InSight Mission Status and Recent Results

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and the InSight Science Team

17 April, 2020

InSight Status

- 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 HP^3 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.

HP^3 Status

- The HP^3 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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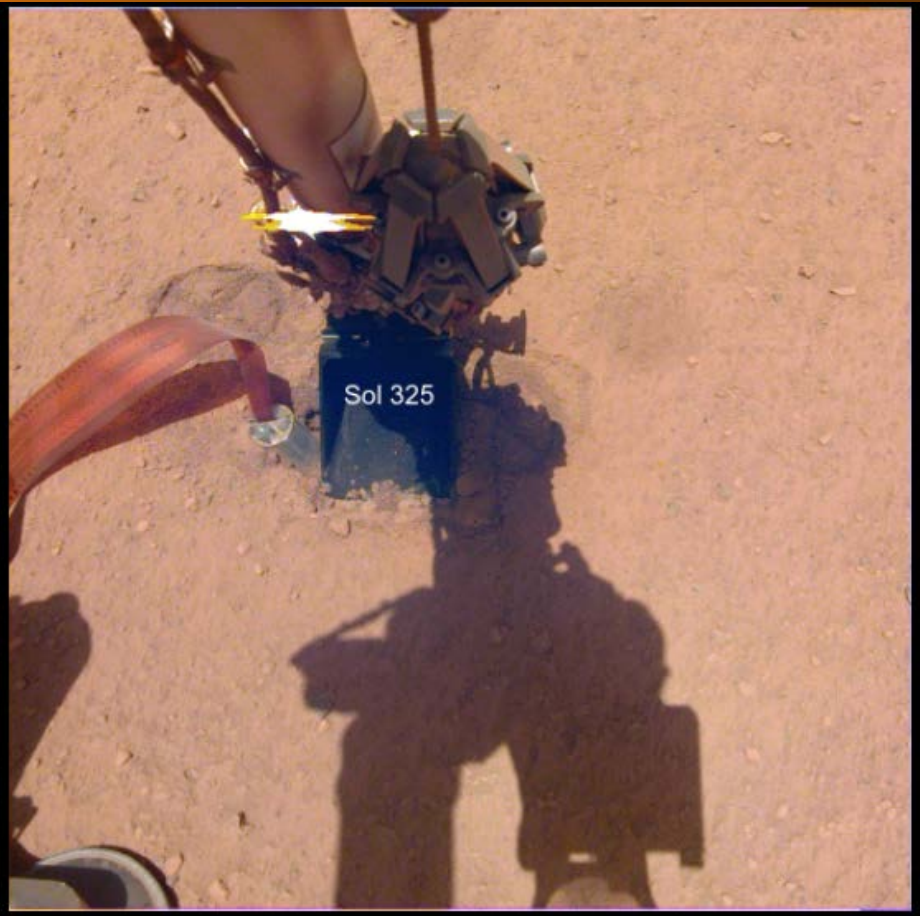
First Three Attempts to “Pin and Hammer”

[JPL Webmaster: Videos lost in .pdf conversion]

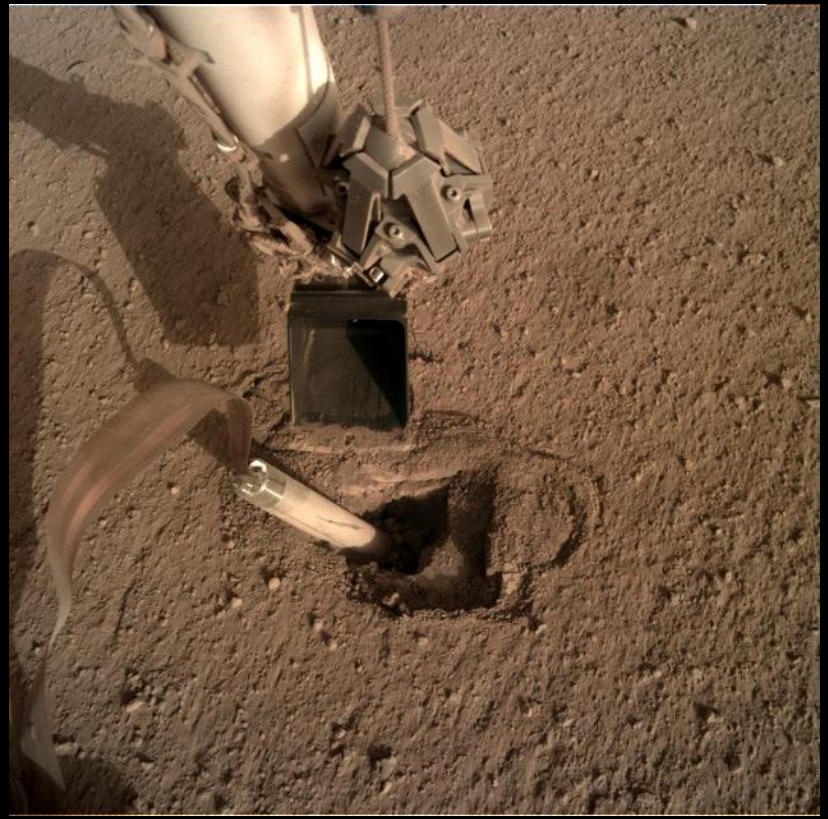
One Step Forward, Three Steps Back...



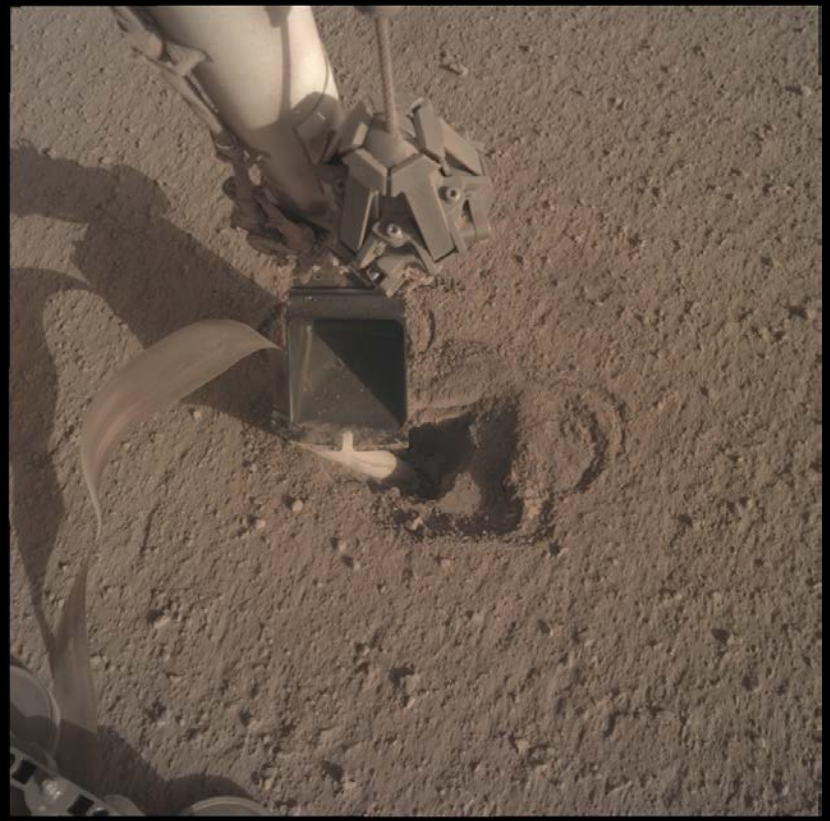
[JPL Webmaster: Videos lost in .pdf conversion]

