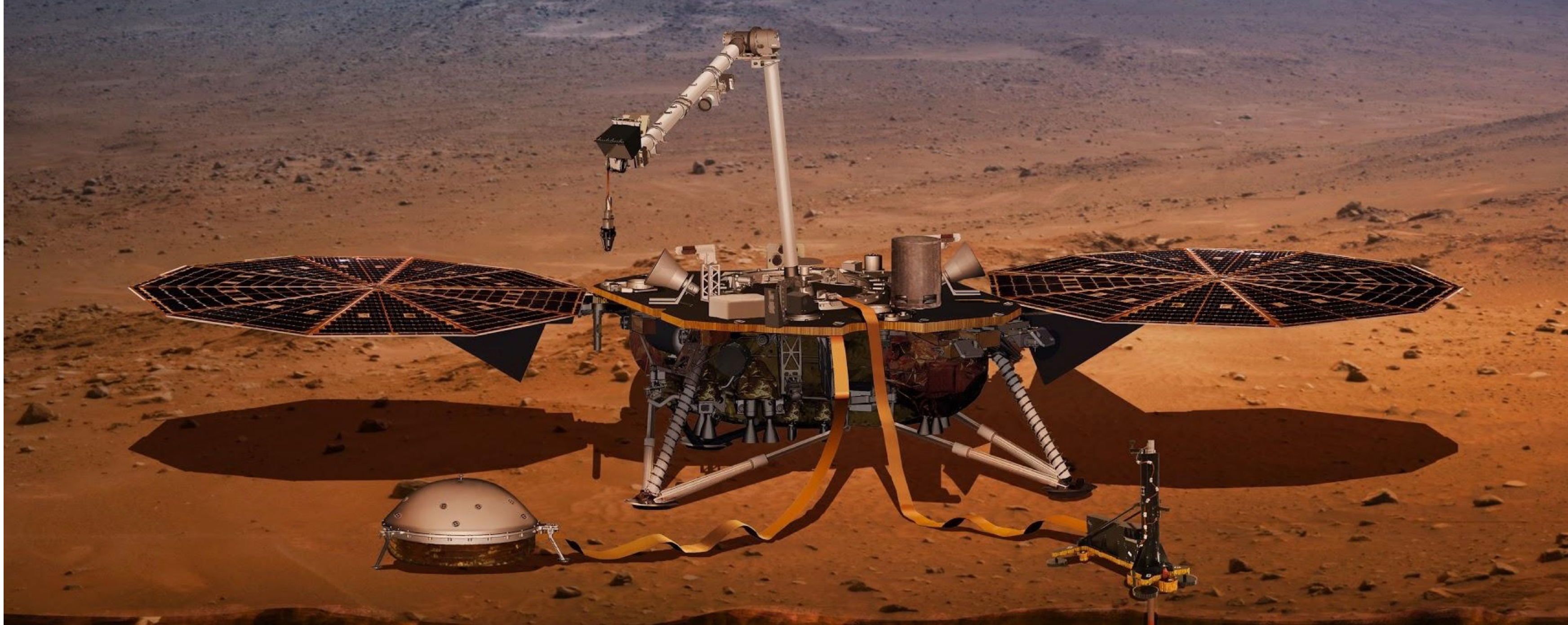


InSight Mission Status and Recent Results

Tom Pike
and the InSight Science Team

4 May, 2020

InSight Status

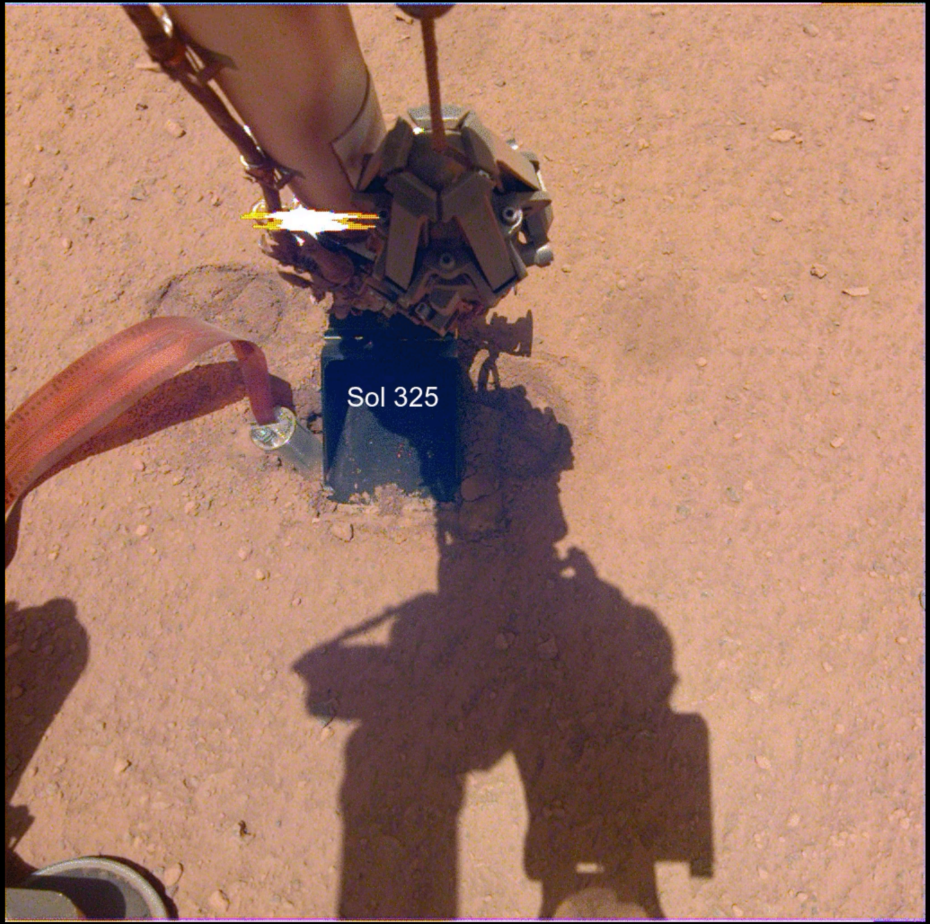
- The InSight spacecraft is just now finishing its 510th sol on Mars and is operating almost flawlessly.
- All the instruments are operating 24.6/7, as well as or better than designed, with the exception of the HP^3 mole.
  - SEIS is measuring motions ~10x better than its design requirement.
  - The 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.

HP3 Status

- 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.

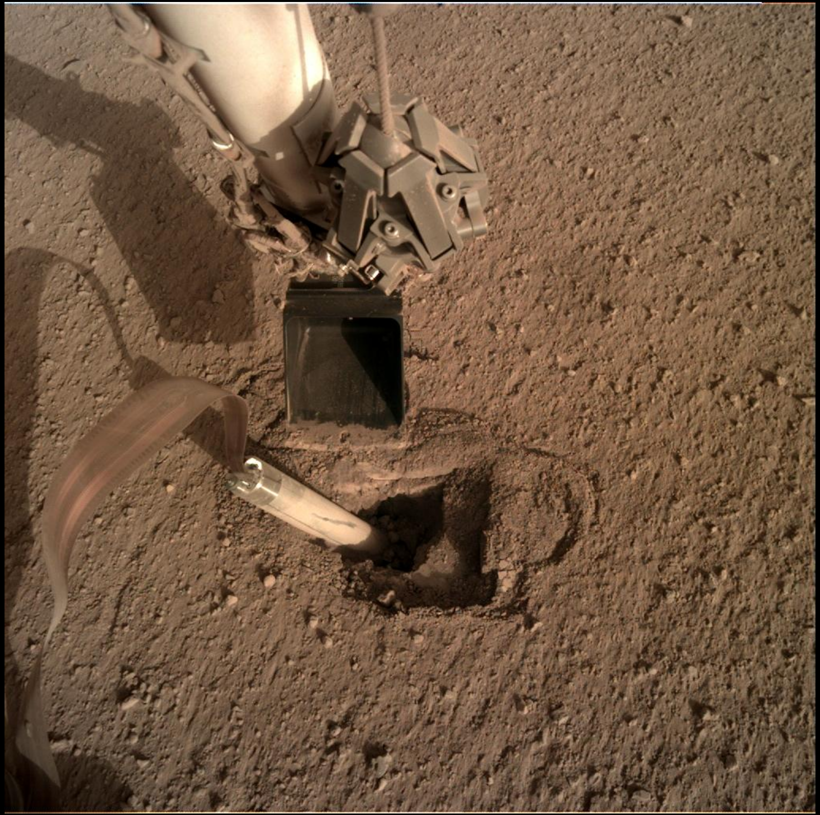
First Three Attempts to "Pin and Hammer"

One Step Forward, Three Steps Back...

