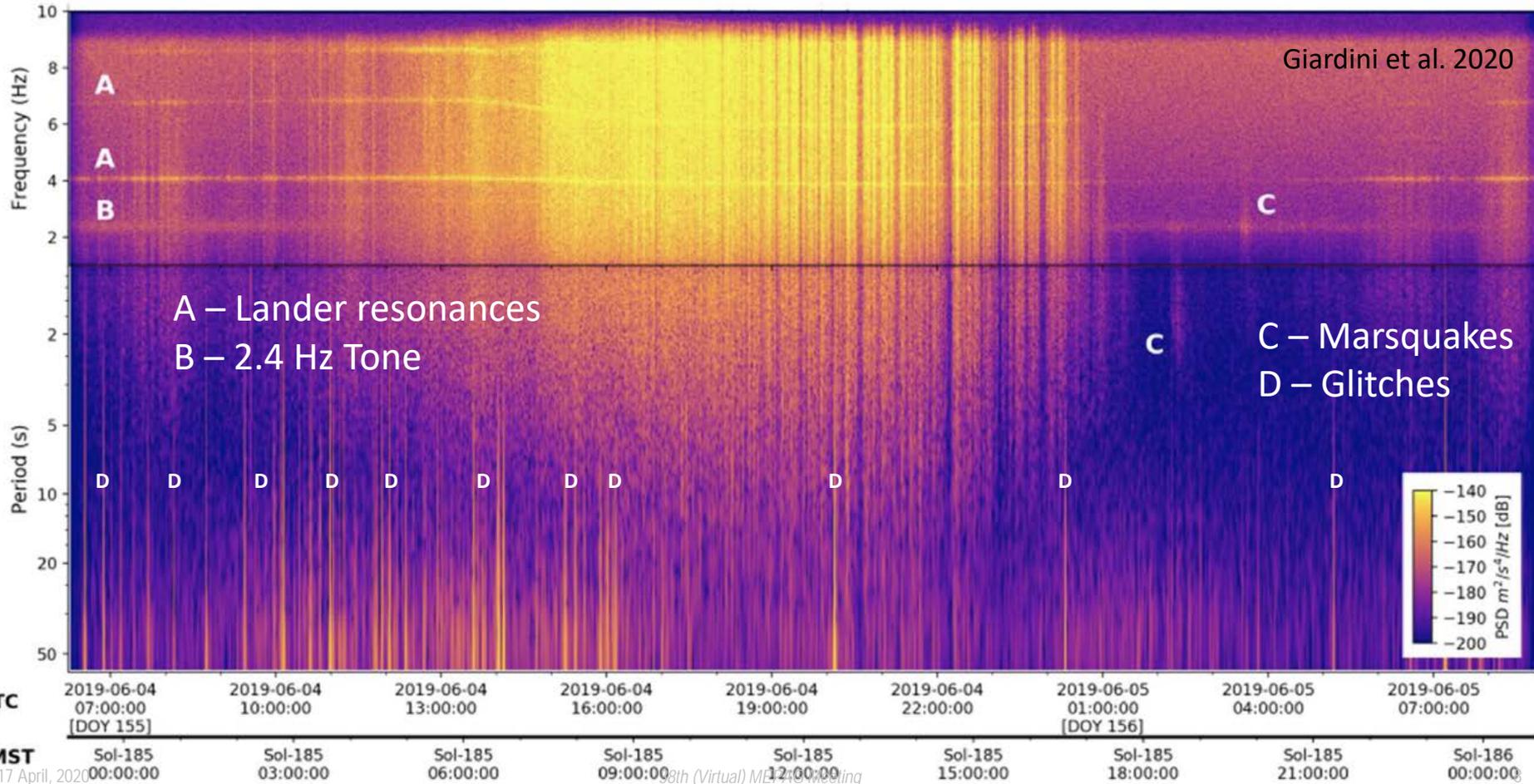
Most recent hammering session – sol 489



- Need extremely high sensitivity – expected (and found!) fewer and smaller quakes than on the Earth
 - Sensitivity target: $2.5 \times 10^{-9} \text{ m/sec}^2/\text{Hz}^{1/2}$
 - This is equivalent to displacement amplitudes smaller than a hydrogen atom
- The development team worked hard to minimize/compensate for all noise sources:
 - Instrument intrinsic noise
 - Temperature variations
 - Wind
 - Atmospheric pressure variations
 - Magnetic field variations
 - Lander vibrations