Curent Phase – Back Cap Push

Getting into position on Mars – sol 427



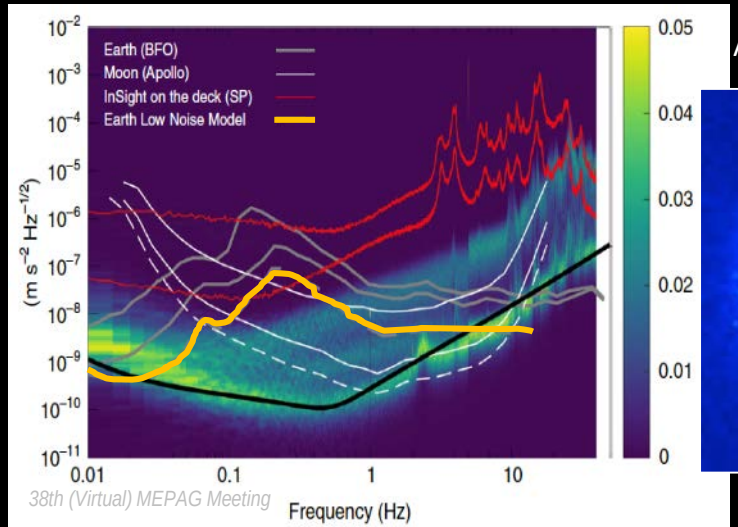
Most recent hammering session – sol 489

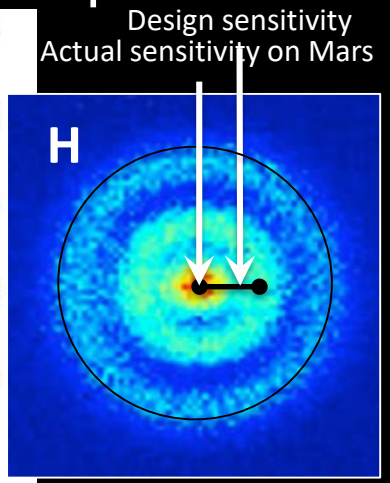


The Challenge of Operating a Seismometer on Mars

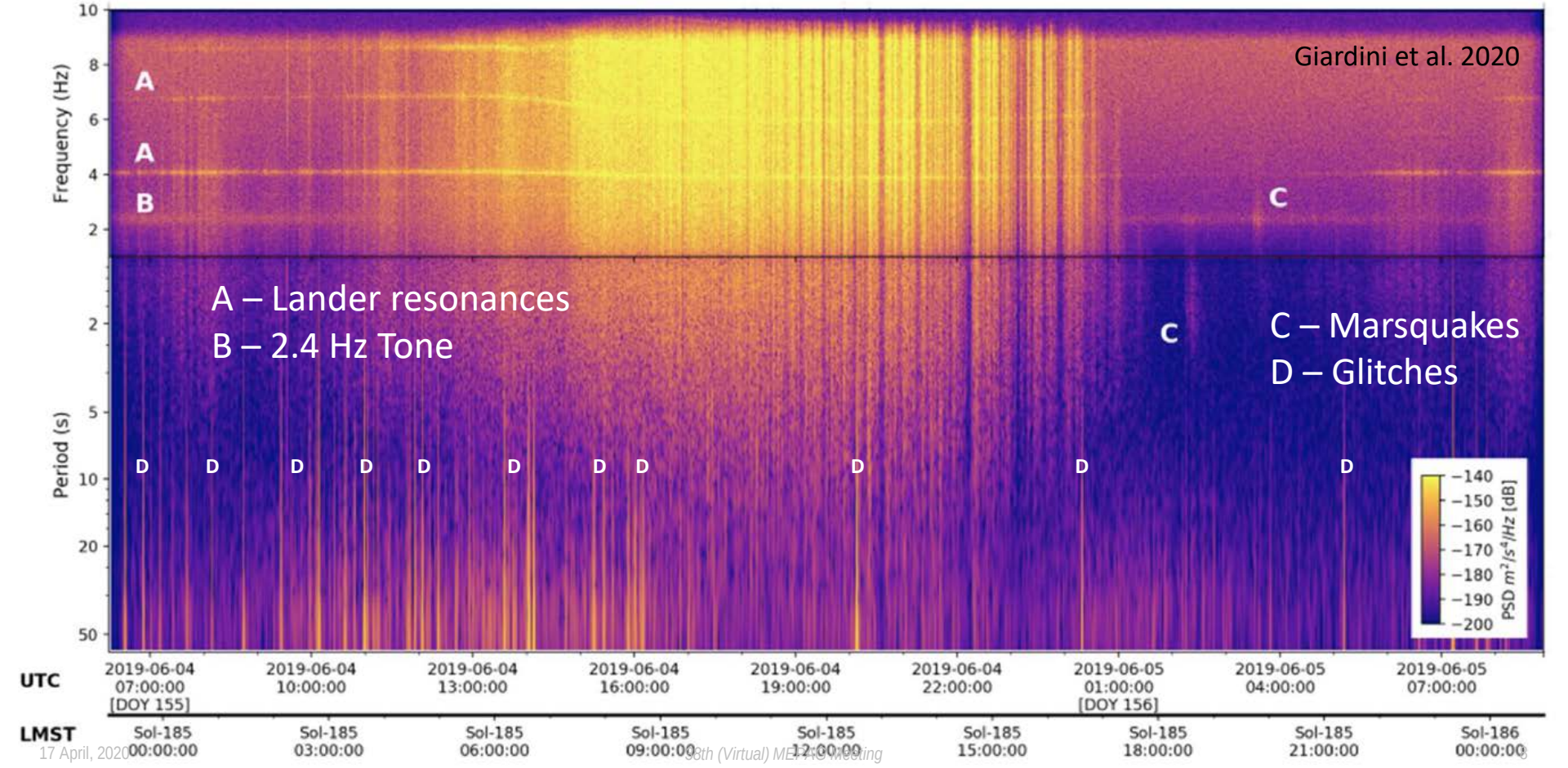
- Need extremely high sensitivity – expected (and found!) fewer and smaller quakes than on the Earth
  - Sensitivity target: 2.5×10^{-9} m/sec^2/Hz$^{1/2}$
  - This is equivalent to displacement amplitudes smaller than a hydrogen atom

- 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

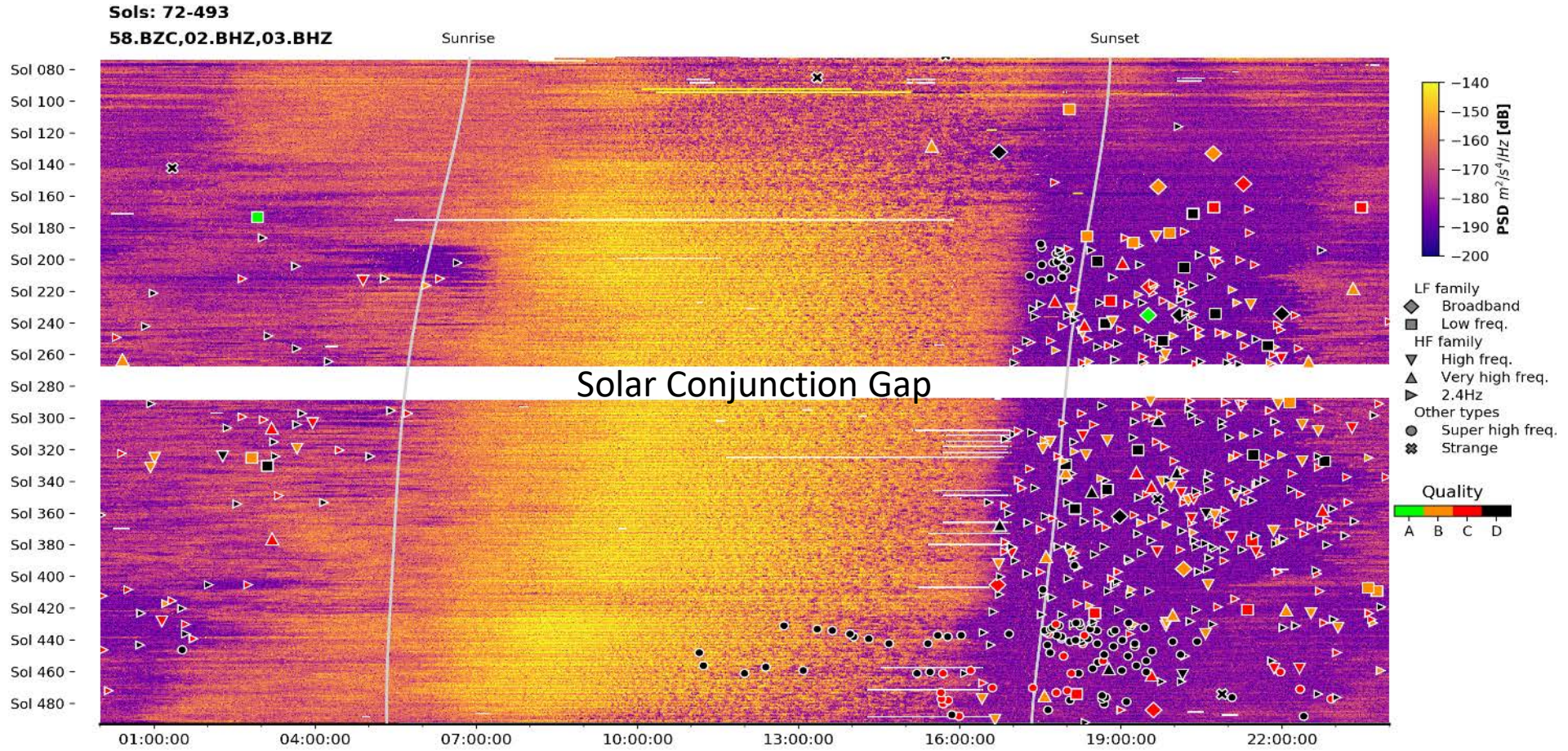




Mars Seismic Data: Full-Sol Spectrogram, Sol 185



All Seismic Data as of Yesterday (Sol 493)