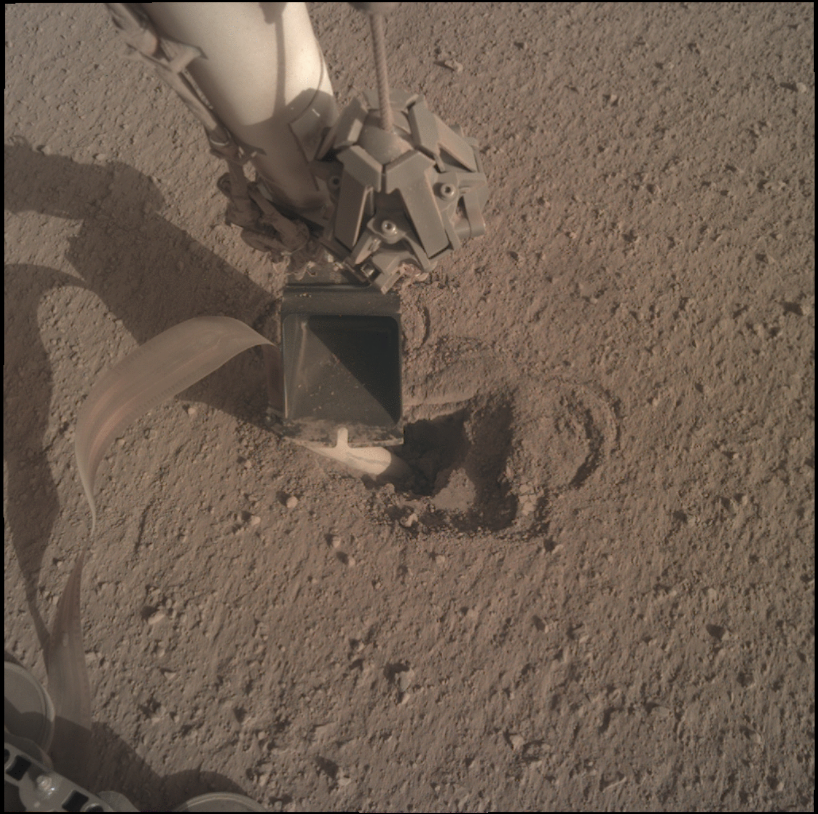


Curent Phase – Back Cap Push

Getting into position on Mars – sol 427



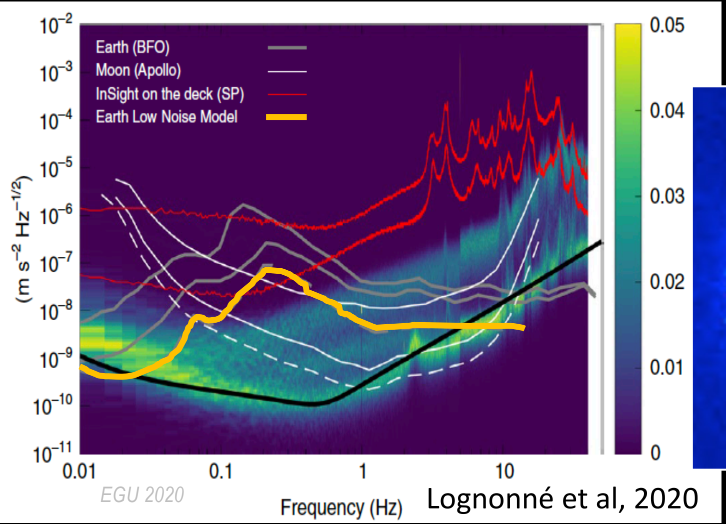
Most recent hammering session – sol 489



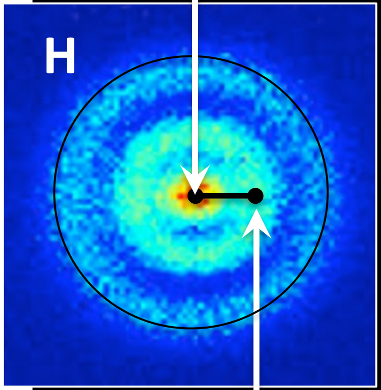
The Challenge of Operating a Seismometer on Mars

- 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

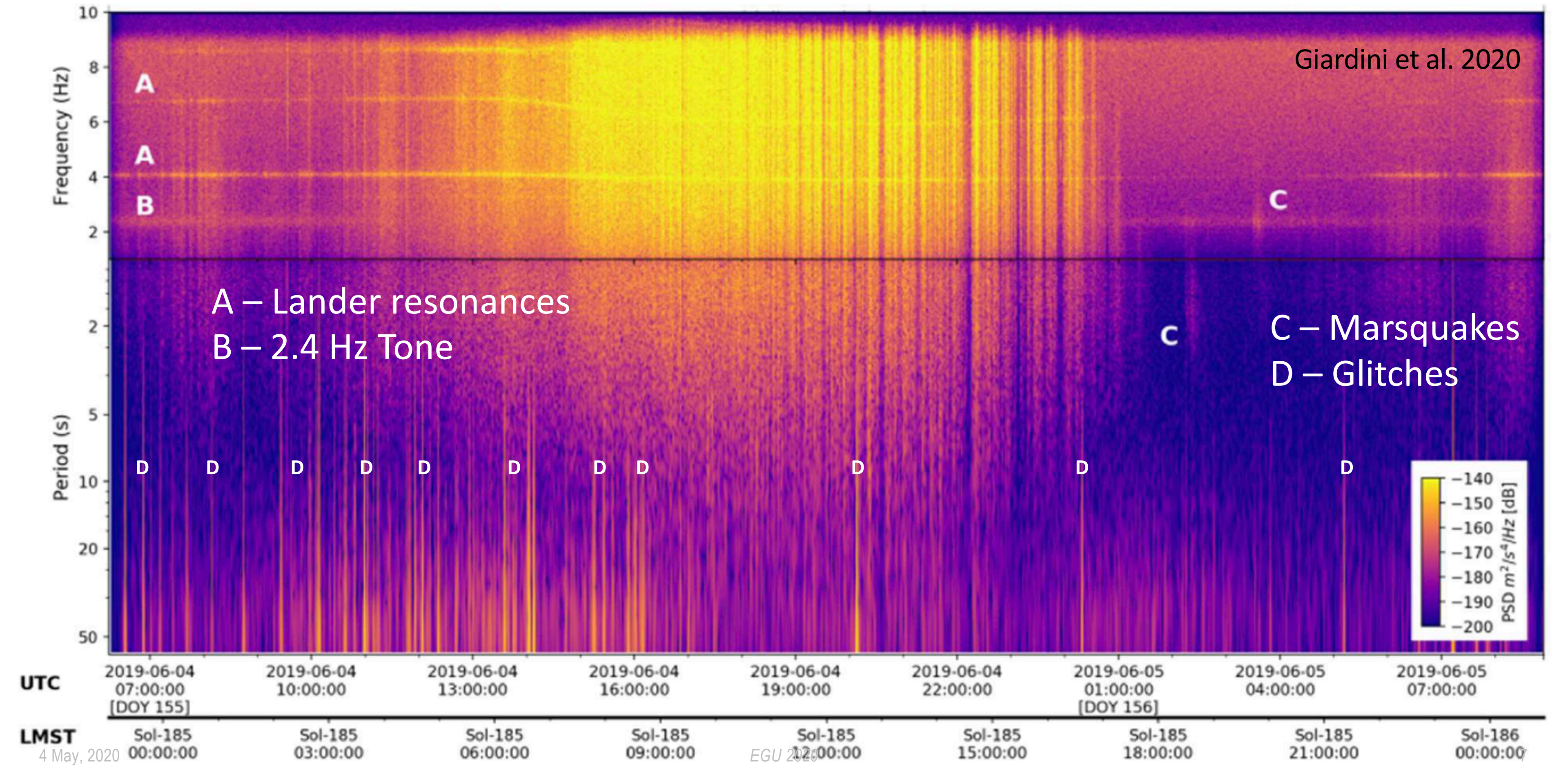
- The development team worked hard to minimize/compensate for all noise sources:
  - Instrument intrinsic noise
  - Temperature variations
  - Wind
  - Atmospheric pressure variations
  - Magnetic field variations
  - Lander vibrations