Giardini et al. 2020

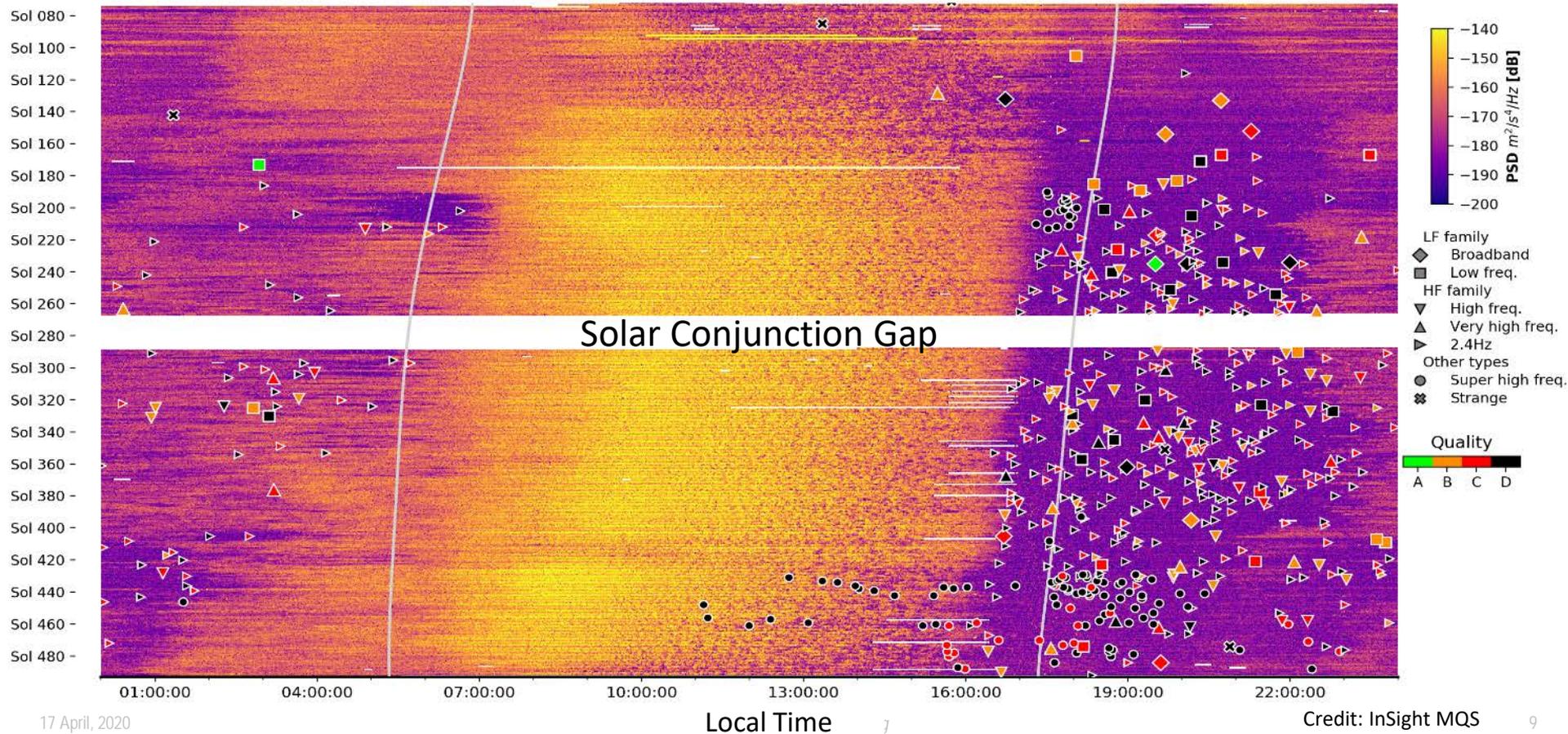


Sols: 72-493

58.BZC,02.BHZ,03.BHZ

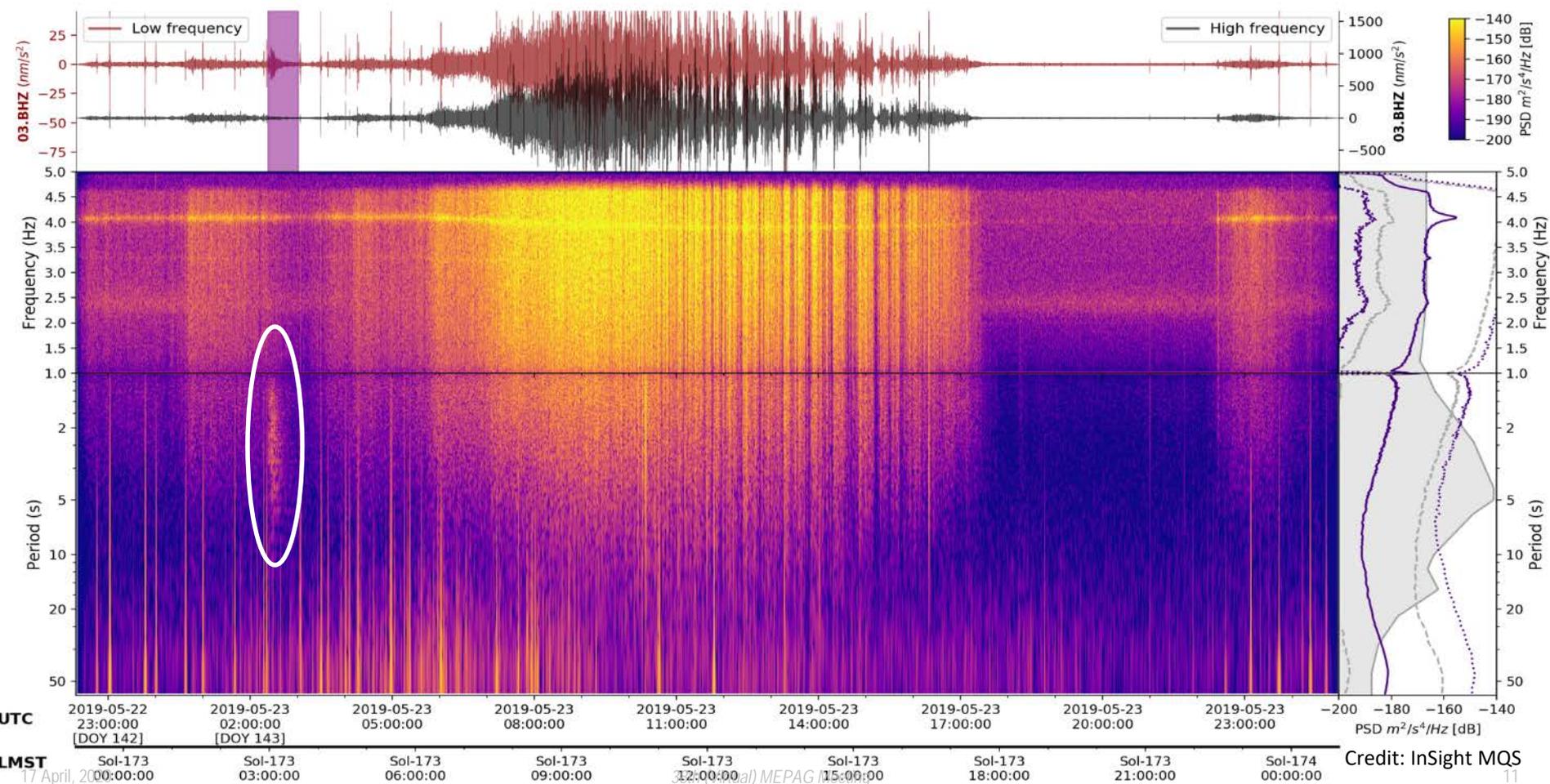
Sunrise

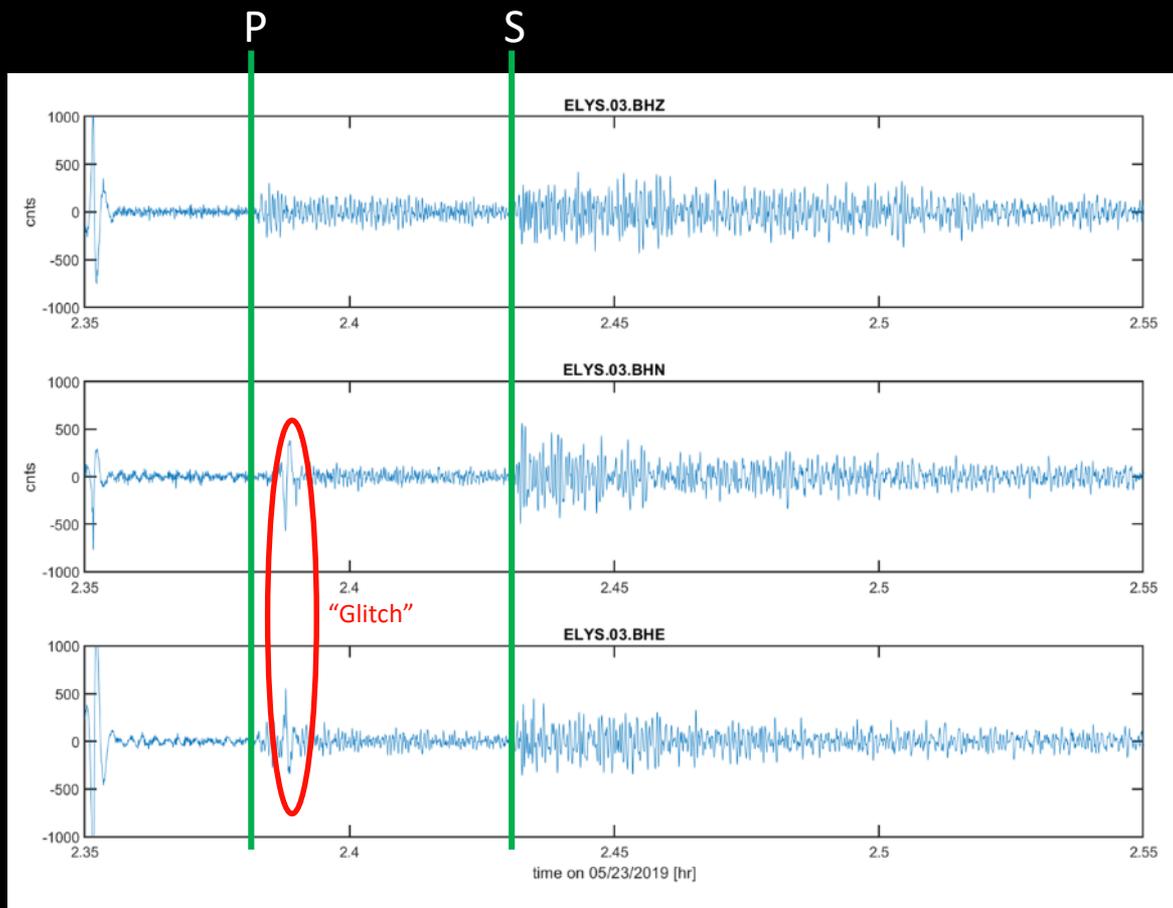
Sunset



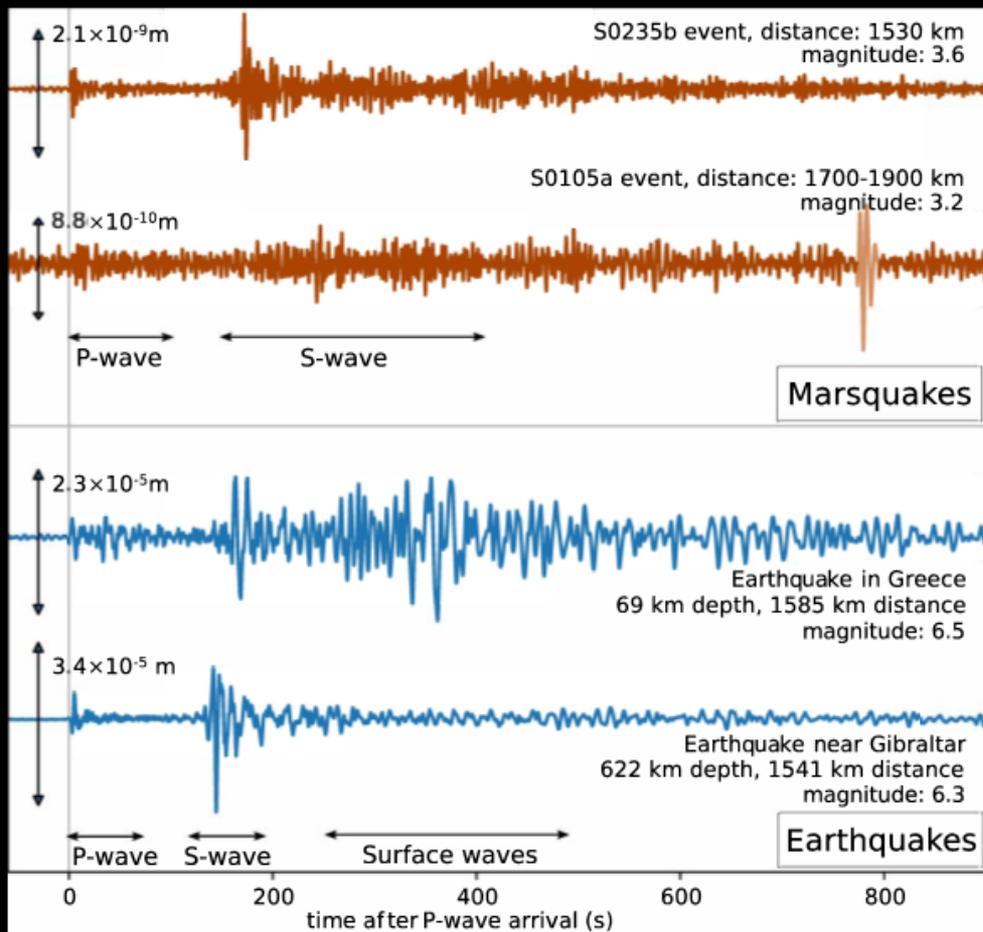
- Currently there are 470 events in the InSight catalog.
 - 2 Quality A
 - » Clear seismic phases (e.g. P and S) and polarization
 - 90 Quality B
 - » Signal clearly observed, clear seismic phases, but no polarization
 - 176 Quality C
 - » Signal clearly observed, but no clear phases