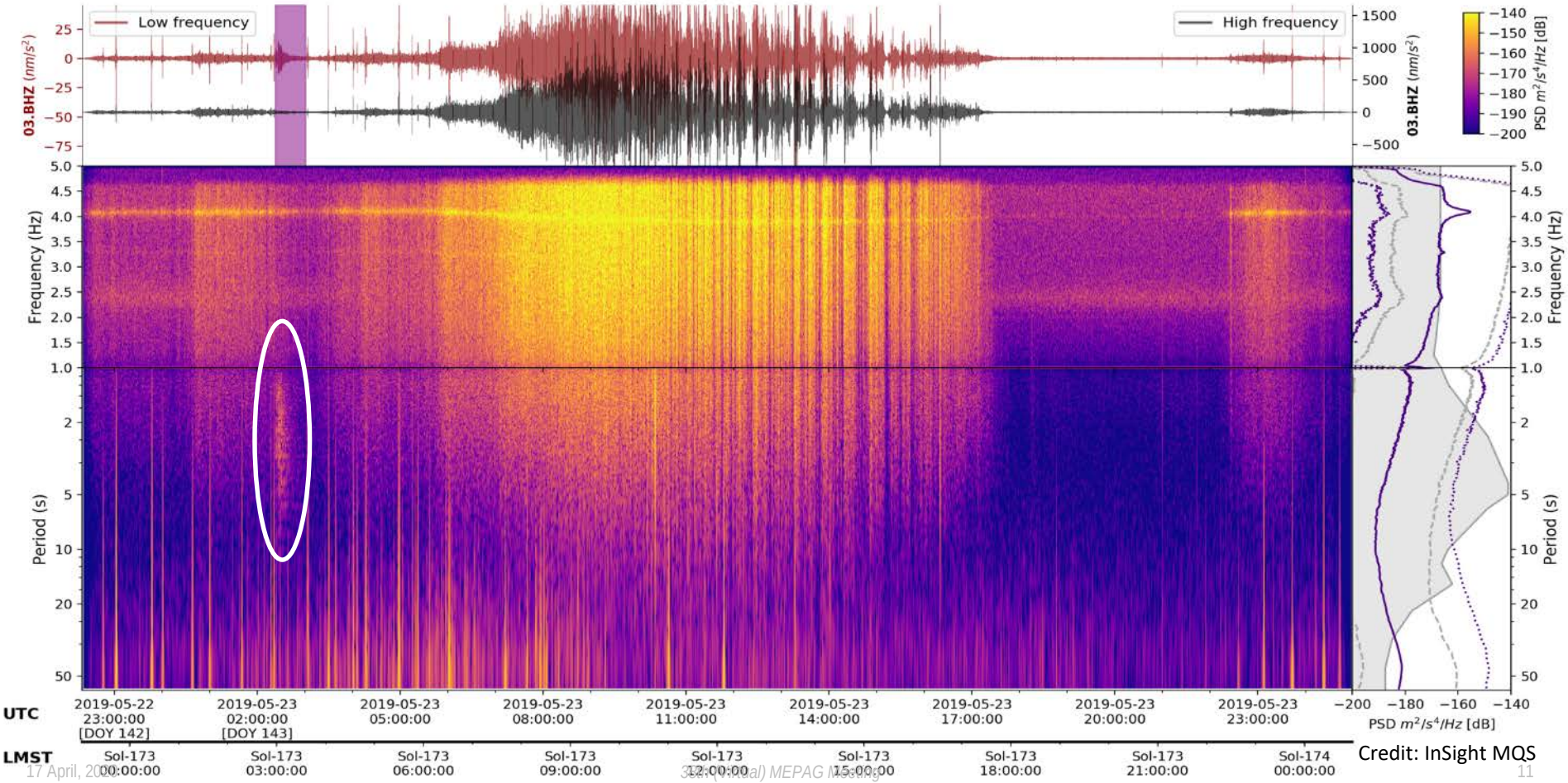
Credit: InSight MQS

InSight Event List (4/16/2020)

- 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 be identified by the InSight MQS as tectonic quakes.
  - Many (most?) of the remaining events are also likely tectonic in origin.

