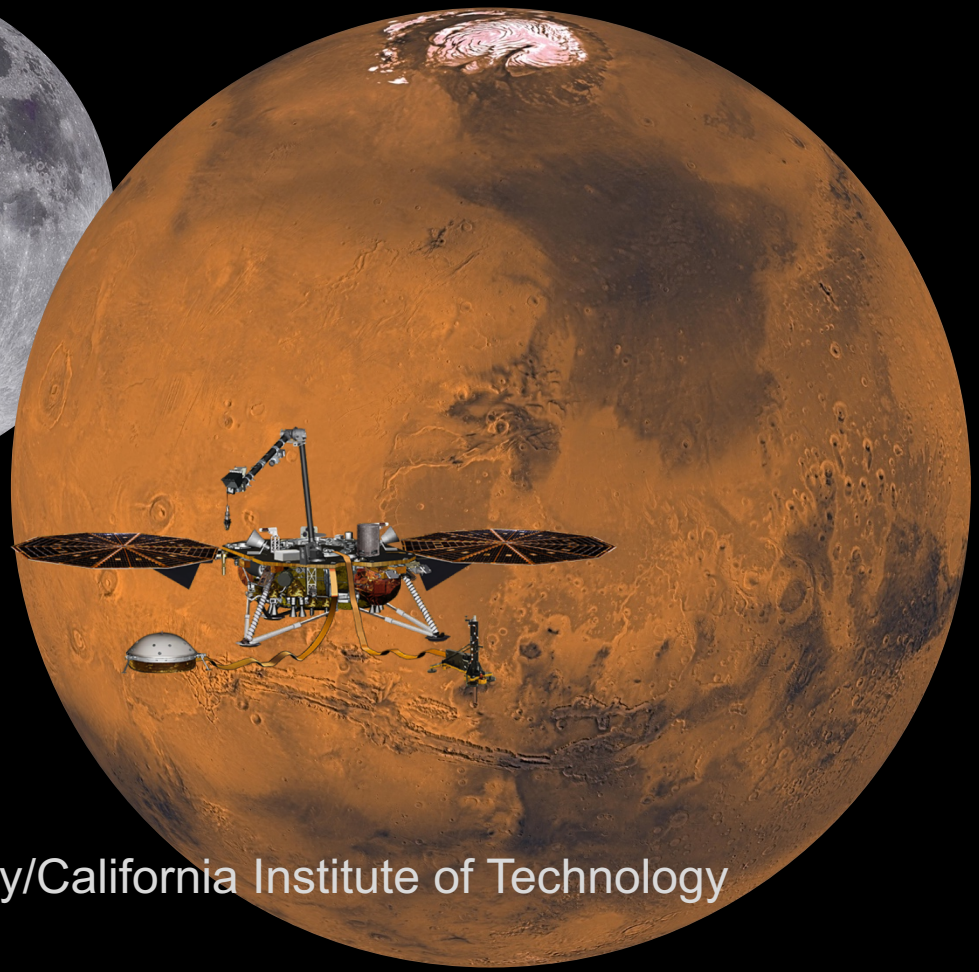
InSight Mission Science



W. Bruce Banerdt
Jet Propulsion Laboratory/California Institute of Technology

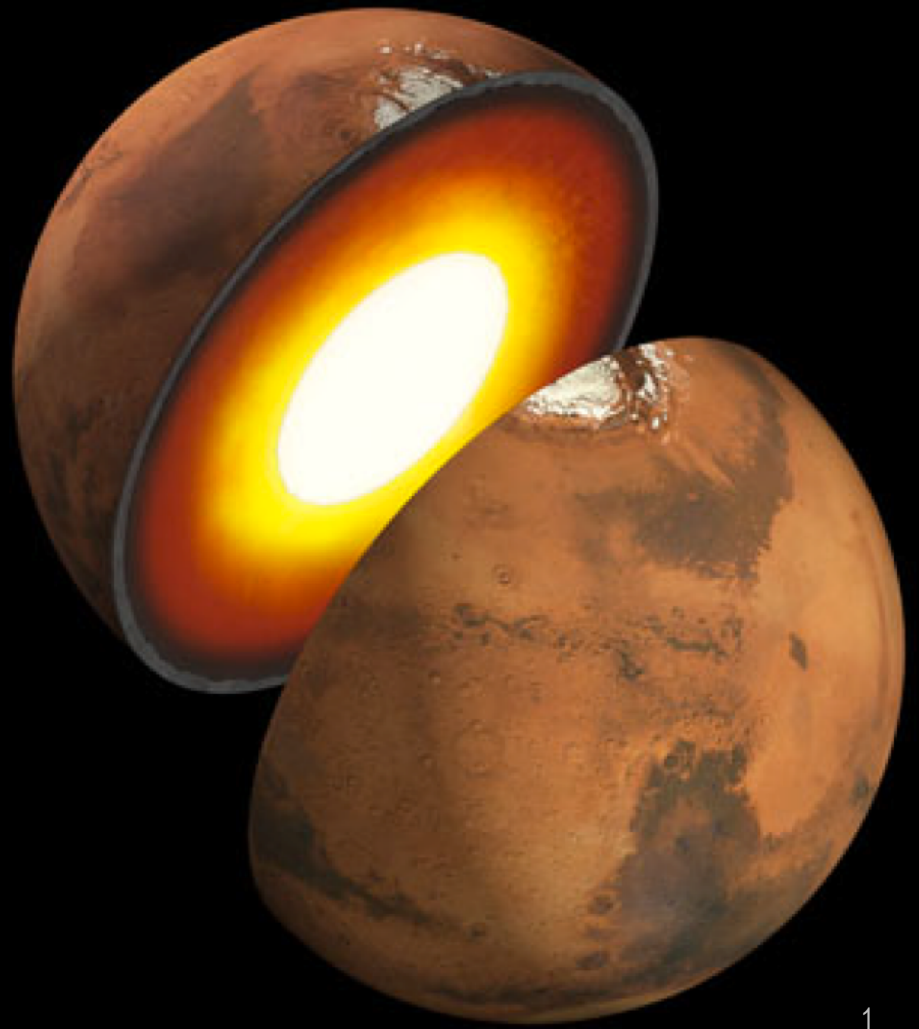
2 March, 2020

InSight Mission Objectives

Goal: Provide constraints on the formation and early evolution processes of terrestrial planets by studying the internal structure of Mars.

In order to address this goal, InSight will determine, through geophysical measurements:

- ❑ Crustal thickness and large-scale layering
- ❑ Mantle structure
- ❑ Core size and density
- ❑ Global heat flux
- ❑ Rate and distribution of seismic activity
- ❑ Rate of meteorite impacts