 - 202 Quality D
 - » Signal only weakly observed
 - » OR likely not a seismic event
 - » OR signal possibly contaminated by environmental conditions
- Virtually all of the Qual A and B, and many of the Qual C have been identified by the InSight MQS as tectonic quakes.
- Many (most?) of the remaining events are also likely tectonic in origin.

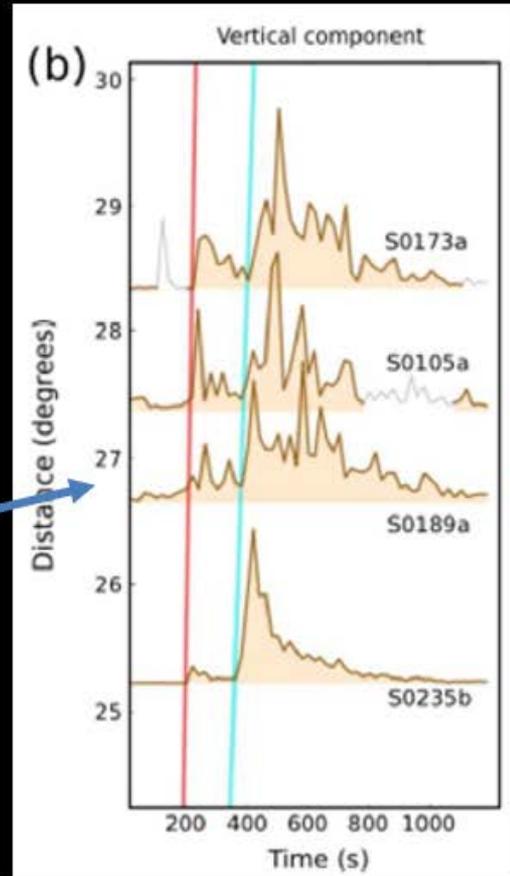
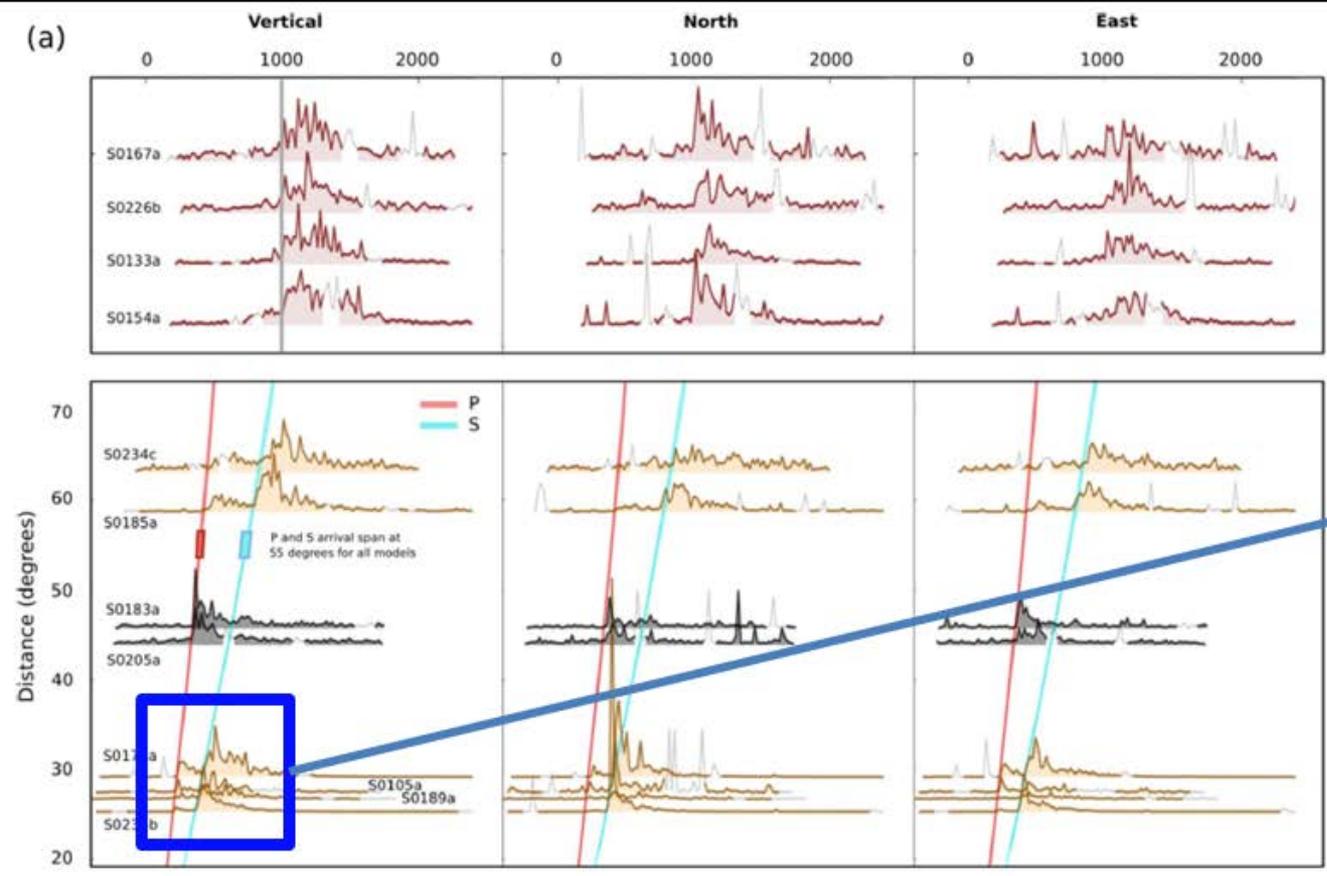
Clearlest Marsquake Signal to Date: S0173a, Magnitude 3.7