Clearest Marsquake Signal to Date: S0173a, Magnitude 3.7



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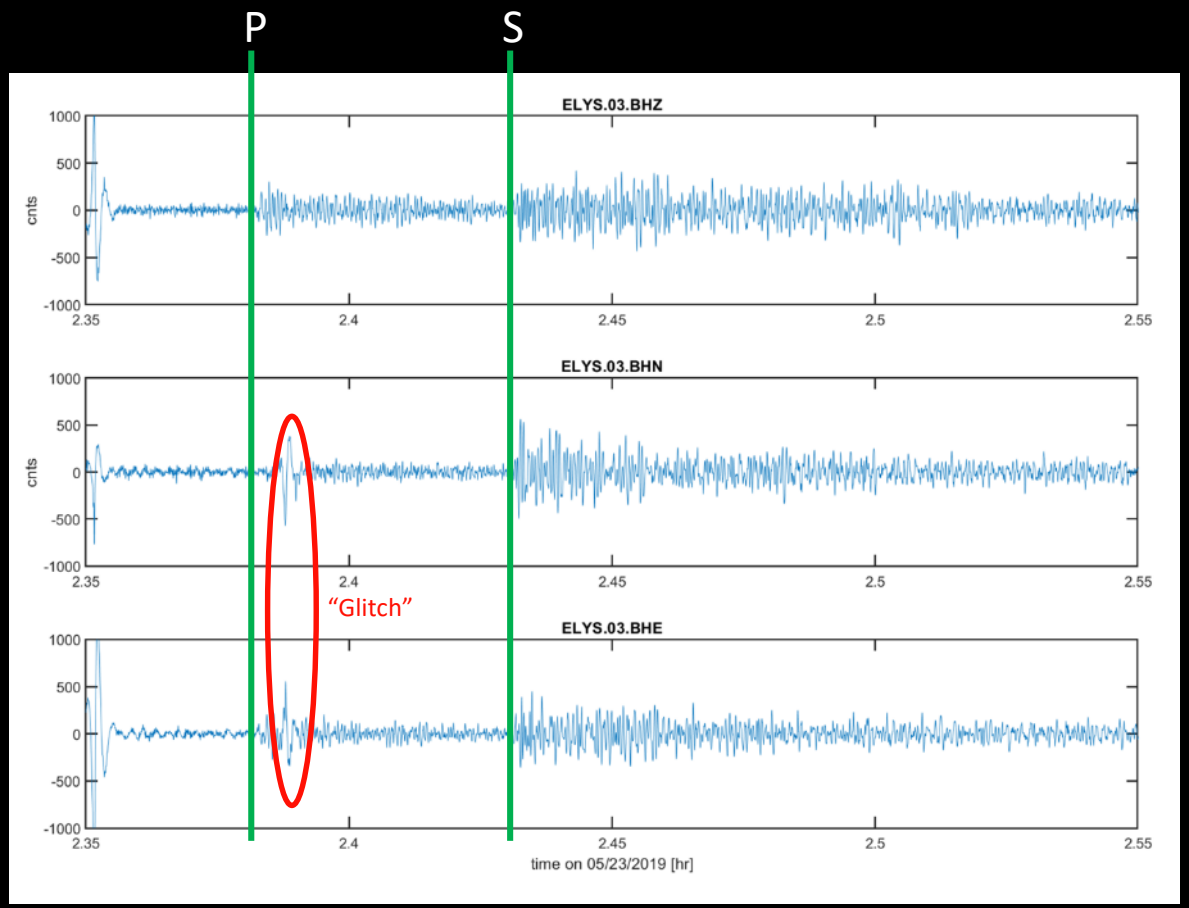
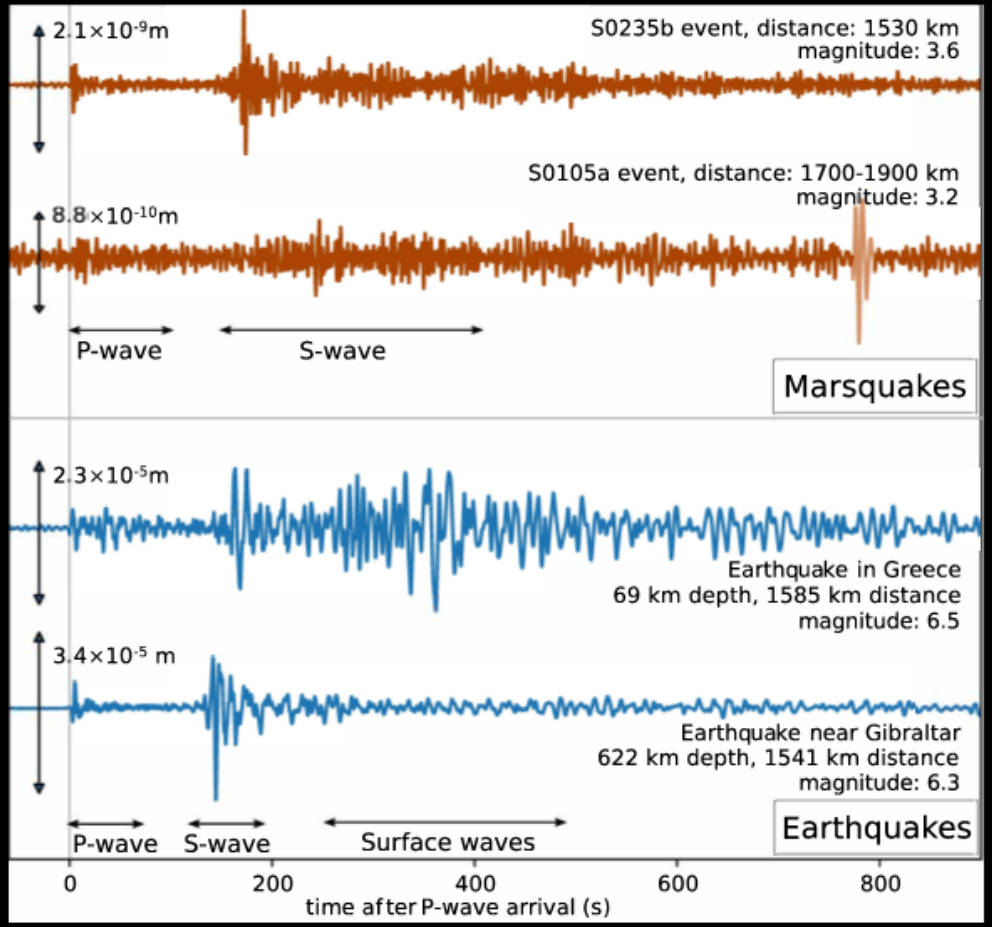
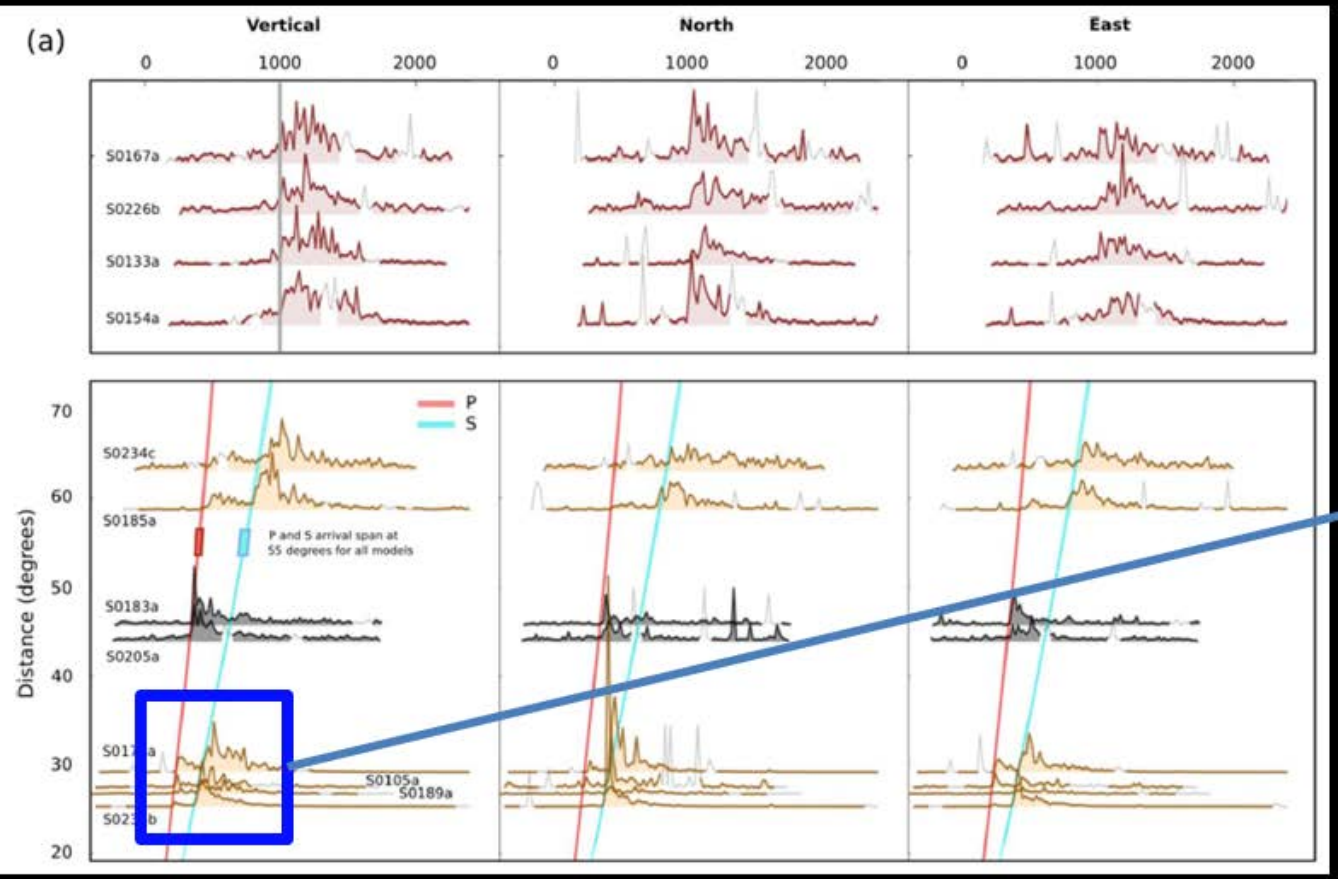


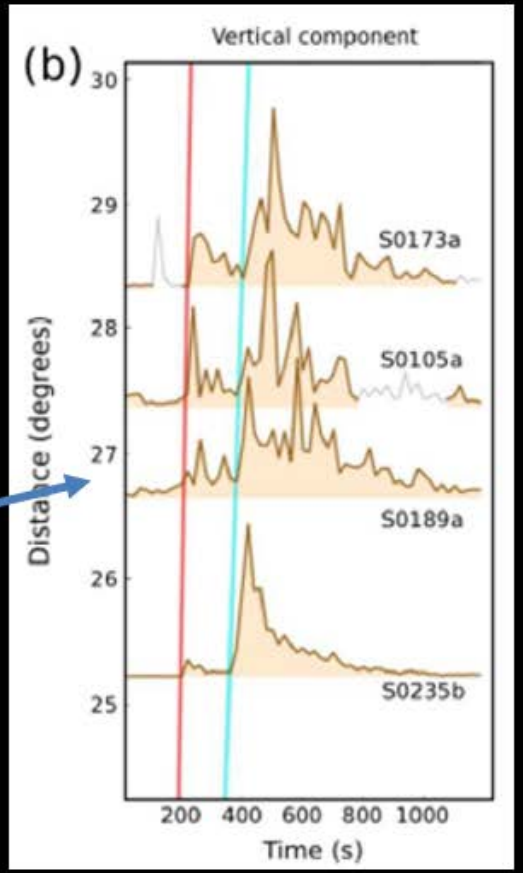
Comparison of Terrestrial and Martian Quake Signals