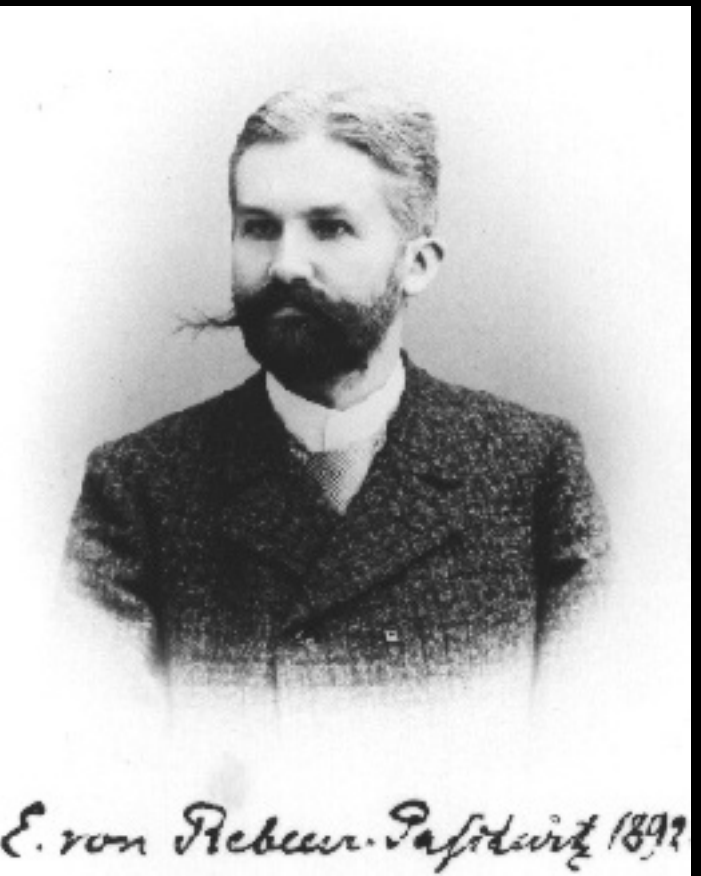


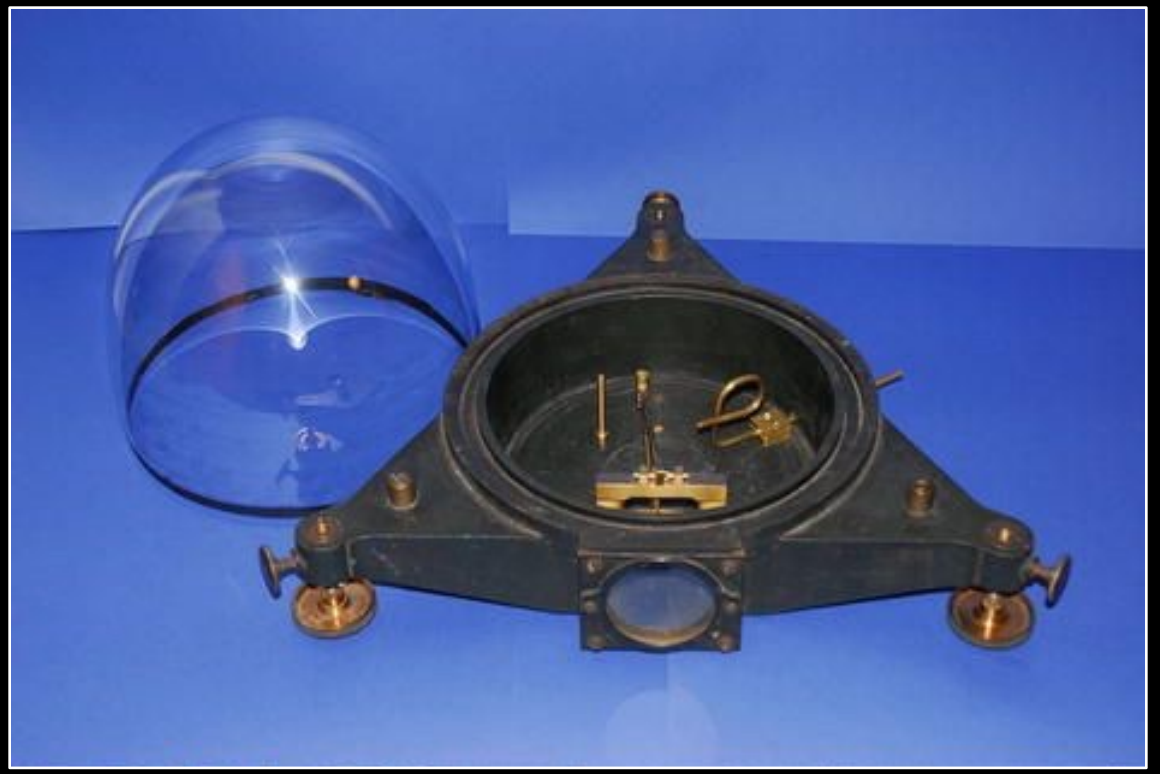
InSight as a Time Machine…

- InSight travels back more than a hundred years, to Earth science at the dawn of the 20th century, to answer basic questions about the planet:
  - What is the thickness of the crust?
  - What is the structure of the mantle?
  - What is the size and density of the core?
  - What is the distribution of seismicity?
  - What is the heat flow from the planet?

1889 – First Remote Detection of an Earthquake

- Ernst von Rebeür-Paschwitz
- A Tokyo earthquake was measured in Potsdam – 8850 km away.