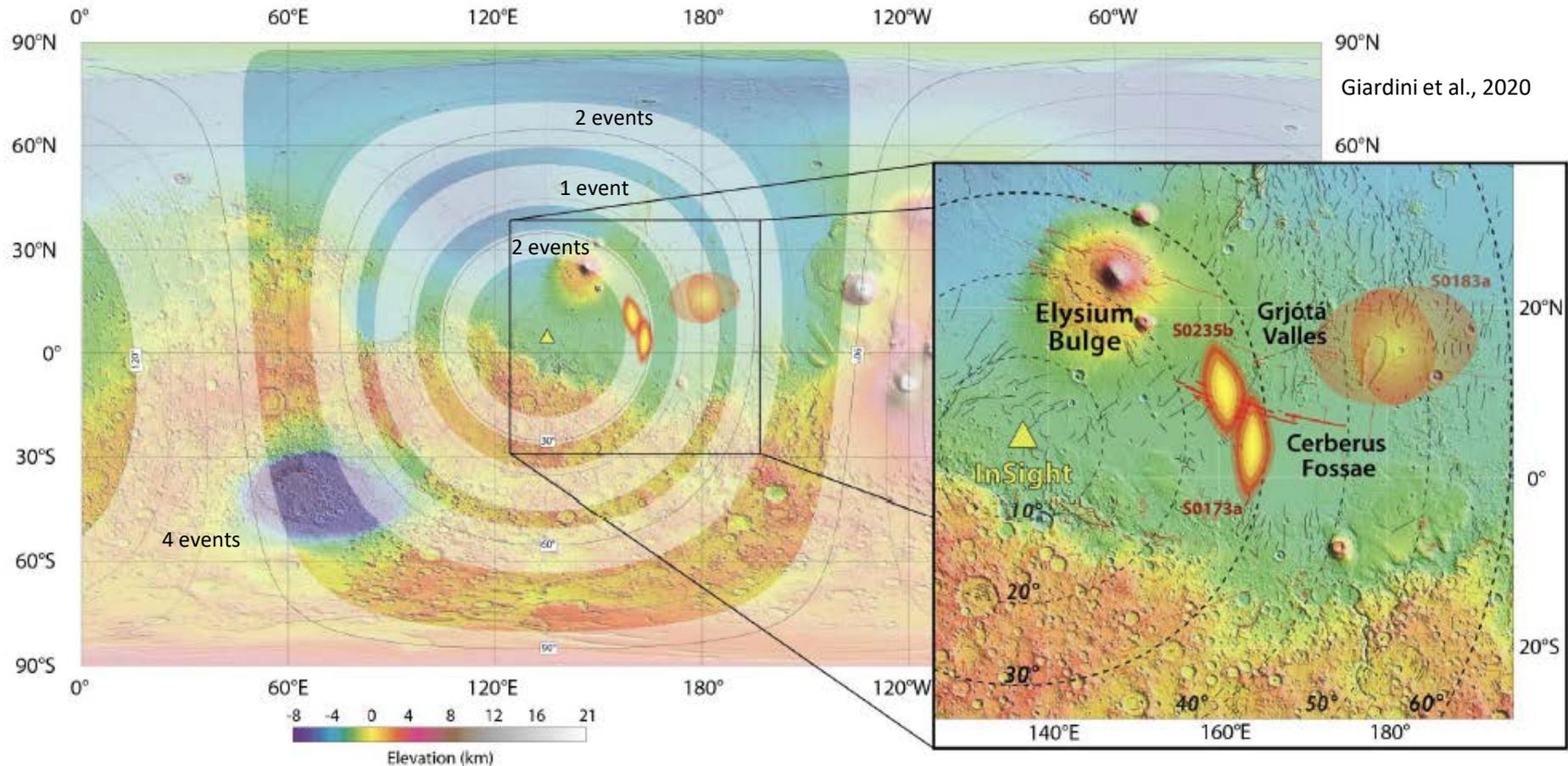


Comparison of Terrestrial and Martian Quake Signals

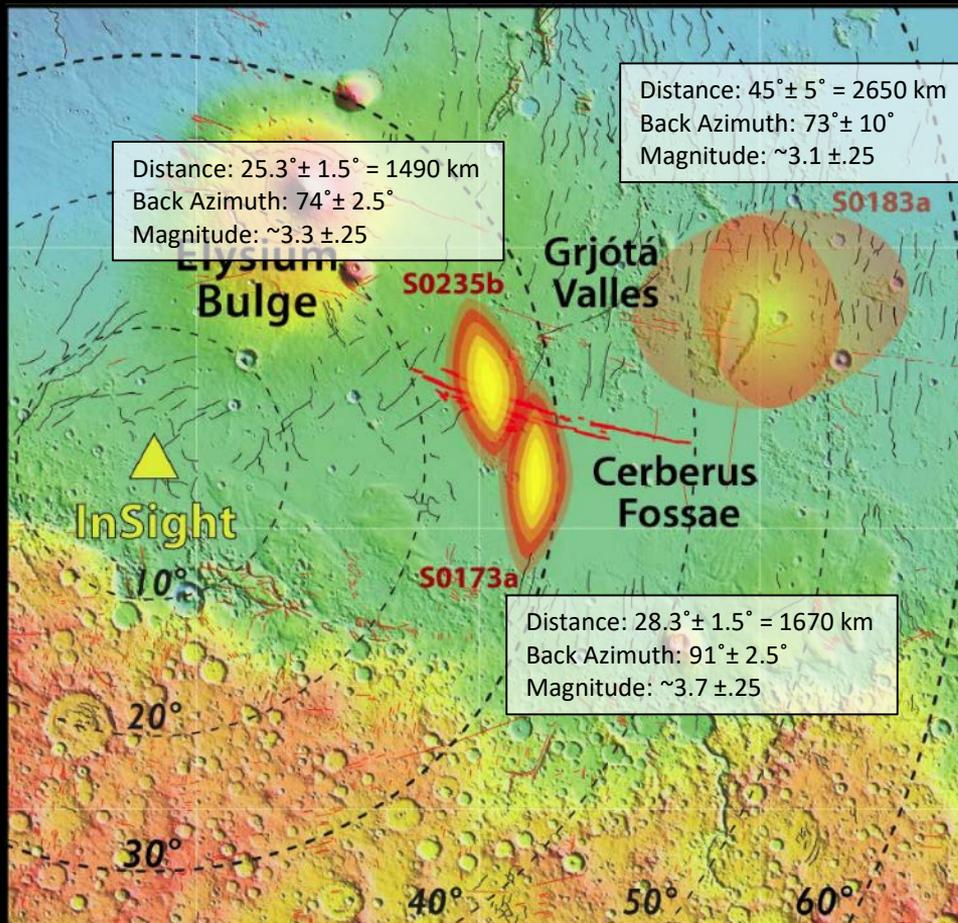




Seismicity Map for Mars – 12 “Locatable” Events

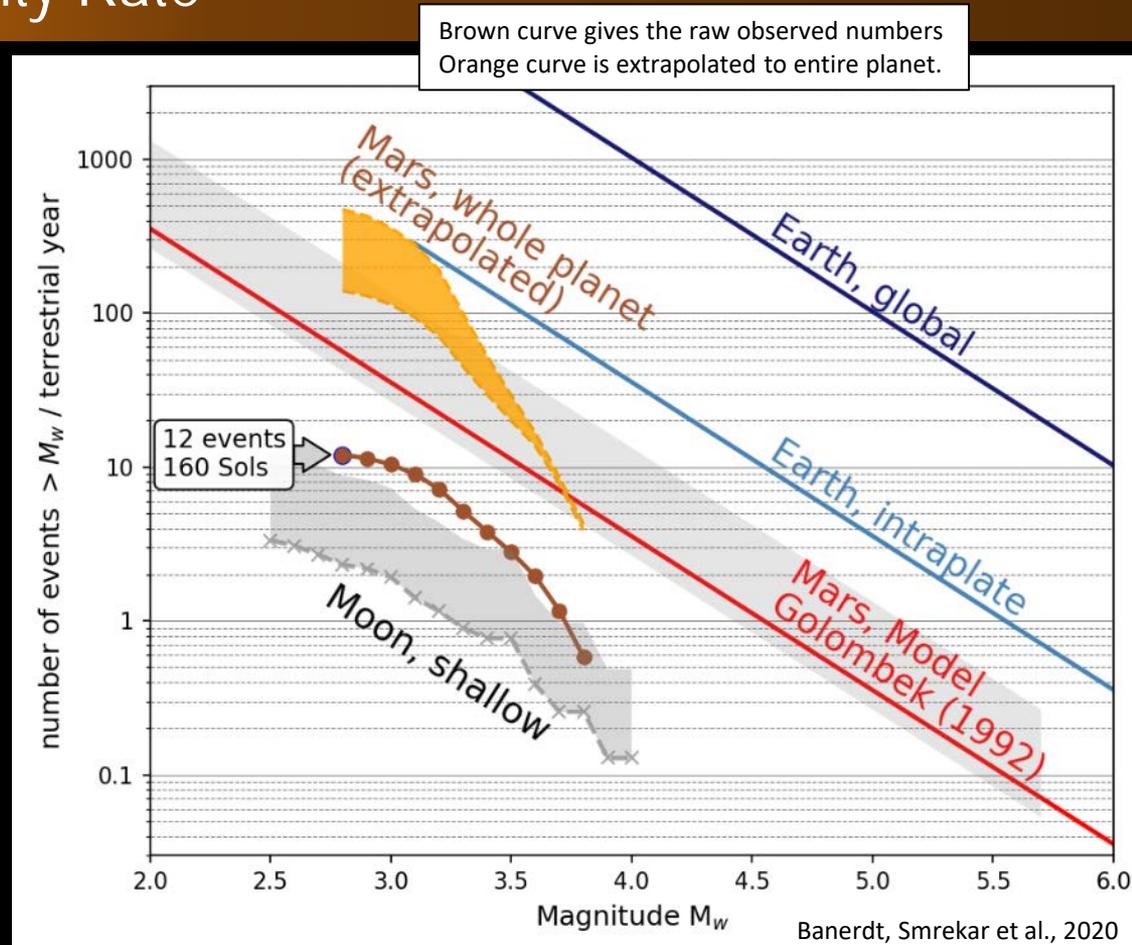


Source Locations for Three Events



Giardini et al., 2020