Banerdt, Smrekar et al. 2020

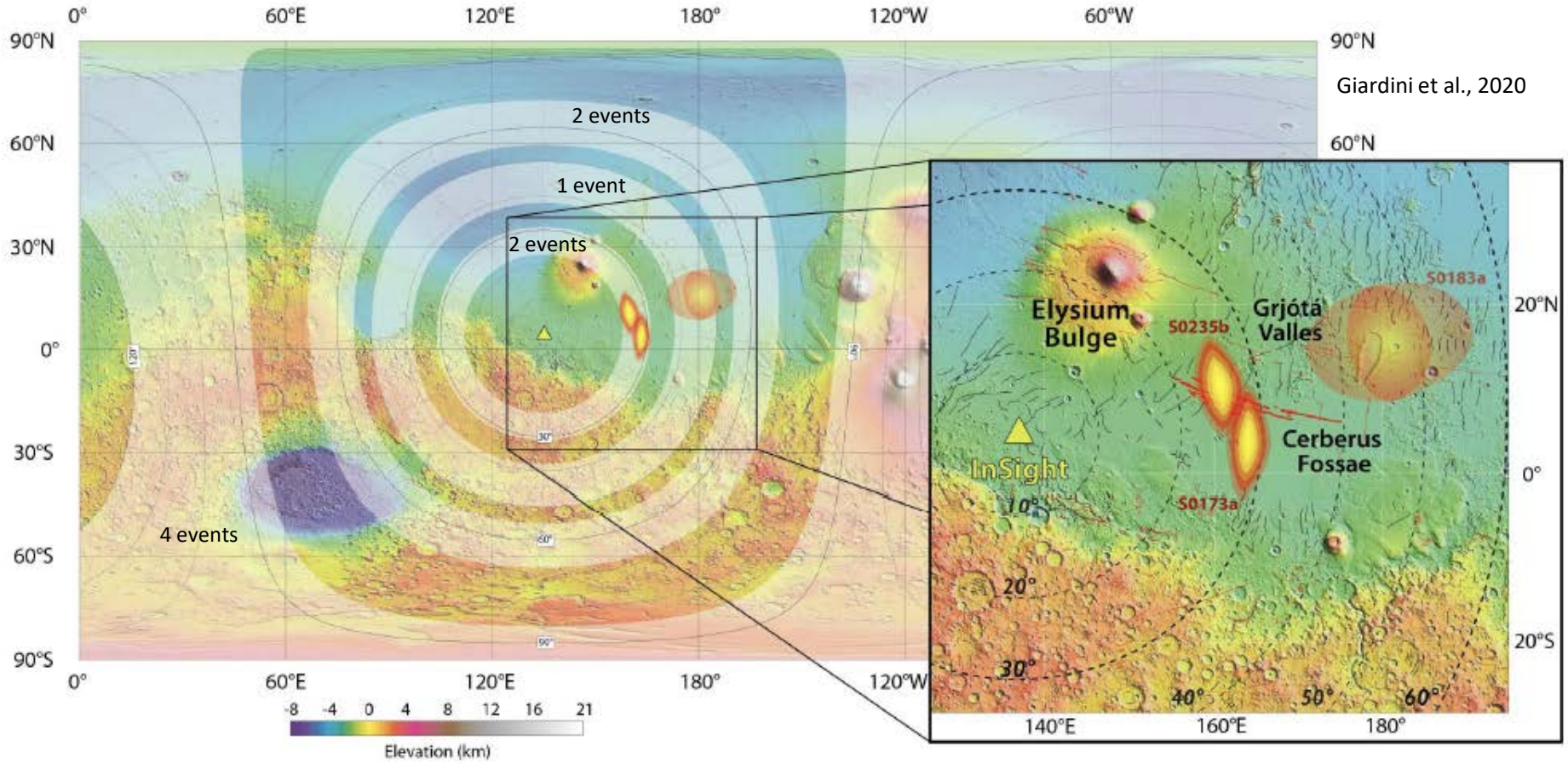
Event Alignment Guided by PSD Envelope Similarity