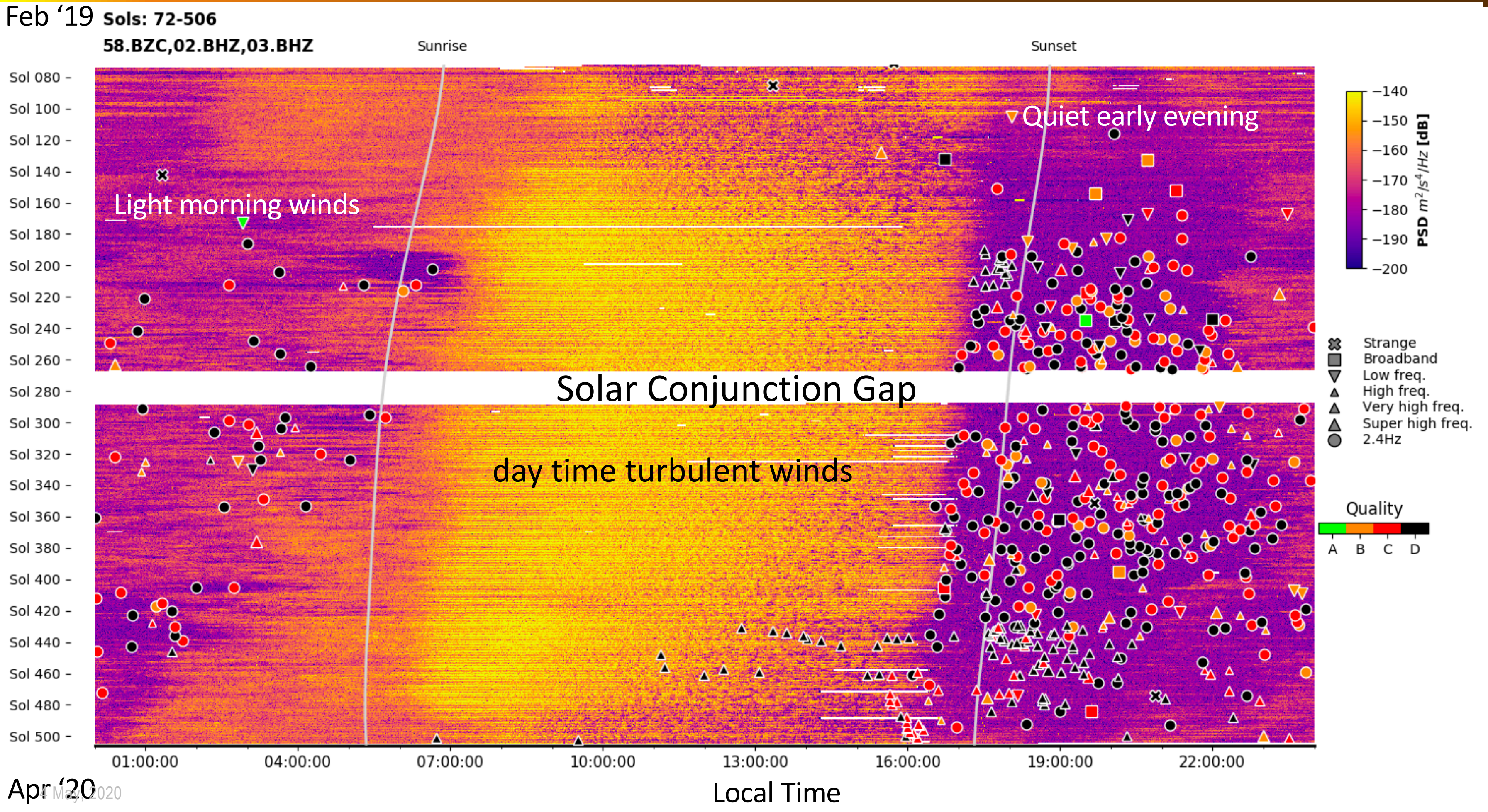
Lognonné et al, 2020



Mars Seismic Data: Full-Sol Spectrogram, Sol 185



All Seismic Data as of Sol 506)