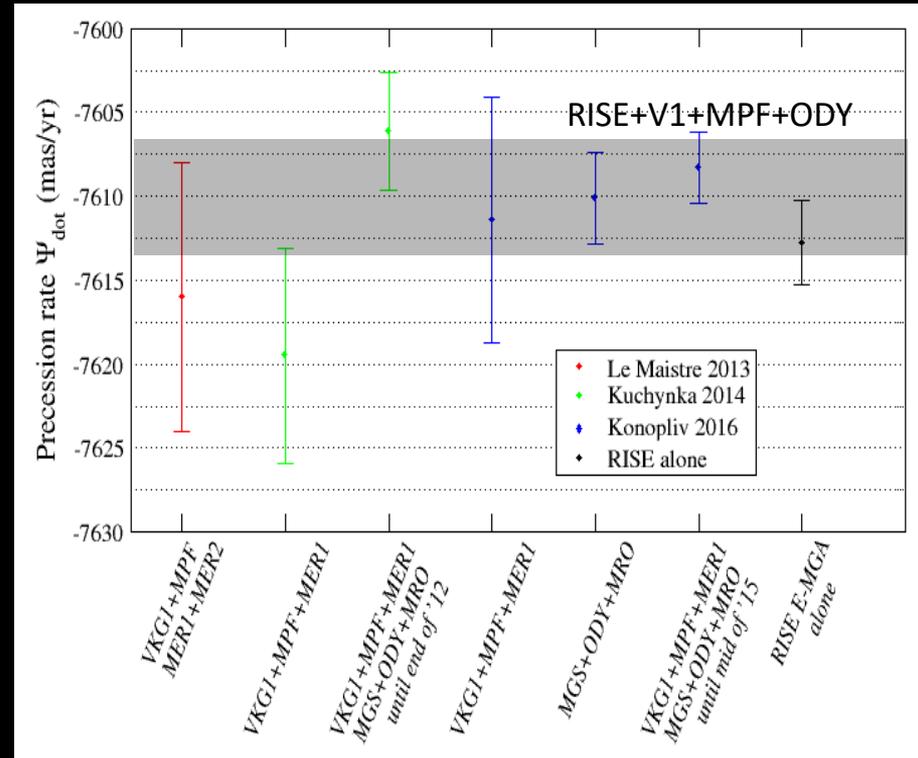
- Mars' activity appears to be close to pre-InSight predictions, perhaps somewhat higher
- However, there may be a deficit of larger marsquakes.
- This is a preliminary estimate based on ~9 months of data; will need the full 2 years of the prime mission for a reliable estimate.