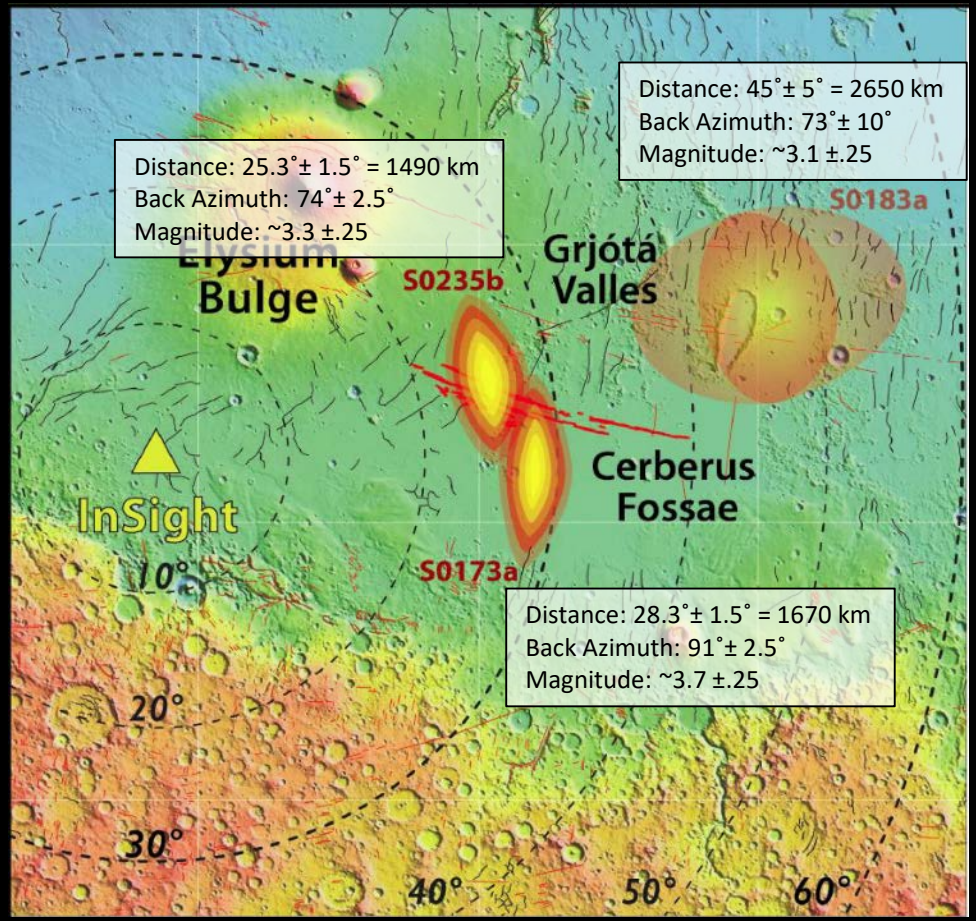


Giardini et al. 2020

Seismicity Map for Mars – 12 “Locatable” Events



Source Locations for Three Events

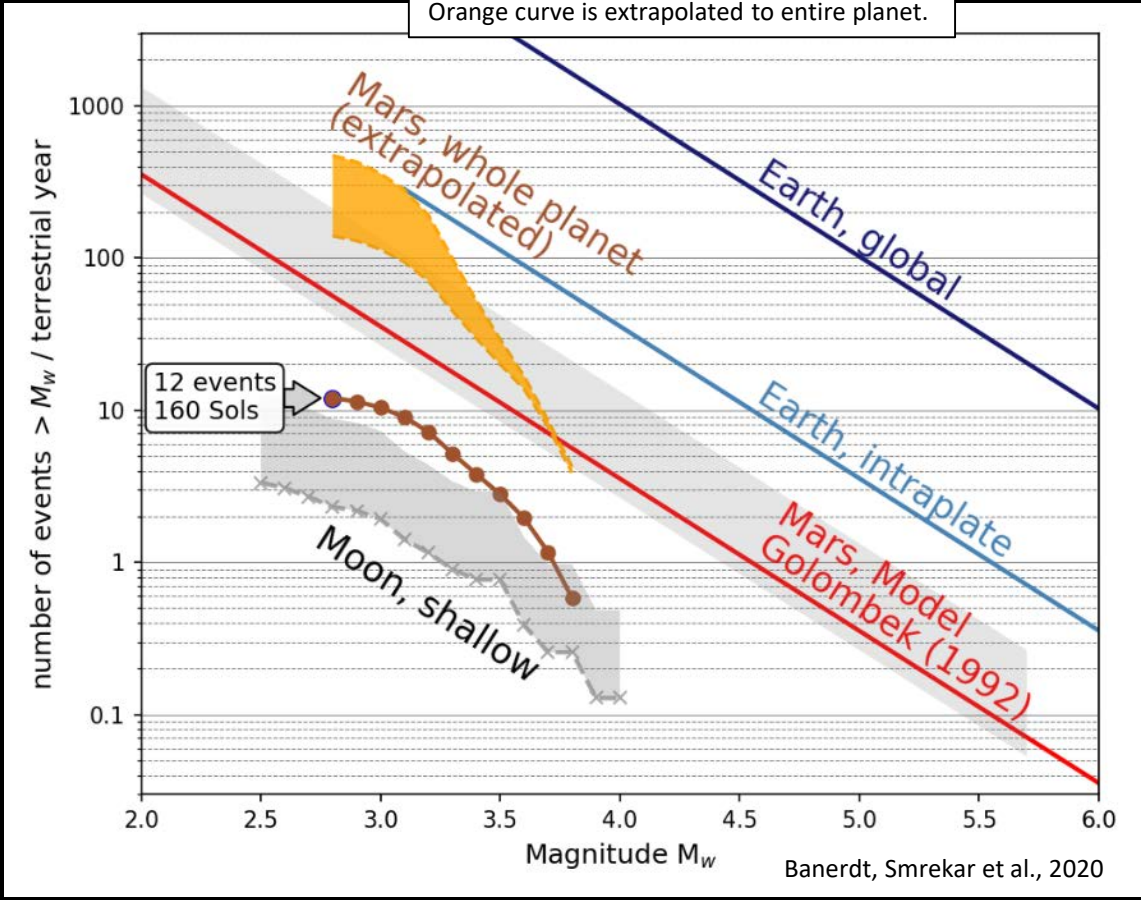


Giardini et al., 2020

Estimating Seismic Activity Rate

- 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.

Brown curve gives the raw observed numbers
Orange curve is extrapolated to entire planet.



Banerdt, Smrekar et al., 2020

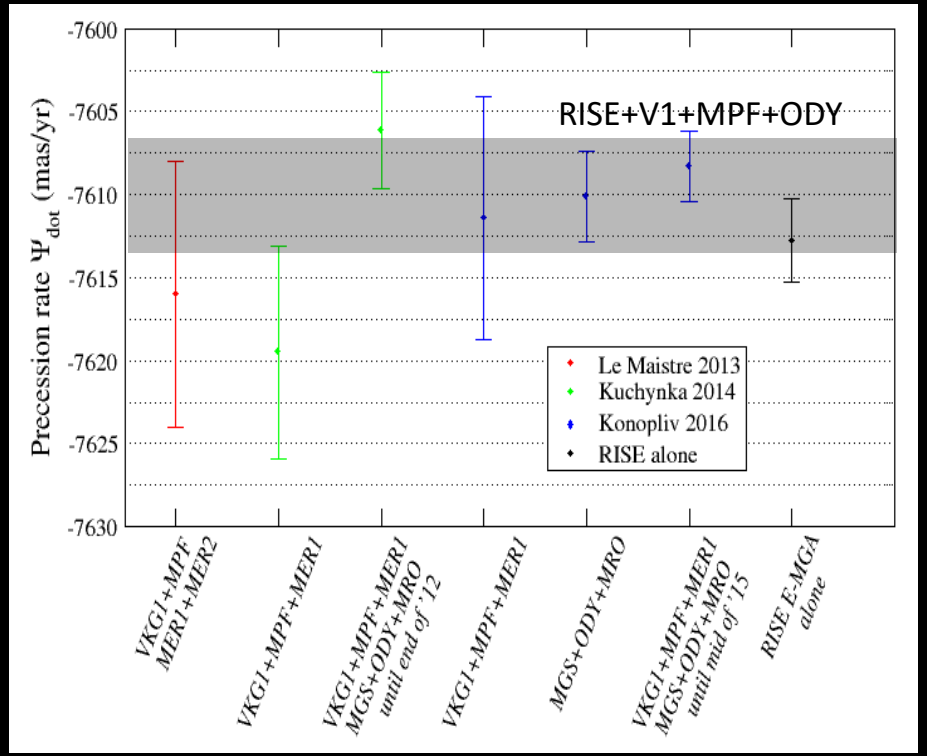
Mars Precession and Moment of Inertia from RISE

- 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 ~year of tracking.

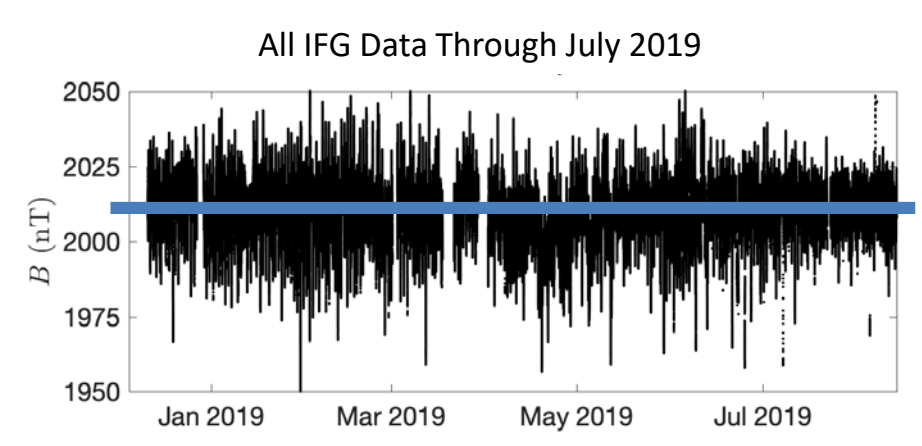


Kahan et al. in prep.

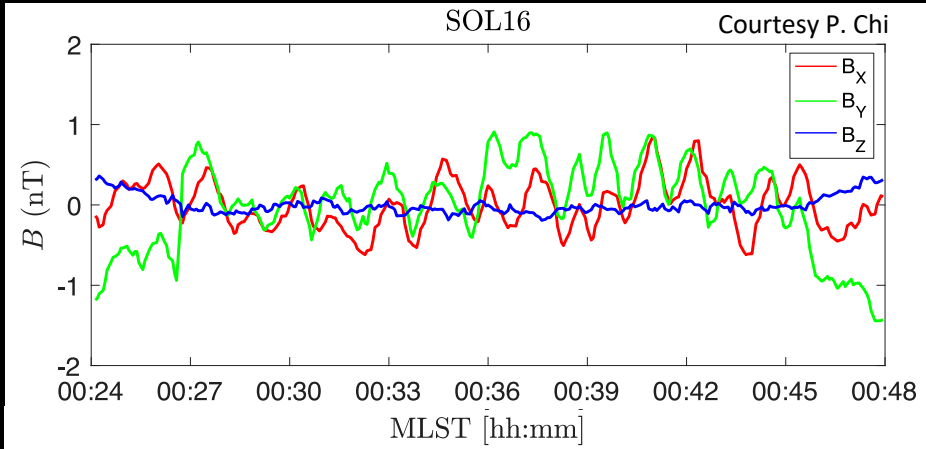
First Magnetic Measurements from the Surface of Mars

Notable early results include:

- DC field at the landing site ~10X stronger than measured from orbit
  - ⇒ 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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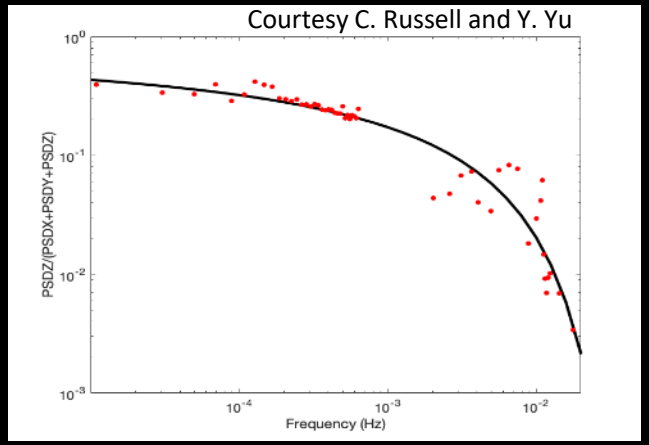
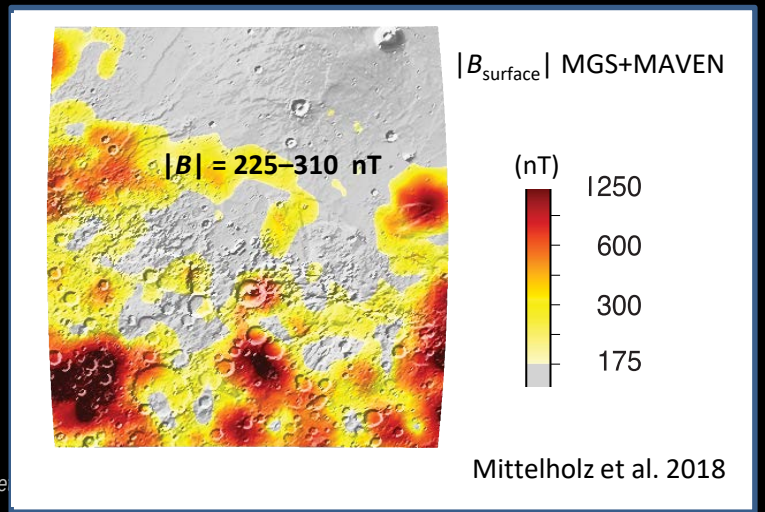
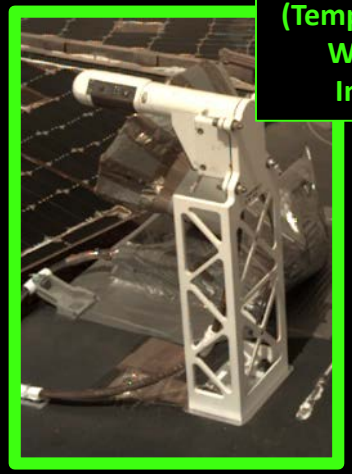