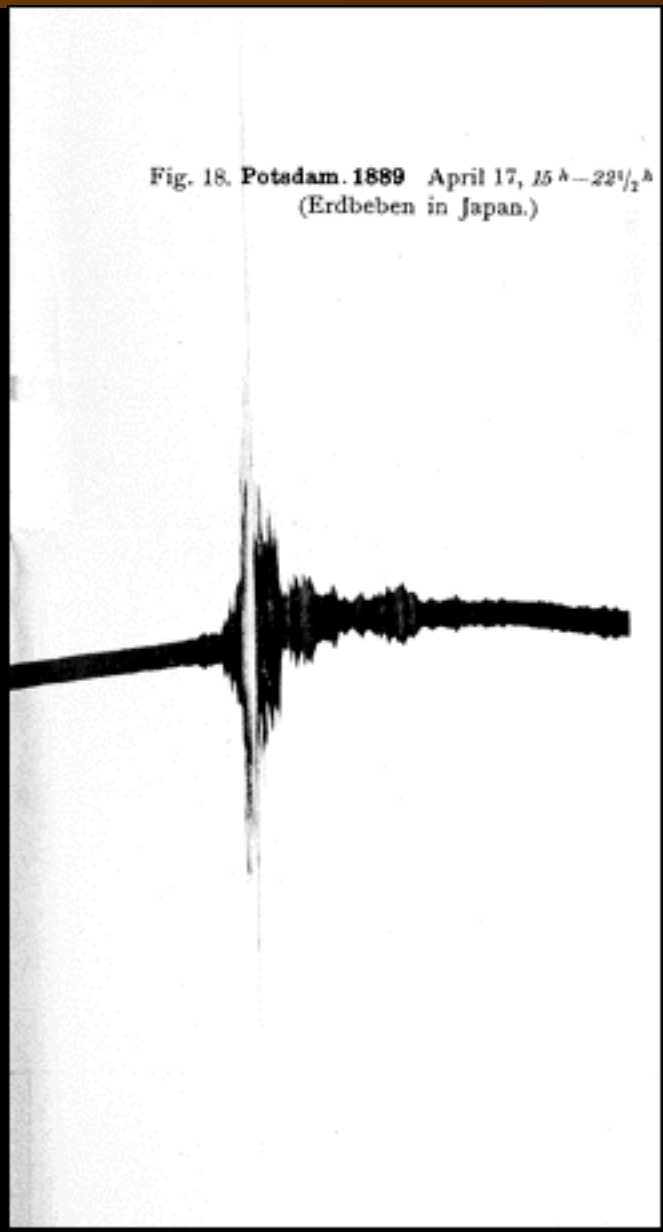
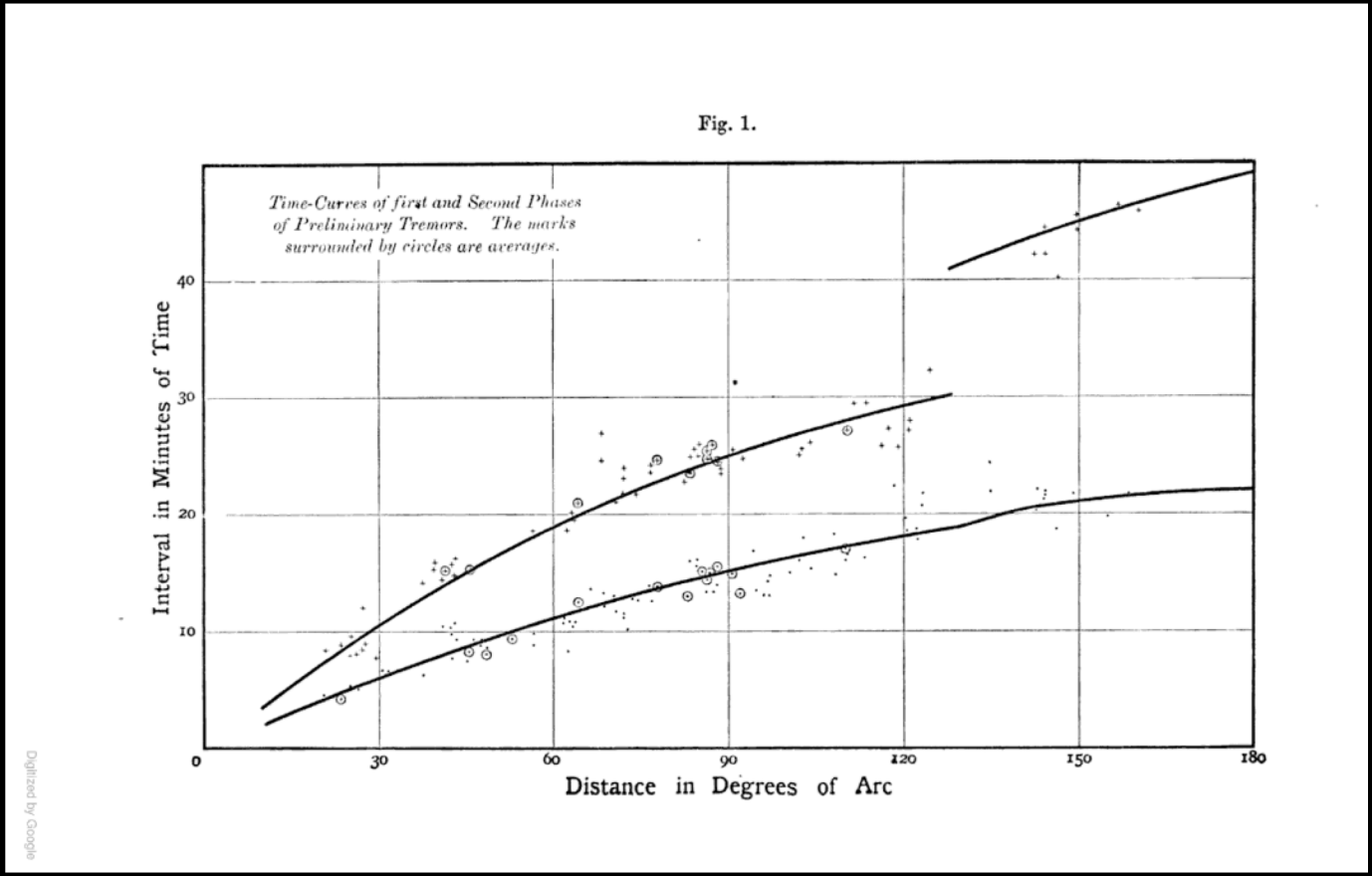