- Precession rate from the first year of RISE tracking alone is as strong as all previous missions combined.
- RISE precession measurement gives a Moment of Inertia of 0.36342 ± 0.00018

But...

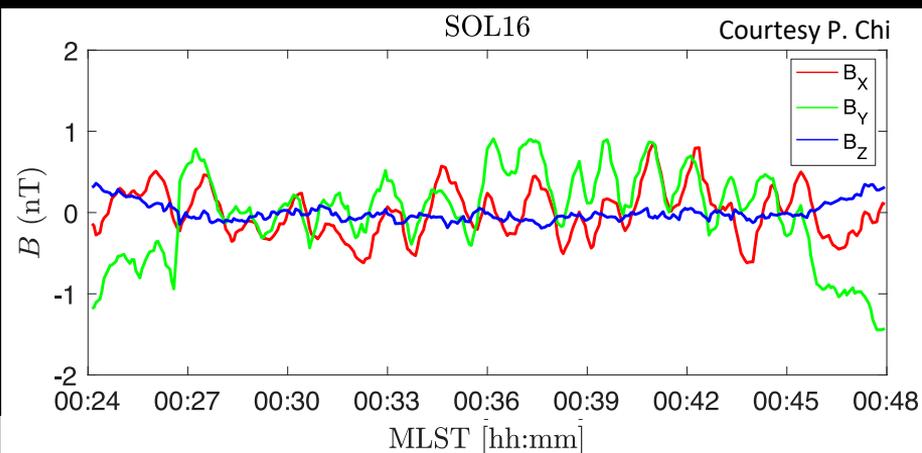
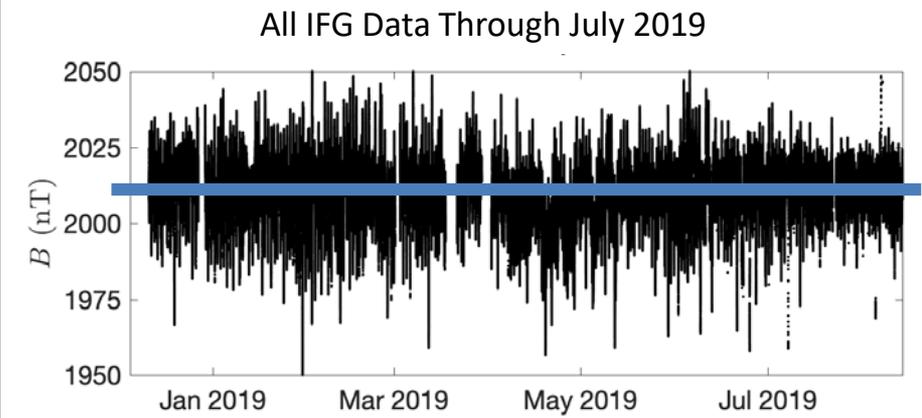
- This is not a particularly interesting result; core radius and density can't be separated.
- Measurement of the nutation to a precision that will allow the separation of core radius and density is expected from an additional \sim year of tracking.



Kahan et al. in prep.

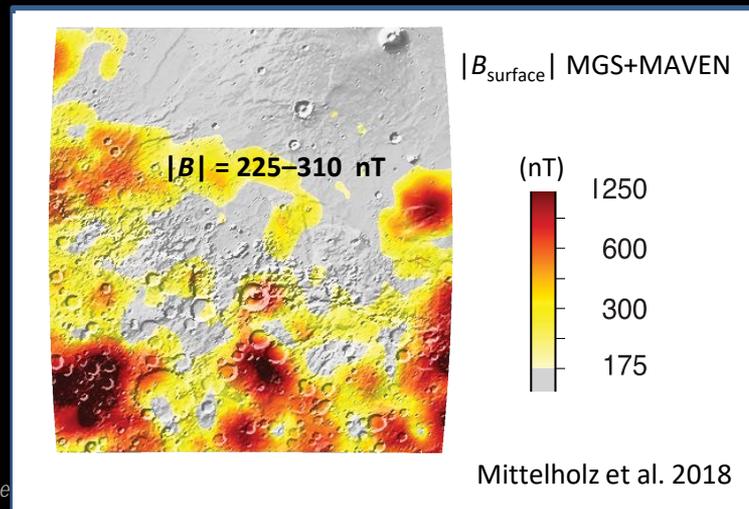
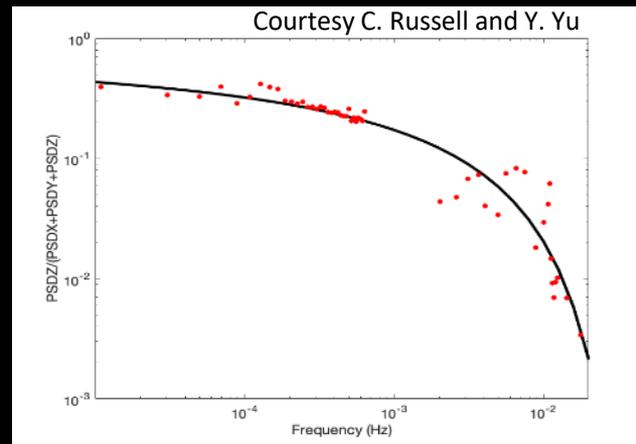
Notable early results include:

- DC field at the landing site $\sim 10X$ stronger than measured from orbit
 \Rightarrow significant crustal variations at spatial scales < 150 km.
- Pulsations are observed with that may be used to probe conductivity; at higher frequencies the power decreases and the vertical components are attenuated relative to horizontal, suggesting relatively high conductivity at depth.



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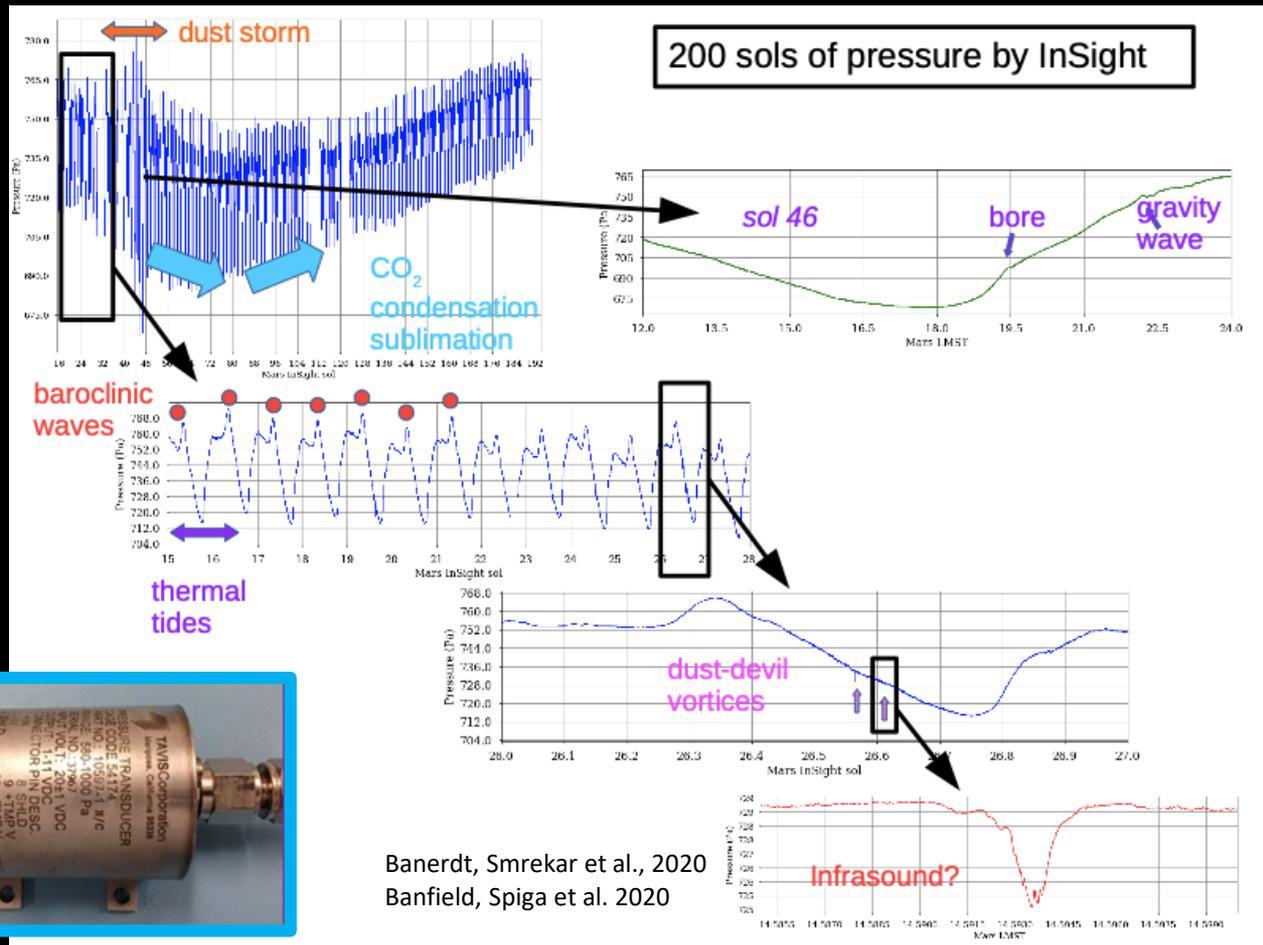
InSight Meteorology