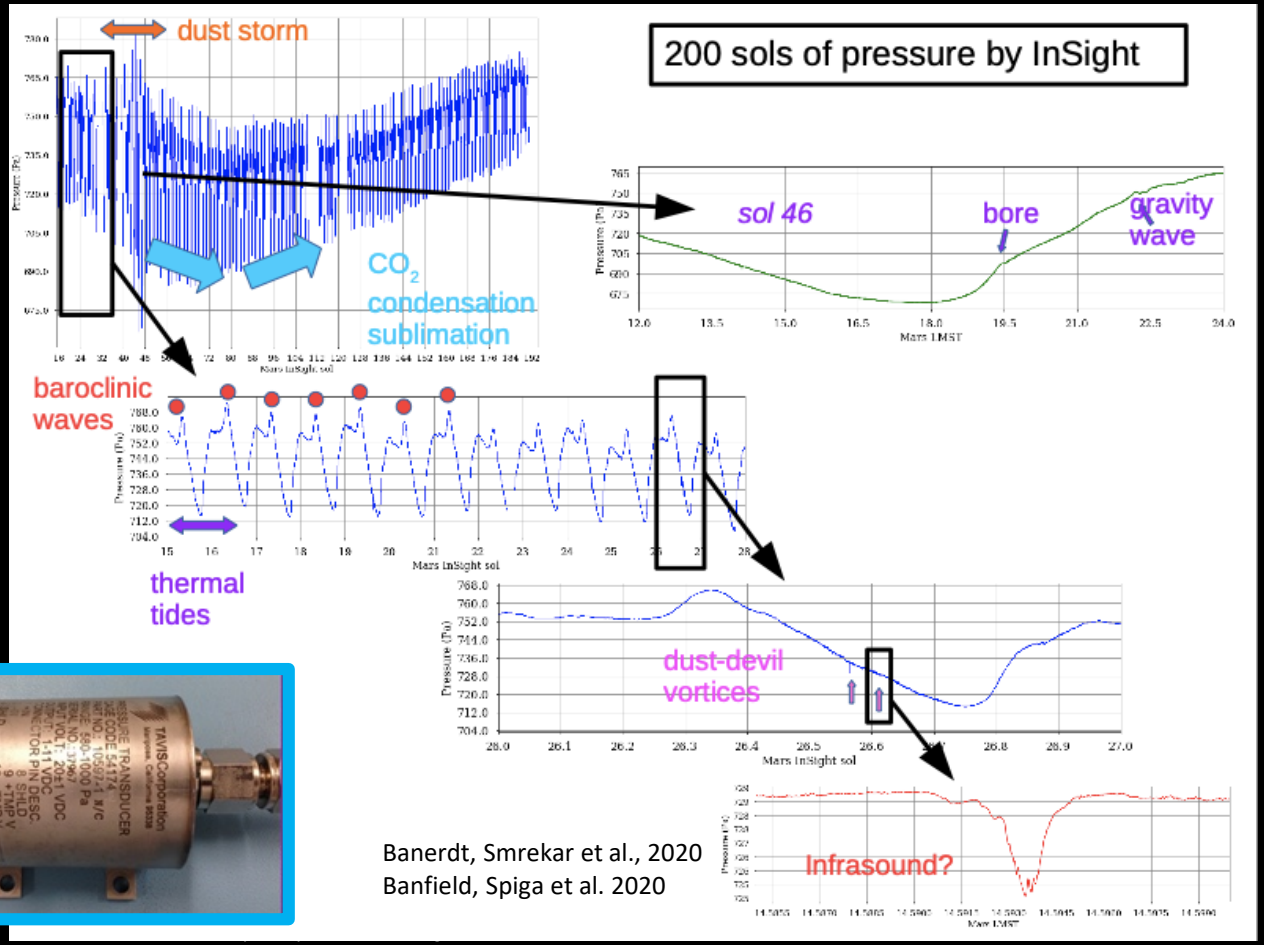
InSight Meteorology

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.



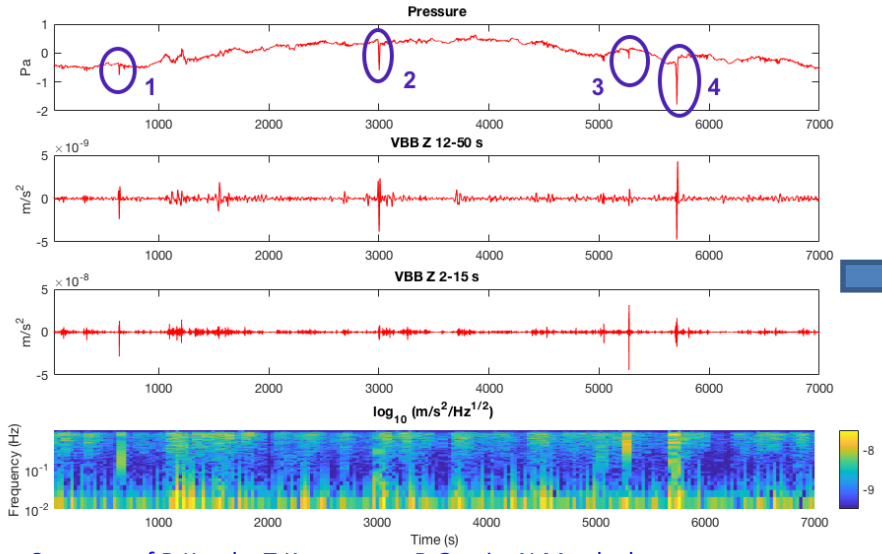
TWINS (Temperature & Wind for InSight)

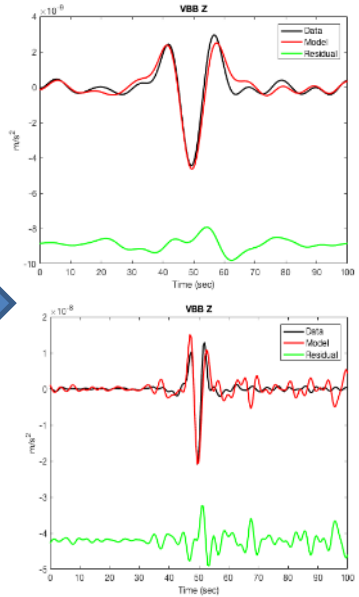
Pressure Sensor

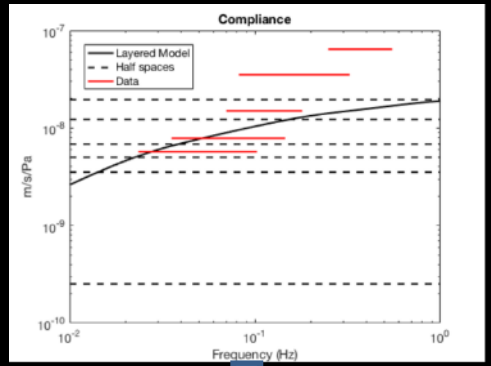


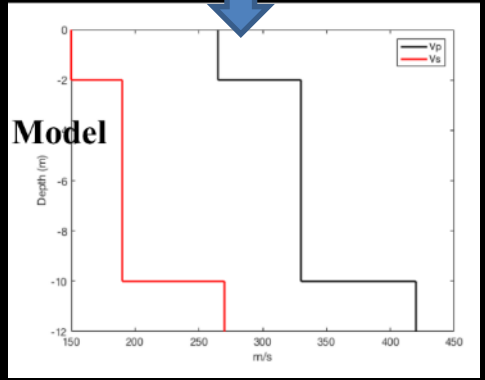
Banerdt, Smrekar et al., 2020
Banfield, Spiga et al. 2020