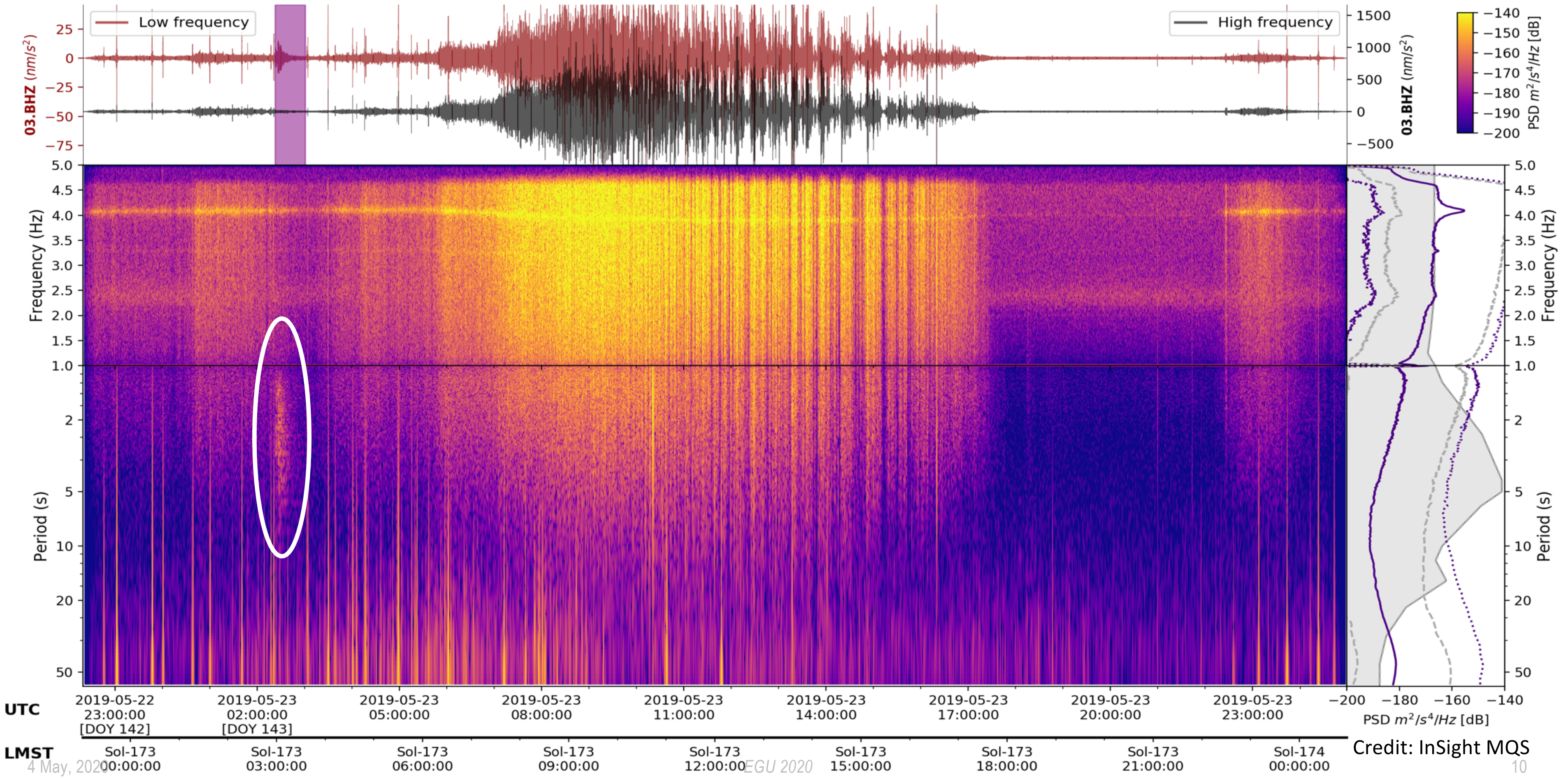


InSight Event List (4/16/2020)

- 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

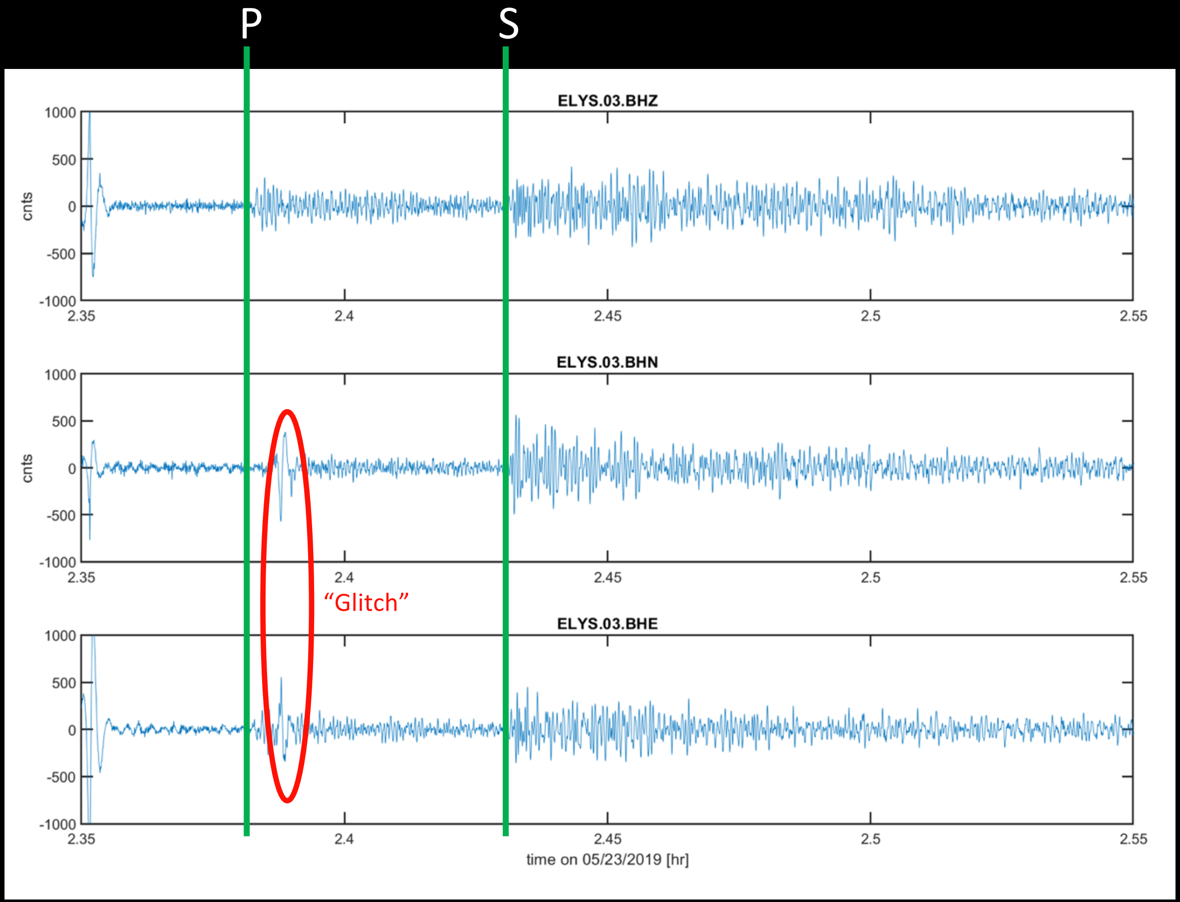
  - Virtually all of the Qual A and B, and many of the Qual C have been be identified by the InSight MQS as tectonic quakes.
  - Many of the remaining events are also likely tectonic in origin.