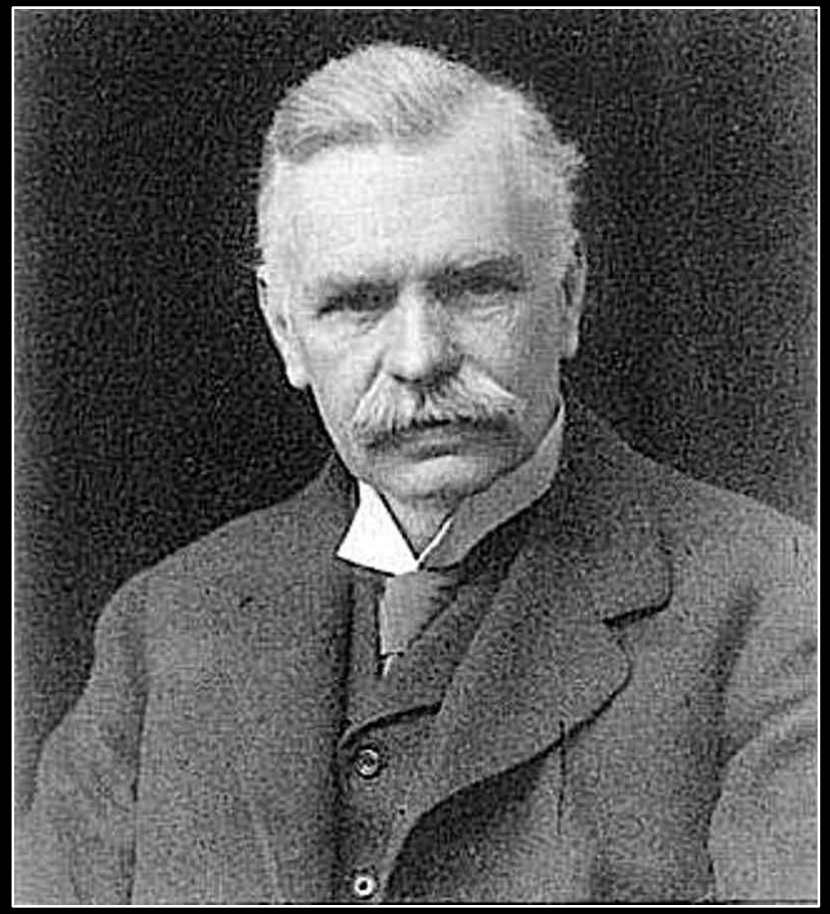