Ground Rigidity from Dust Devils







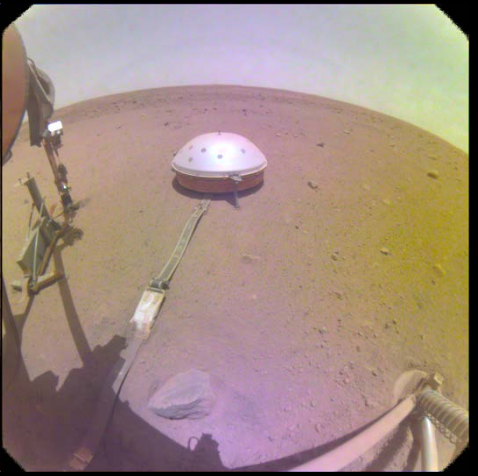


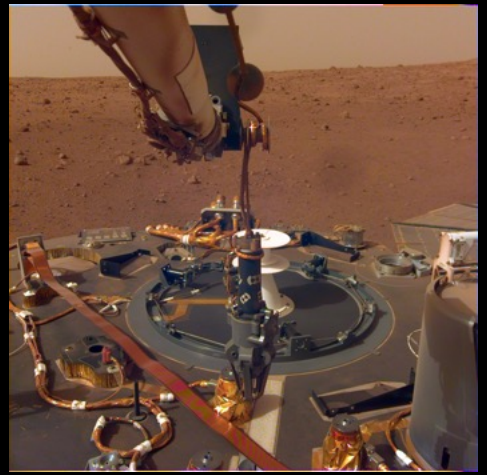
- Courtesy of B.Kenda, T.Kawamura, R.Garcia, N.Murdoch

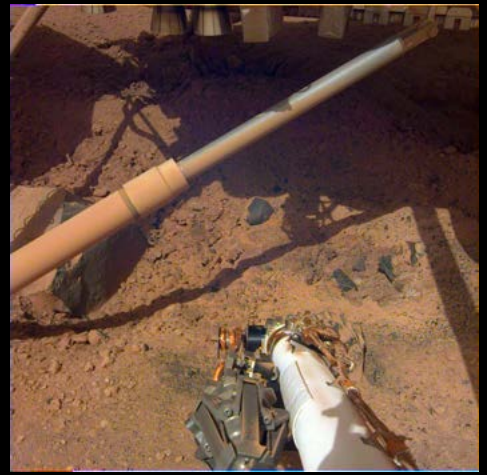
The InSight pressure sensor detects ~10 pressure drops per day

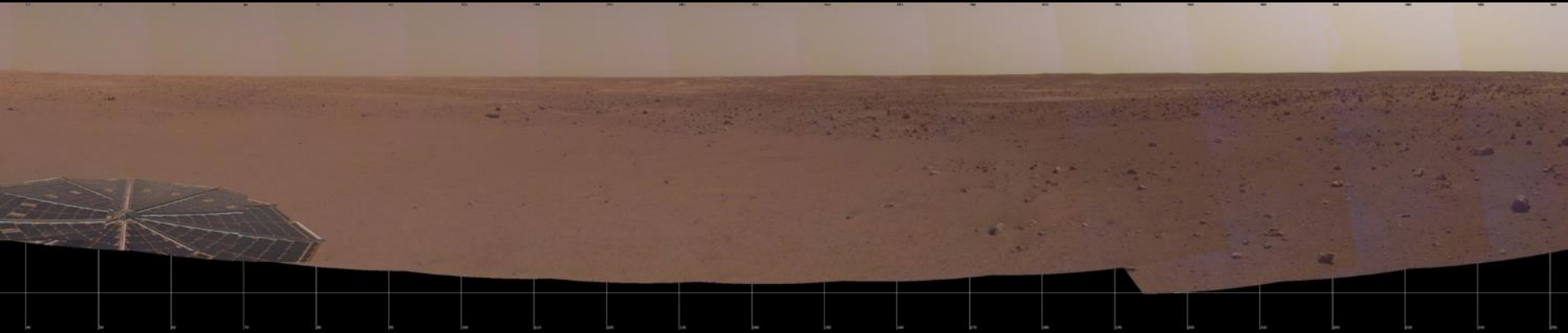
Associated ground deformation measured by SEIS provides an estimate of ground compliance to ~3-5 m depth

Pictures! (4360 Images as of Sol 490, 13 April, 2020)









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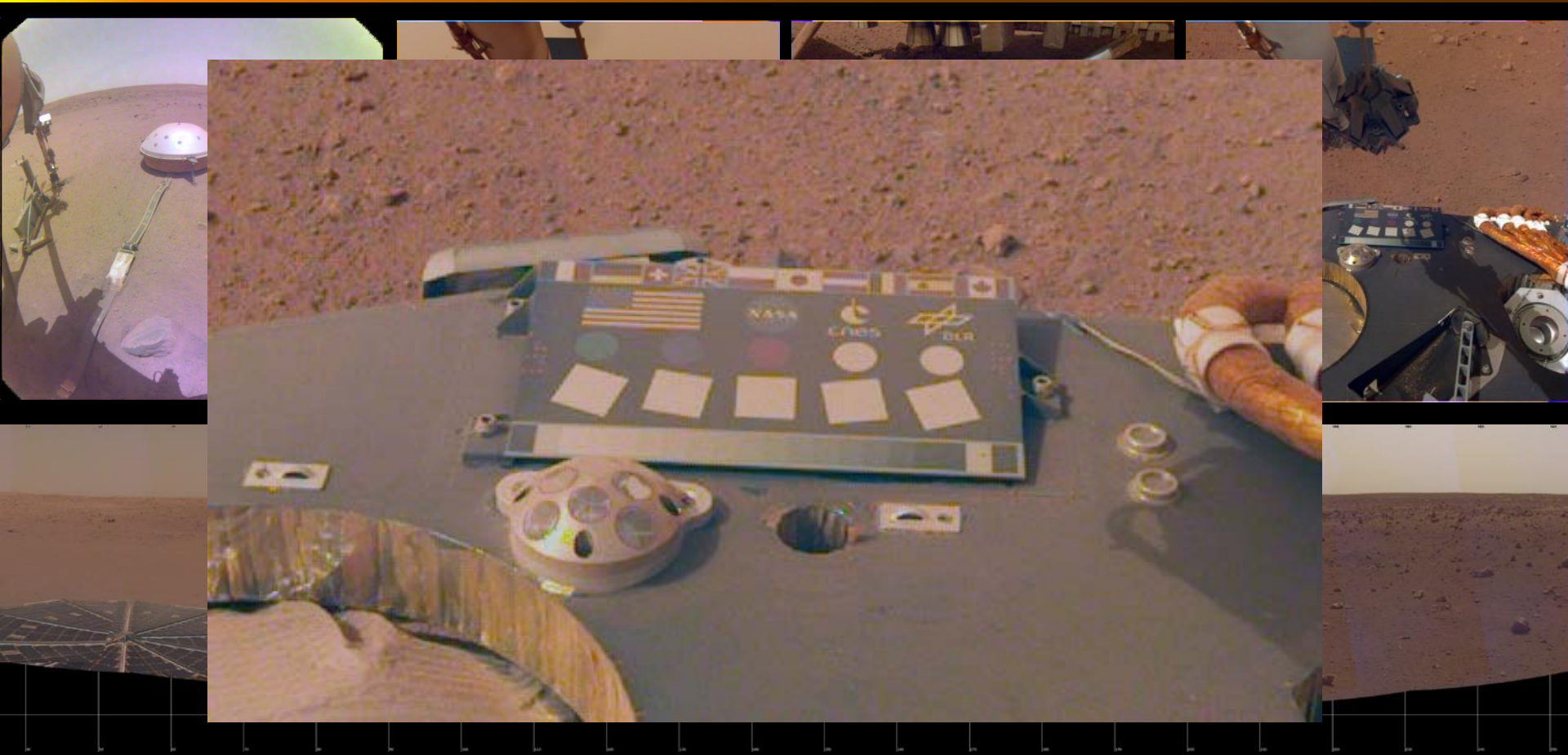

Sunset over Elysium, sol 145