InSight is returning continuous high-rate pressure, temperature, and wind measurements, providing an unprecedented view of atmospheric behavior at time scales from less than a second to months and seasons.

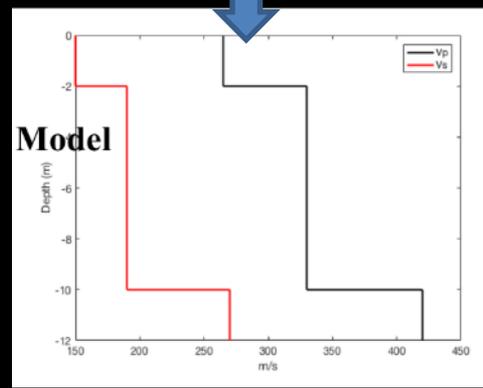
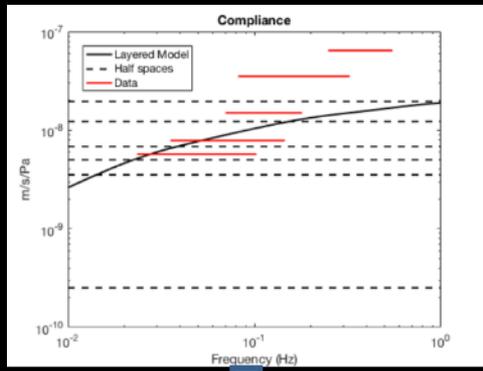
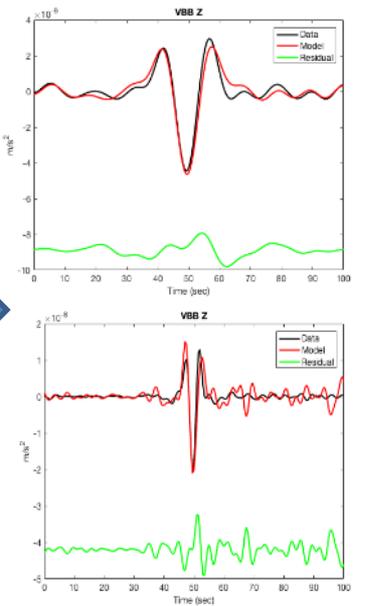
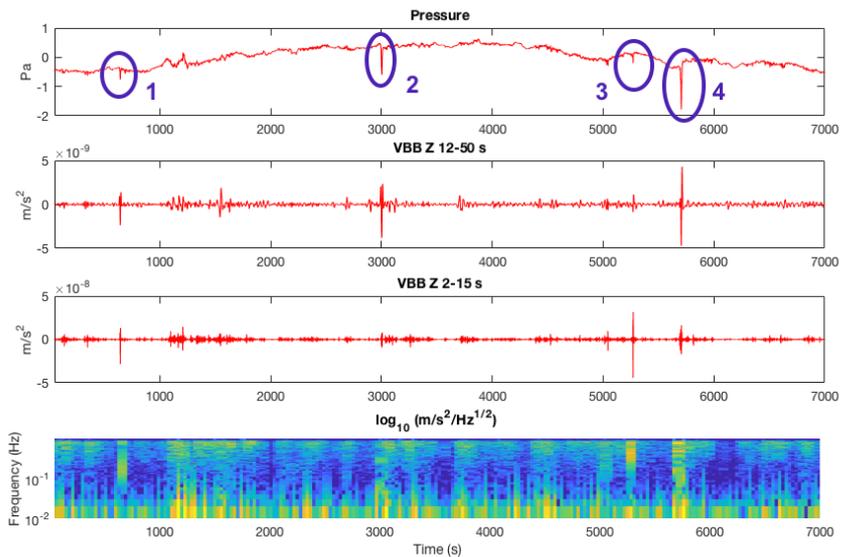


TWINS
(Temperature & Wind for InSight)