Fig. 18. **Potsdam. 1889** April 17, $15^h - 22^1/_2{}^h$
(Erdbeben in Japan.)

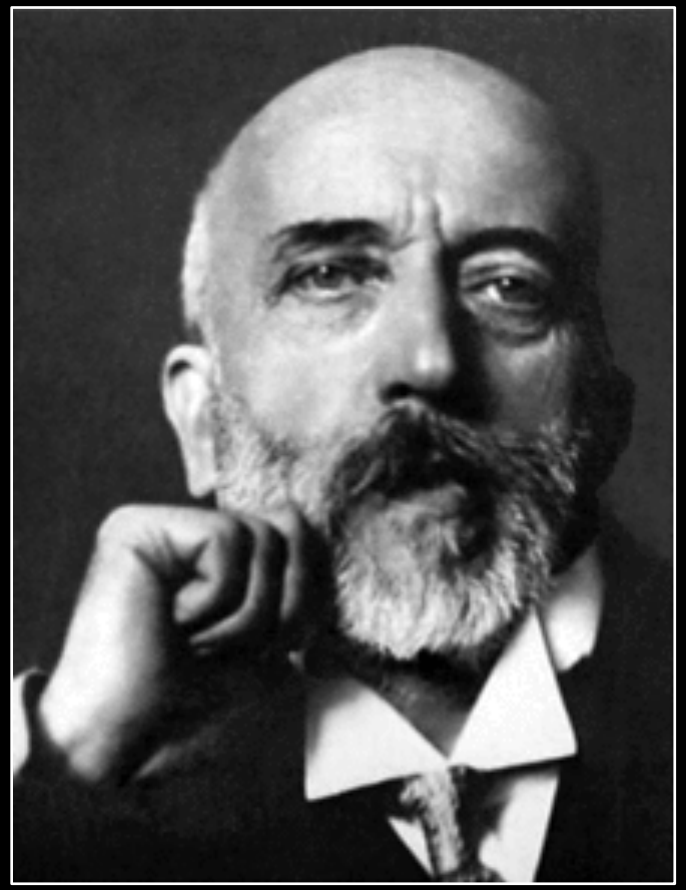
1906 – Detection of the Earth's Core

- Richard Dixon Oldham
- Derived from the interpretation of earthquake travel times.