Clearest Marsquake Signal to Date: S0173a, Magnitude 3.7

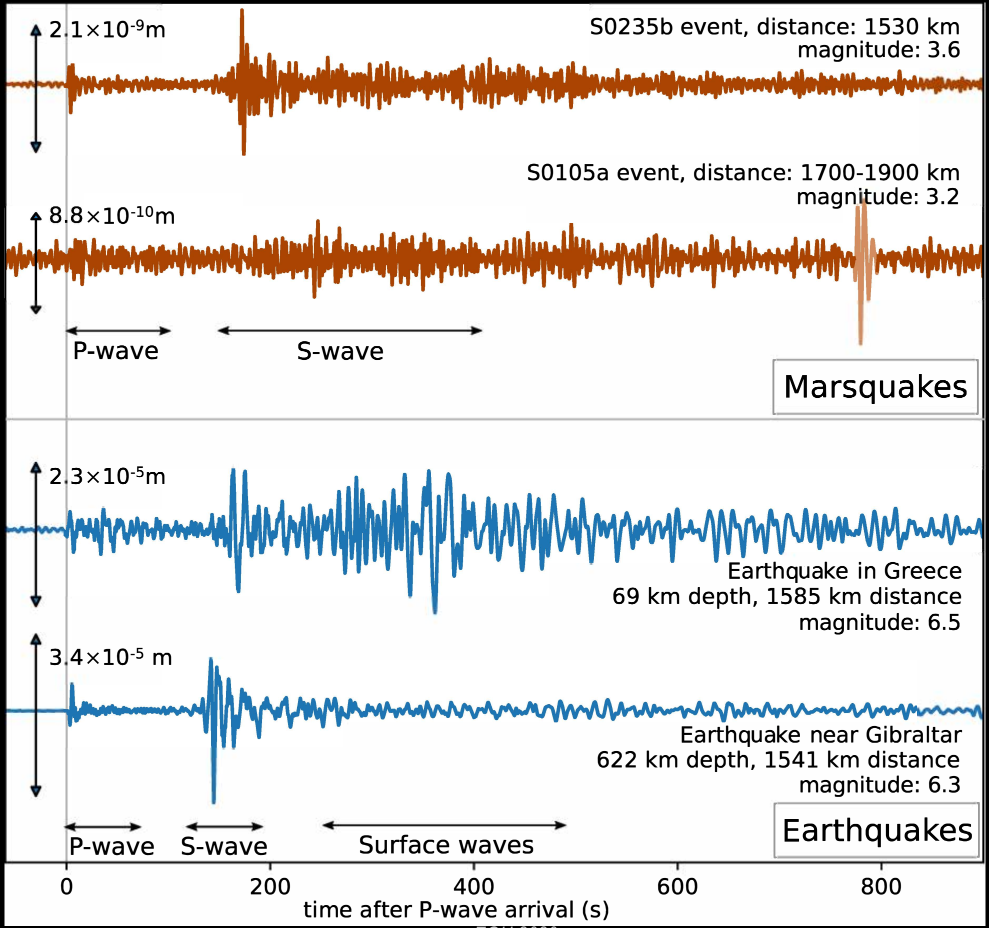


Credit: InSight MQS

Clearest Marsquake Signal to Date: S0173a, Magnitude 3.7

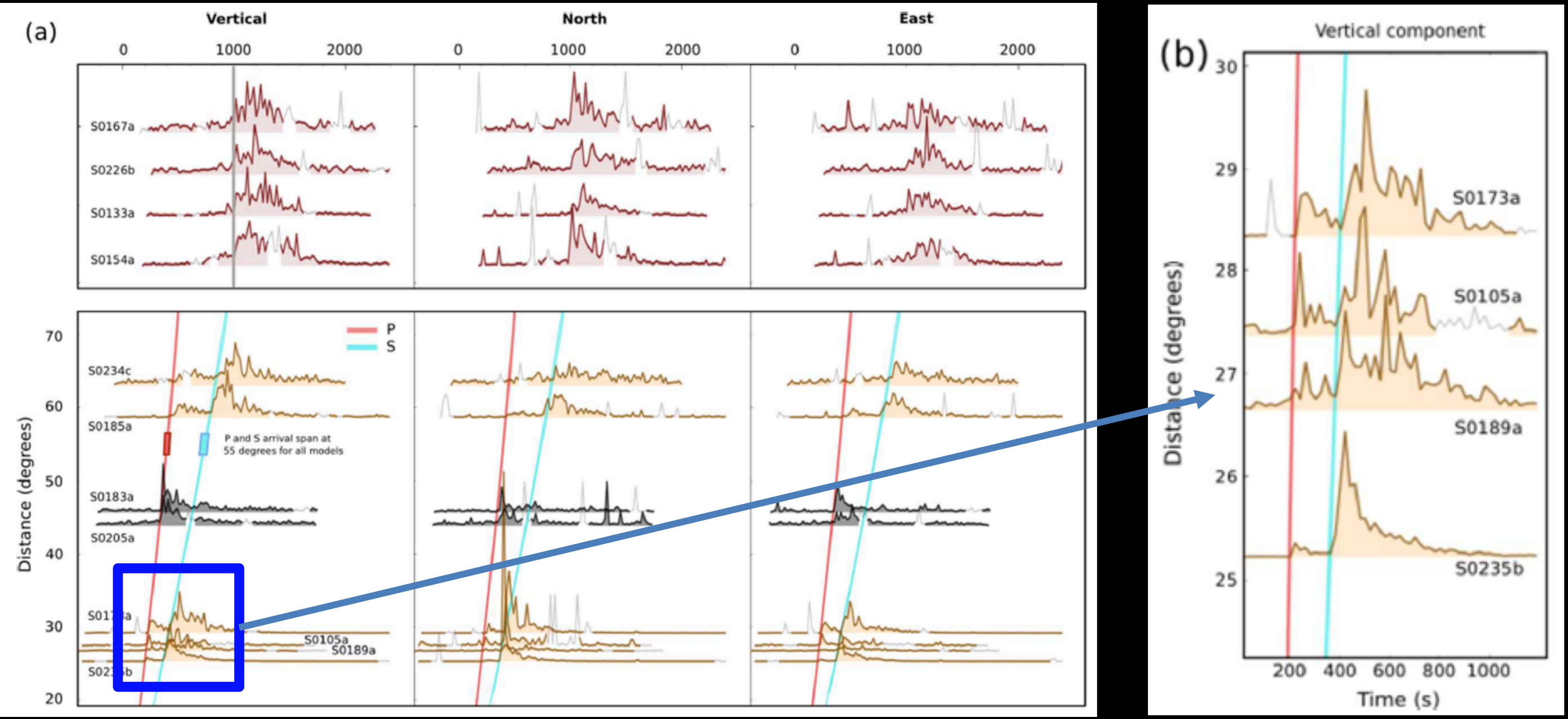


Comparison of Terrestrial and Martian Quake Signals



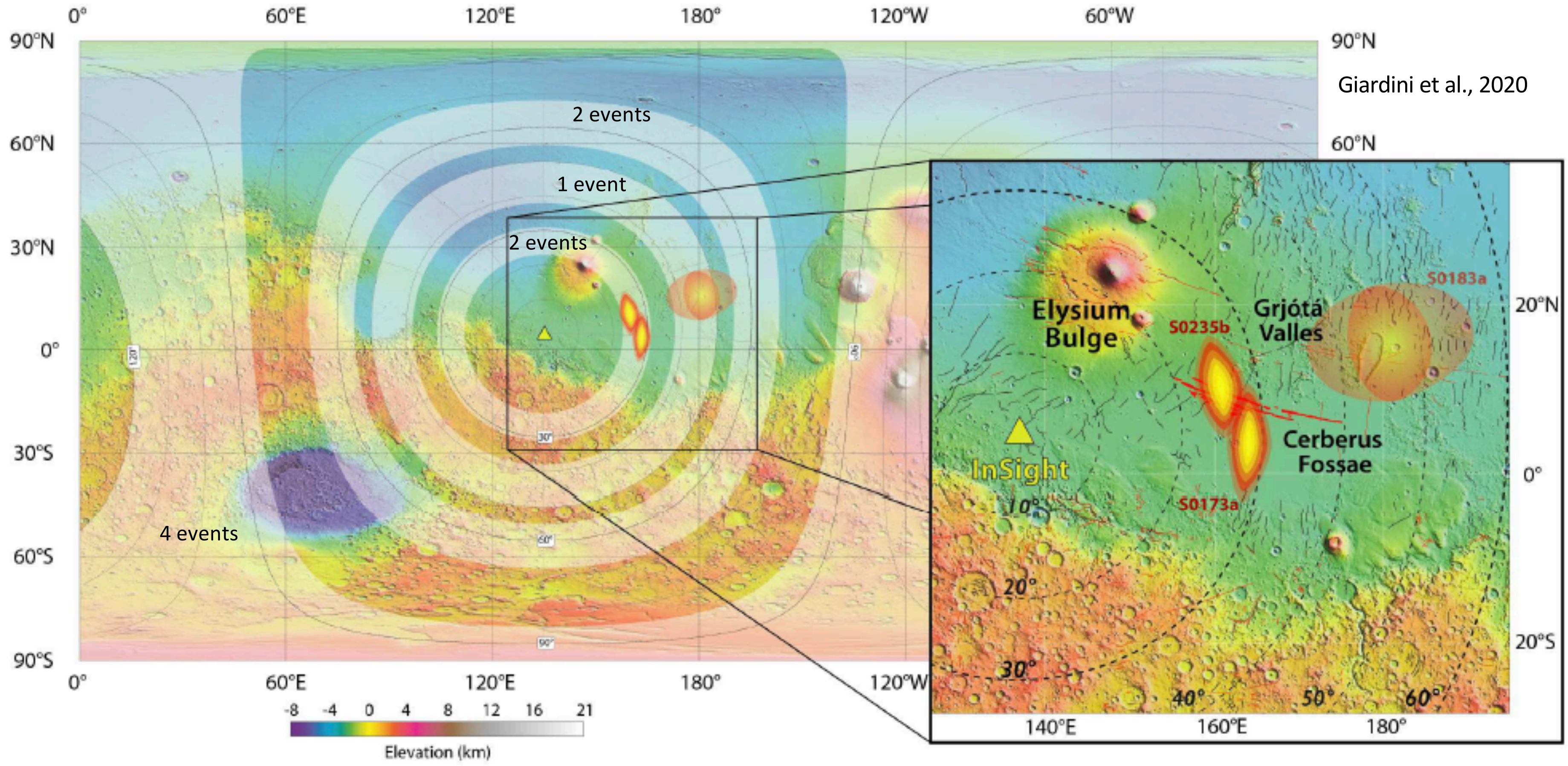
Banerdt, Smrekar et al. 2020

Event Alignment Guided by PSD Envelope Similarity