Pressure Sensor



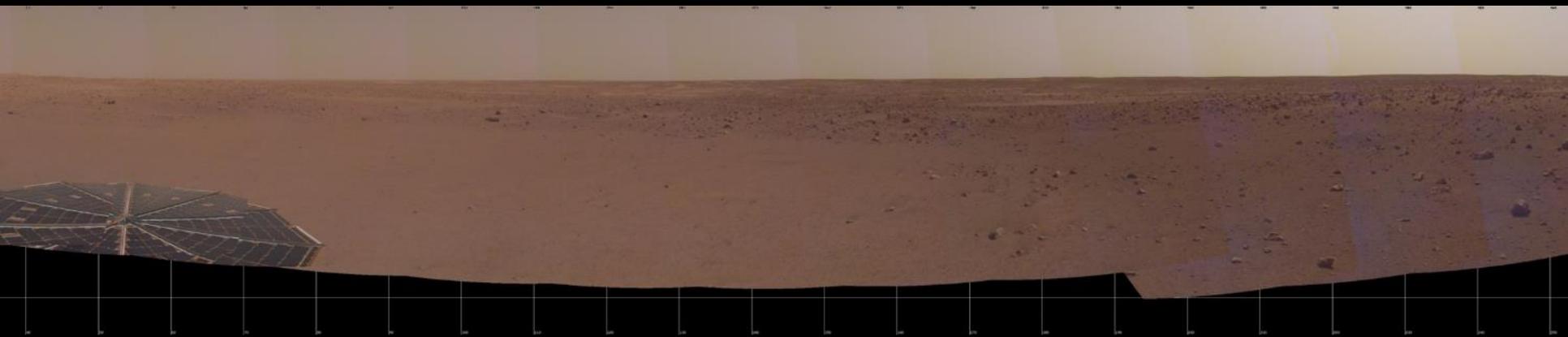
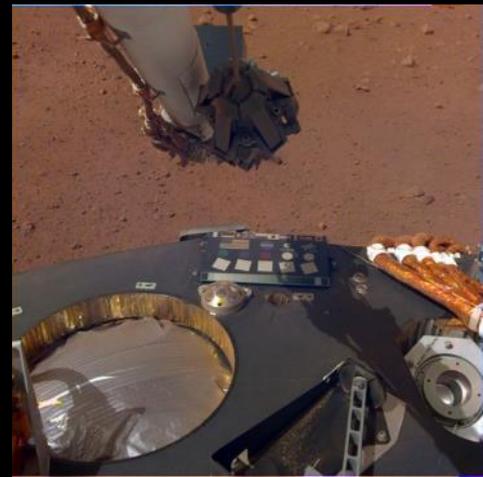
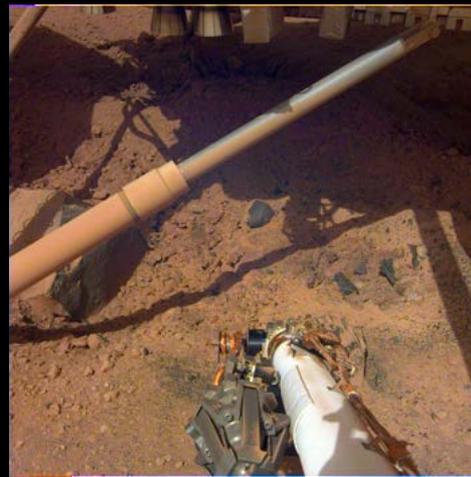
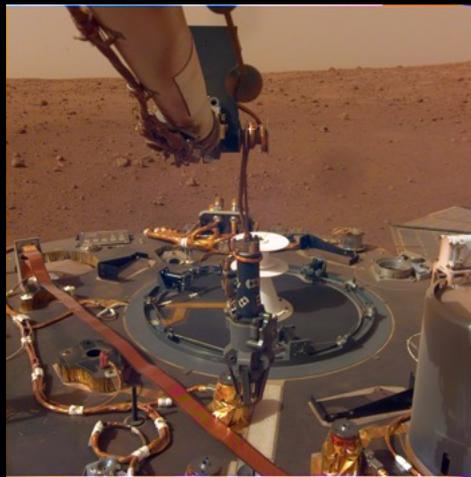
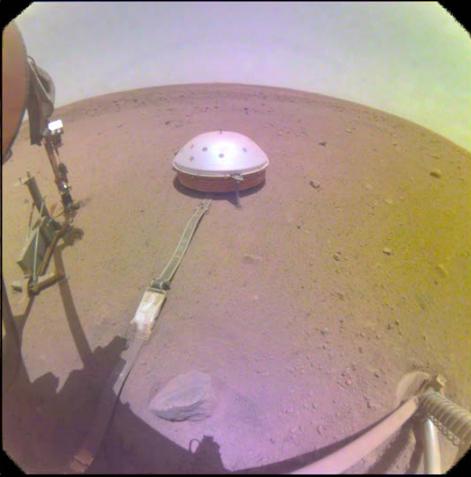
Banerdt, Smrekar et al., 2020
Banfield, Spiga et al. 2020

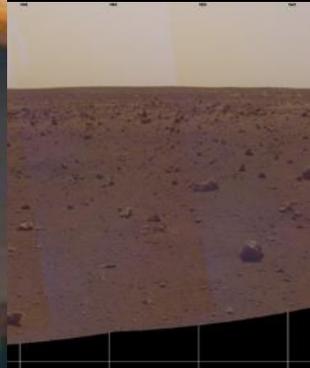
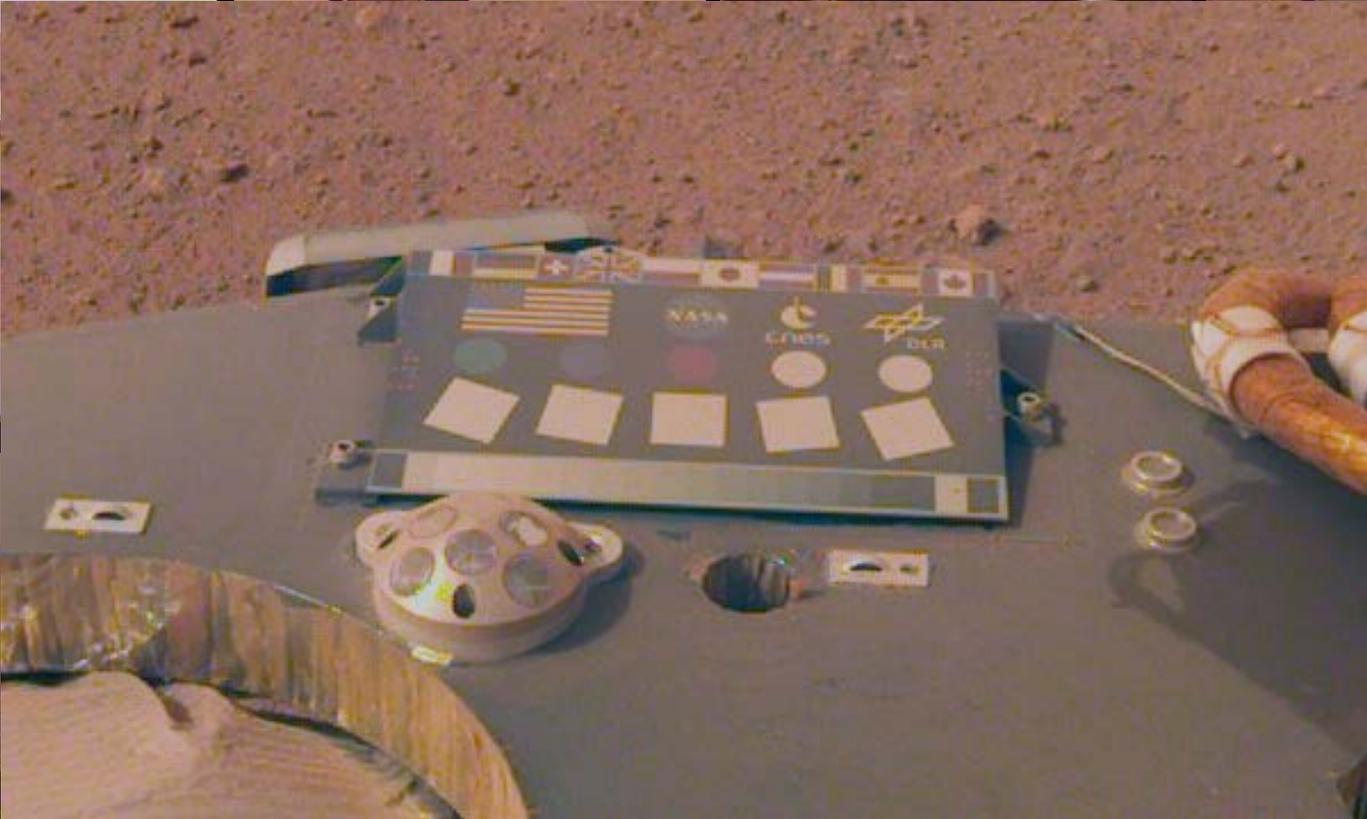


• Courtesy of B.Kenda, T.Kawamura, R.Garcia, N.Murdoch

The InSight pressure sensor detects ~10 pressure drops per day

Associated ground deformation measured by SEIS provides an estimate of ground compliance to ~3-5 m depth





Sunset over Elysium, sol 145