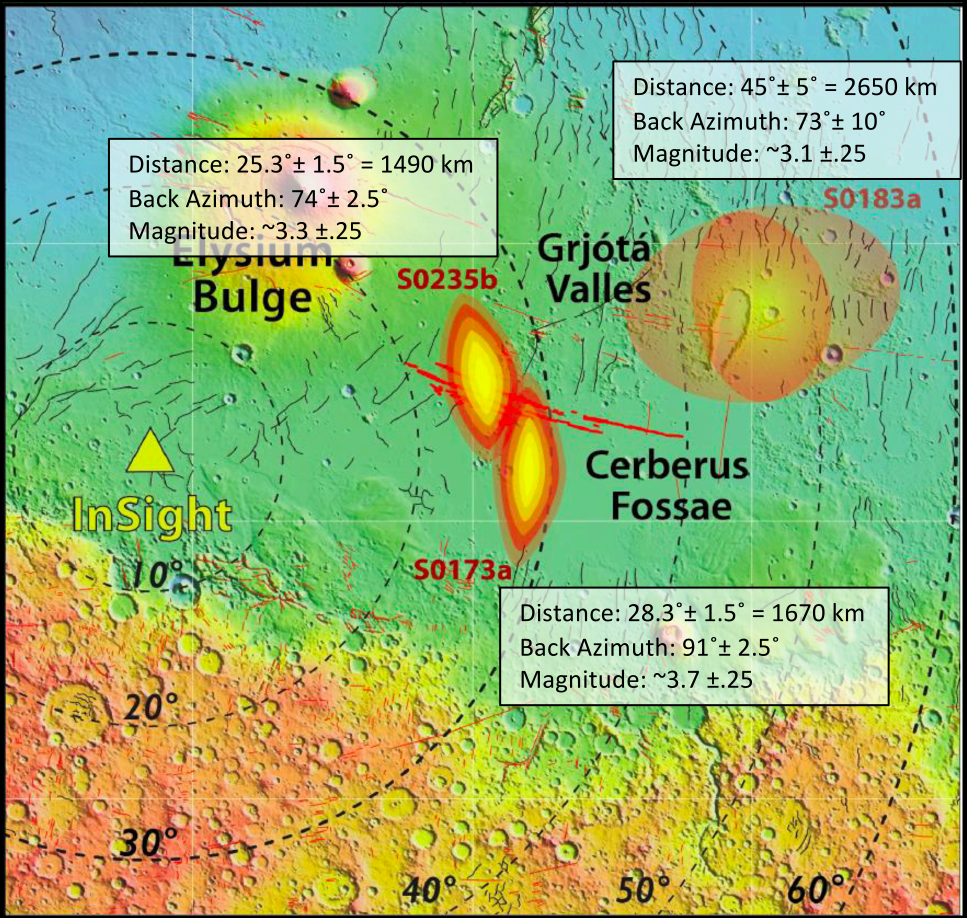


Giardini et al. 2020

Seismicity Map for Mars – 12 "Locatable" Events



Source Locations for Three Events

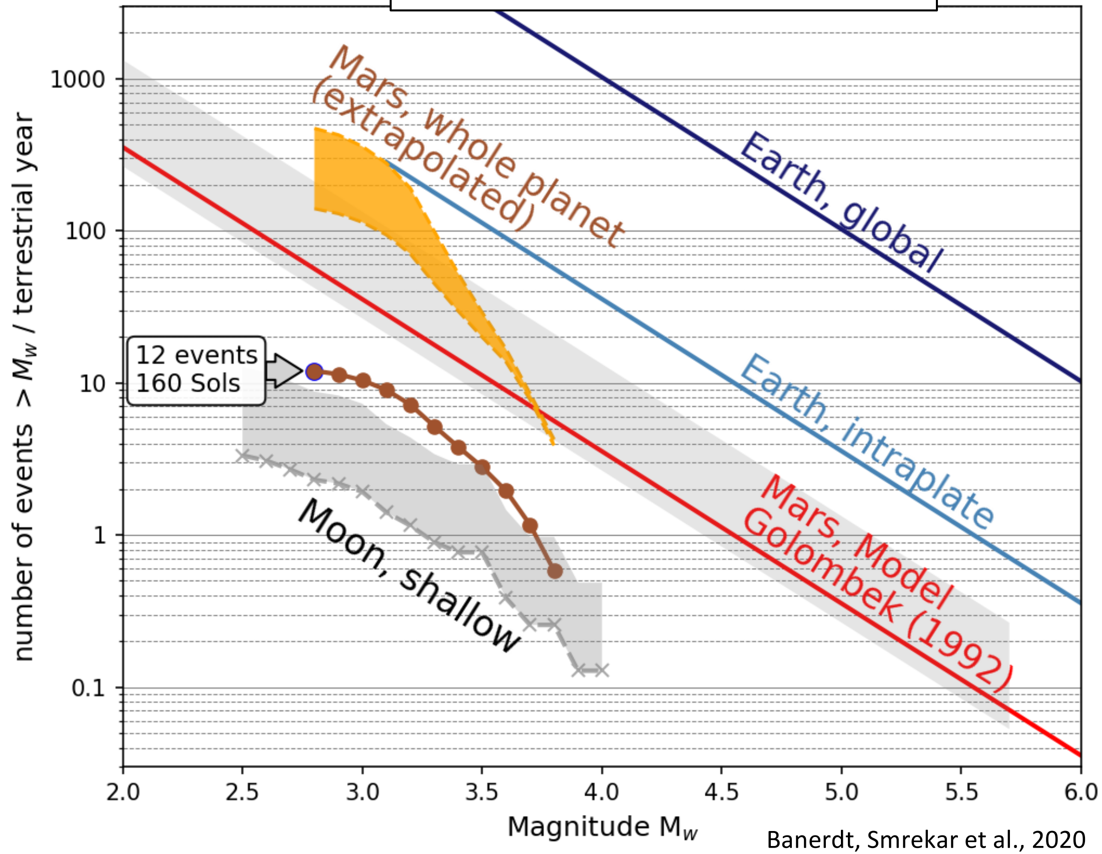


Giardini et al., 2020

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

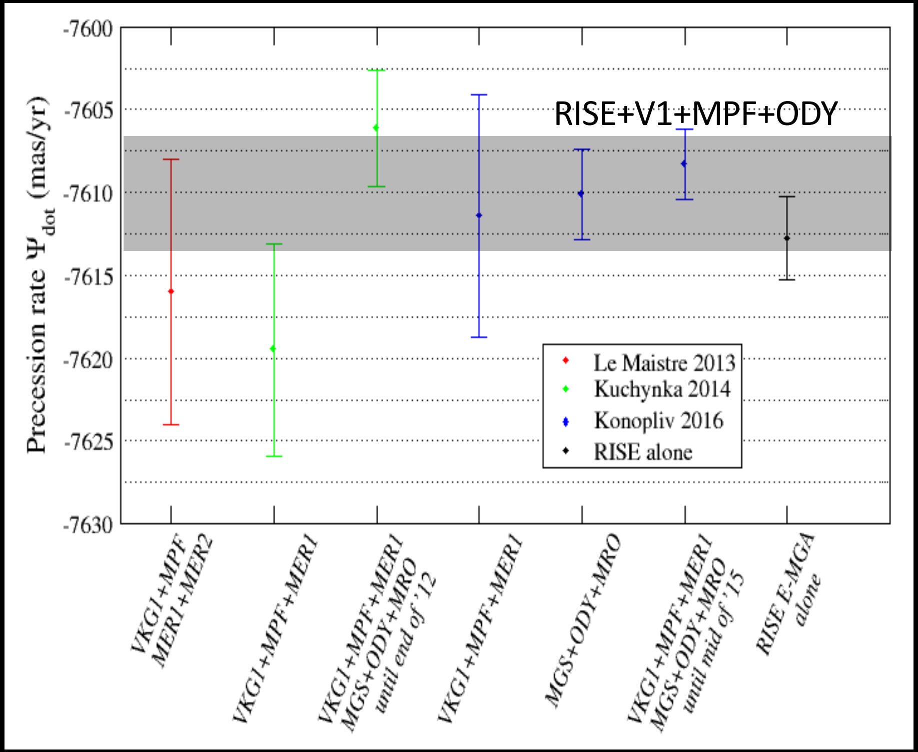
Mars Precession and Moment of Inertia from RISE

- 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.



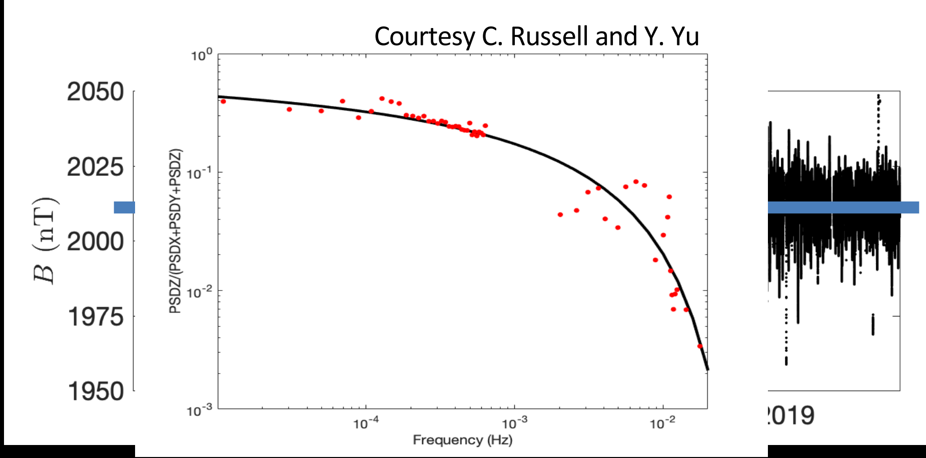
Kahan et al. in prep.

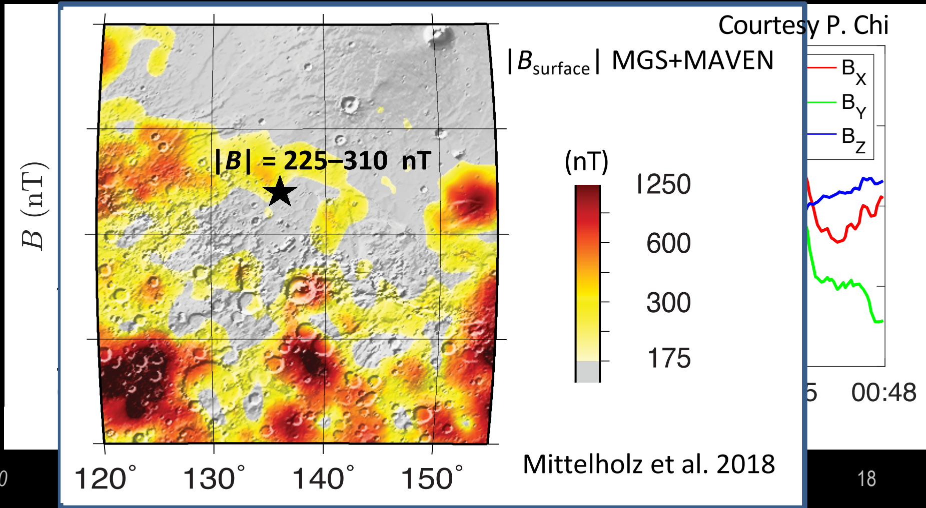
First Magnetic Measurements from the Surface of Mars

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.

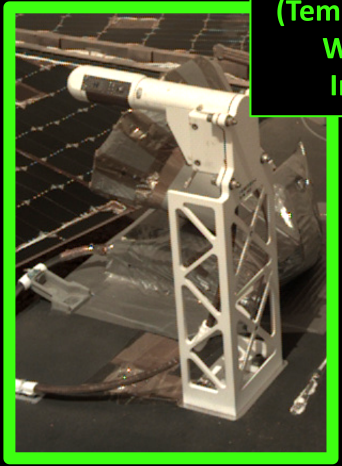




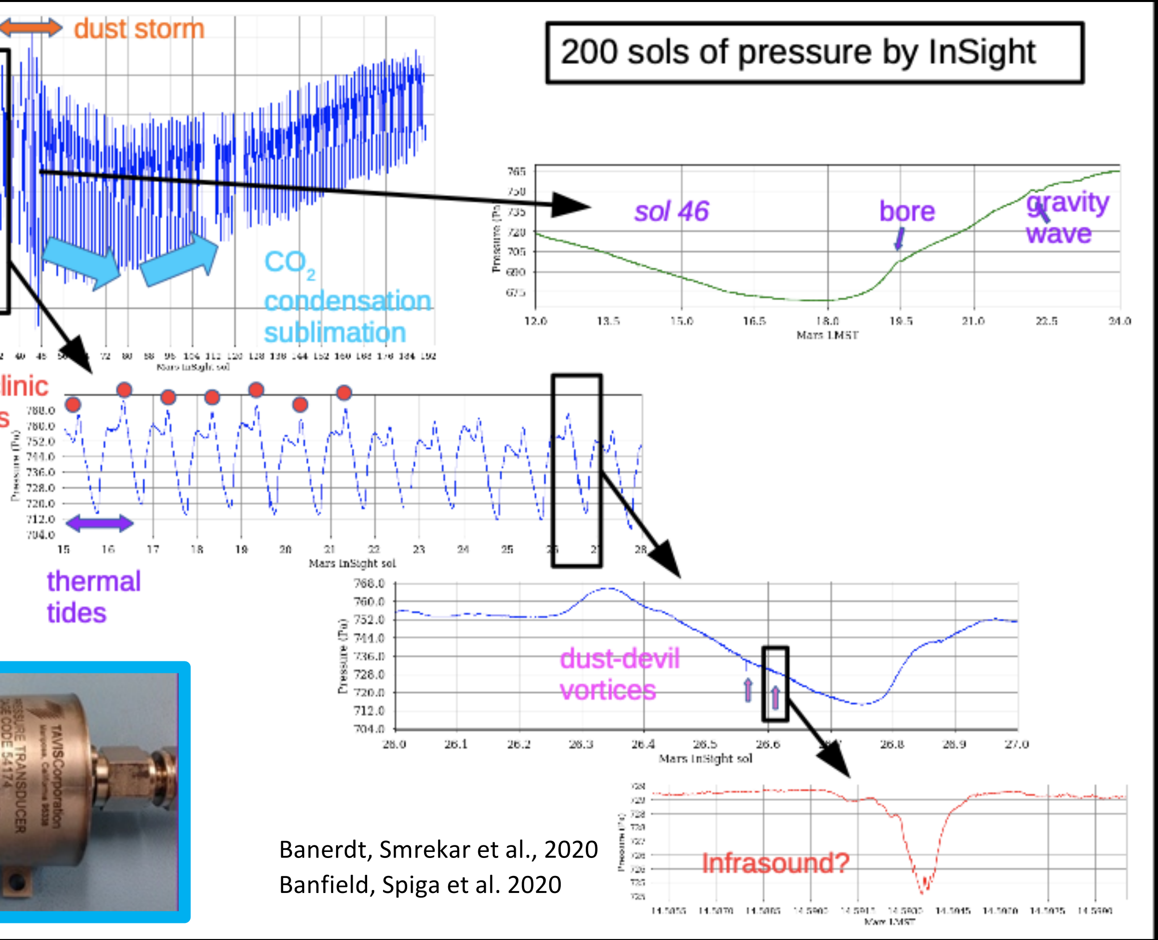
InSight Meteorology

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)

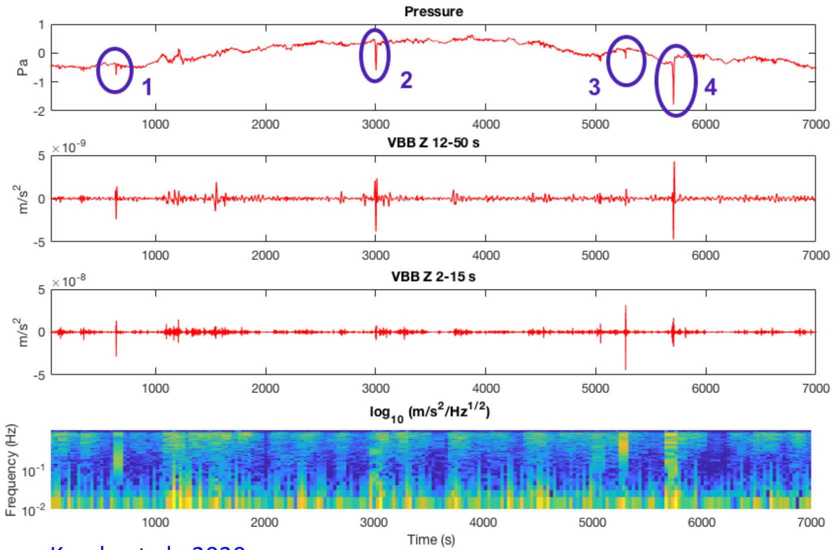


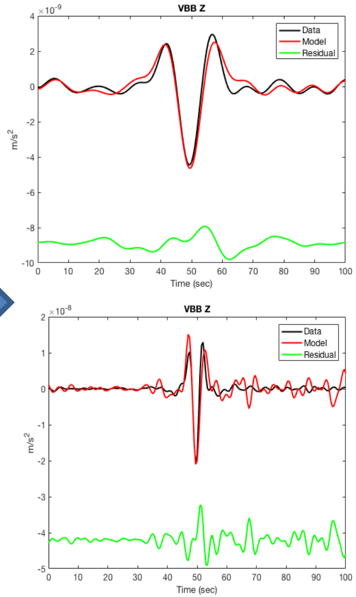
Pressure Sensor



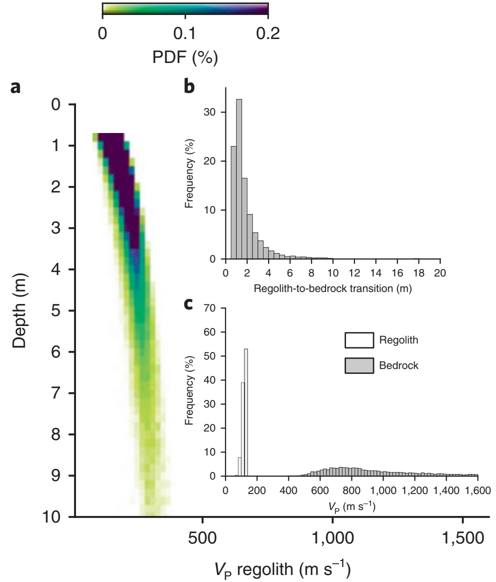
Banerdt, Smrekar et al., 2020
Banfield, Spiga et al. 2020

Ground Rigidity from Dust Devils





• Kenda et al., 2020

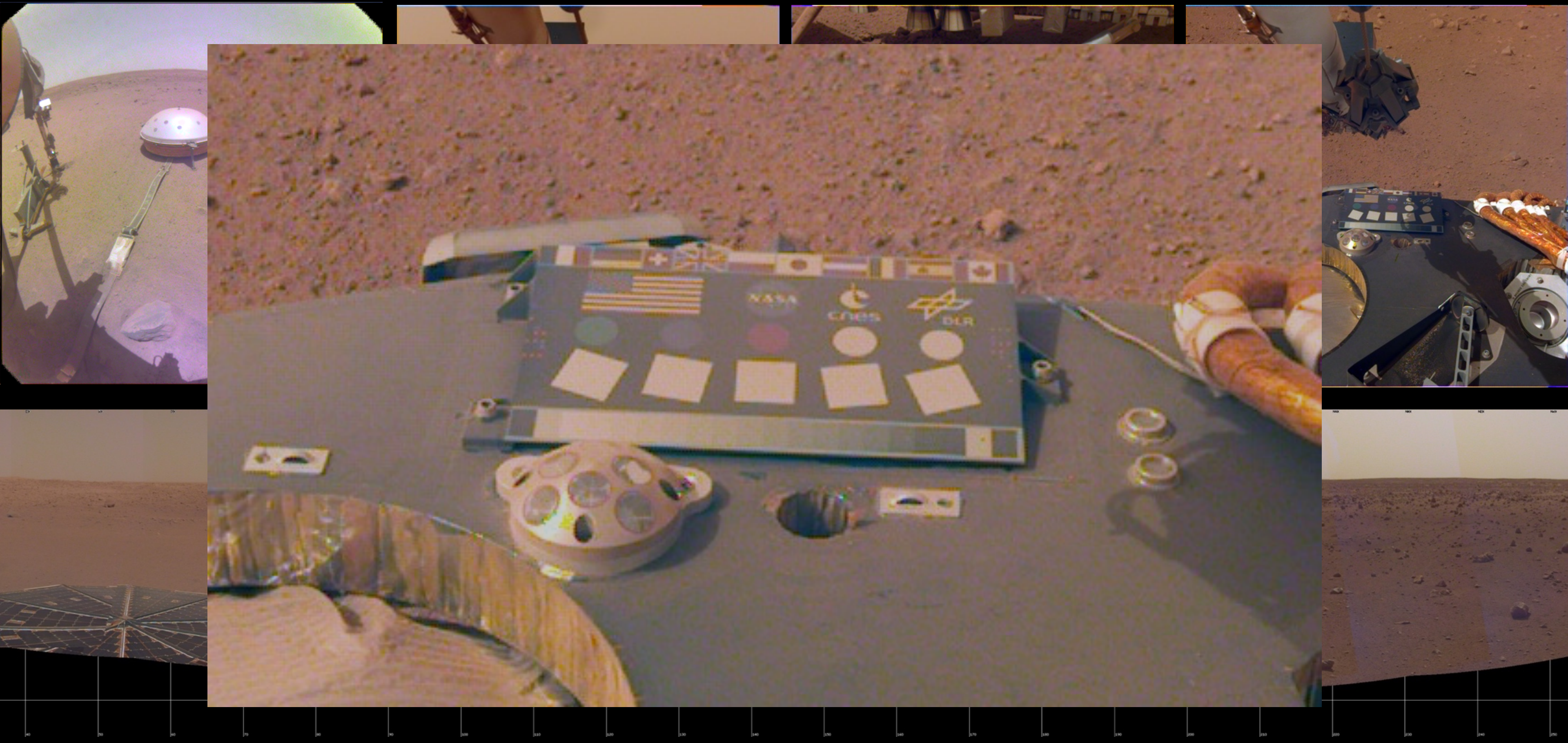


Lognonné et al., 2020

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)




Sunset over Elysium, sol 145