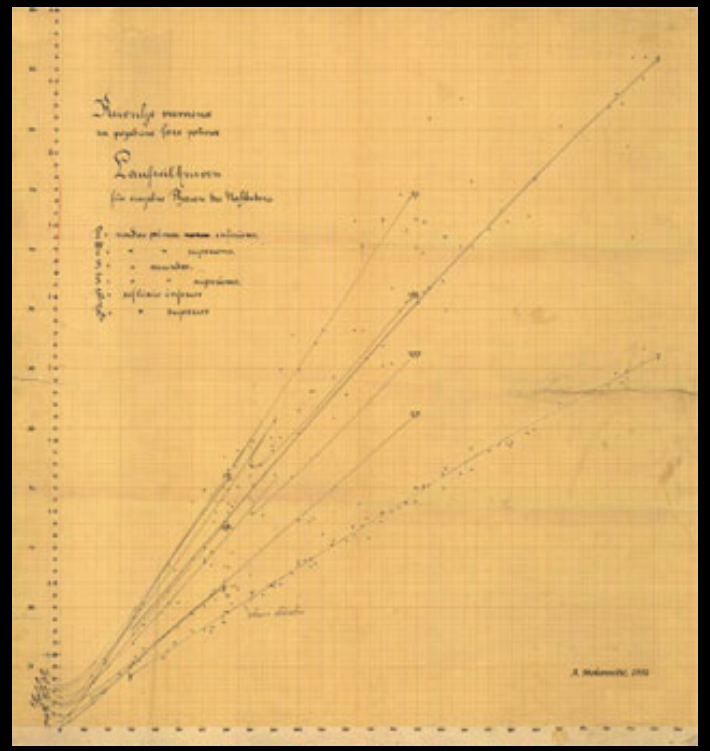


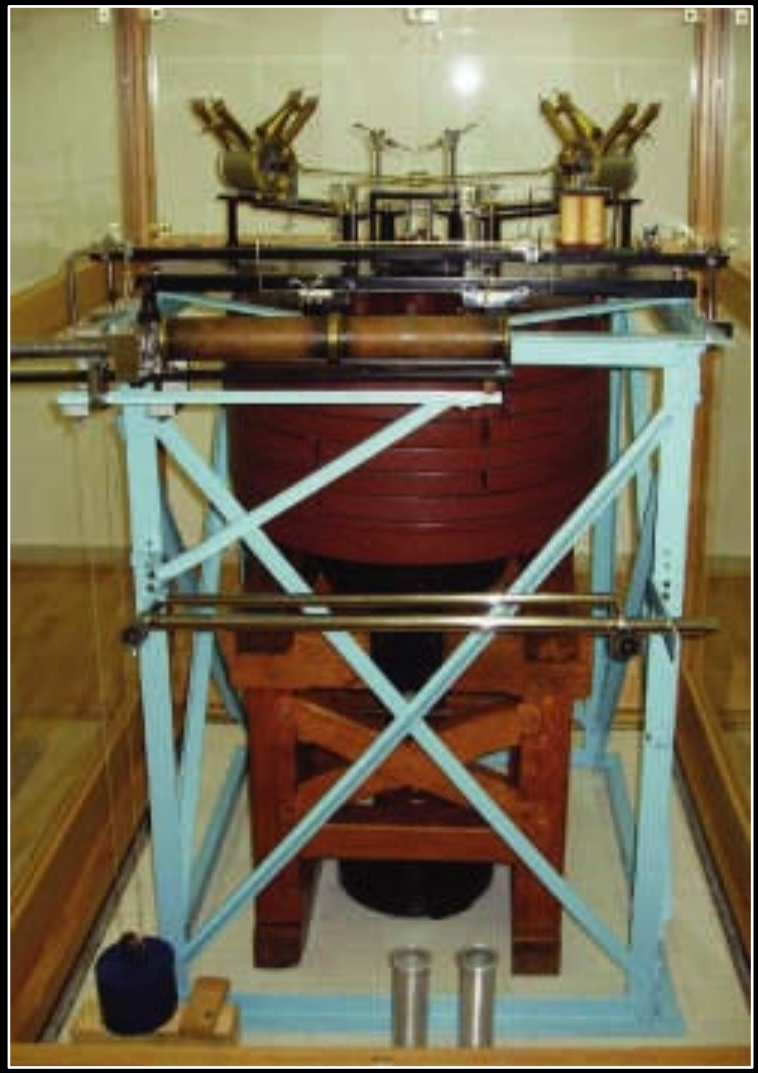
1909 – Thickness of the Earth's Crust



Andrija Mohorovičić

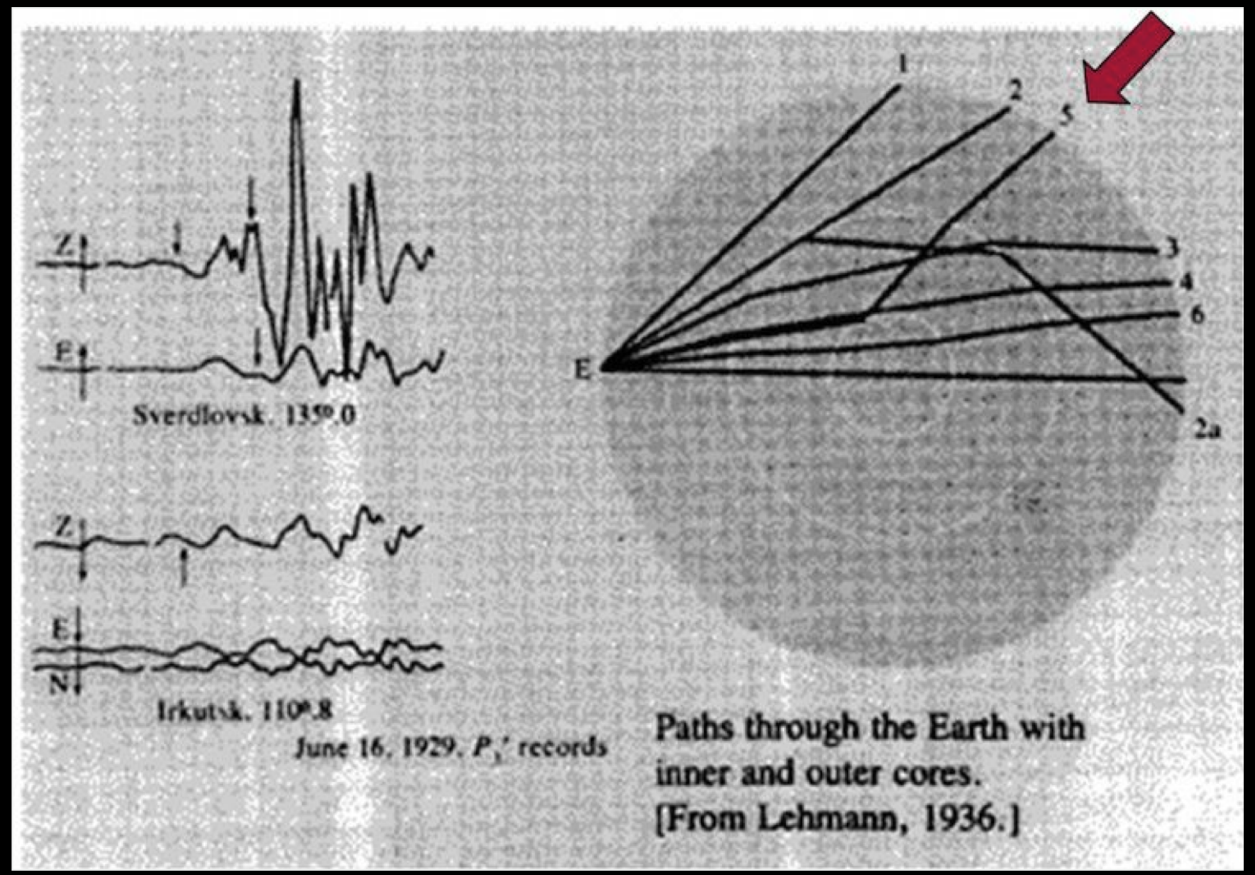
- Kupa Valley quake of 8 October 1909
- 50 km thickness beneath Croatia





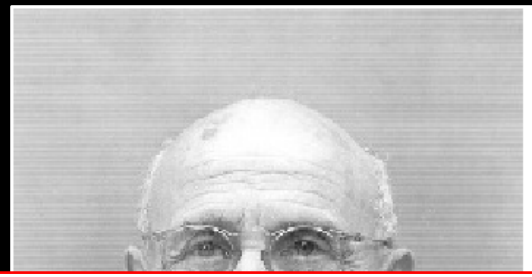
Wiechert horizontal seismograph

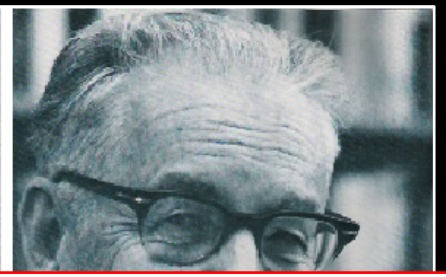
1936 – Detection of the Earth's Inner Core



Inge Lehman

1941 – Distribution of the Earth's Seismicity





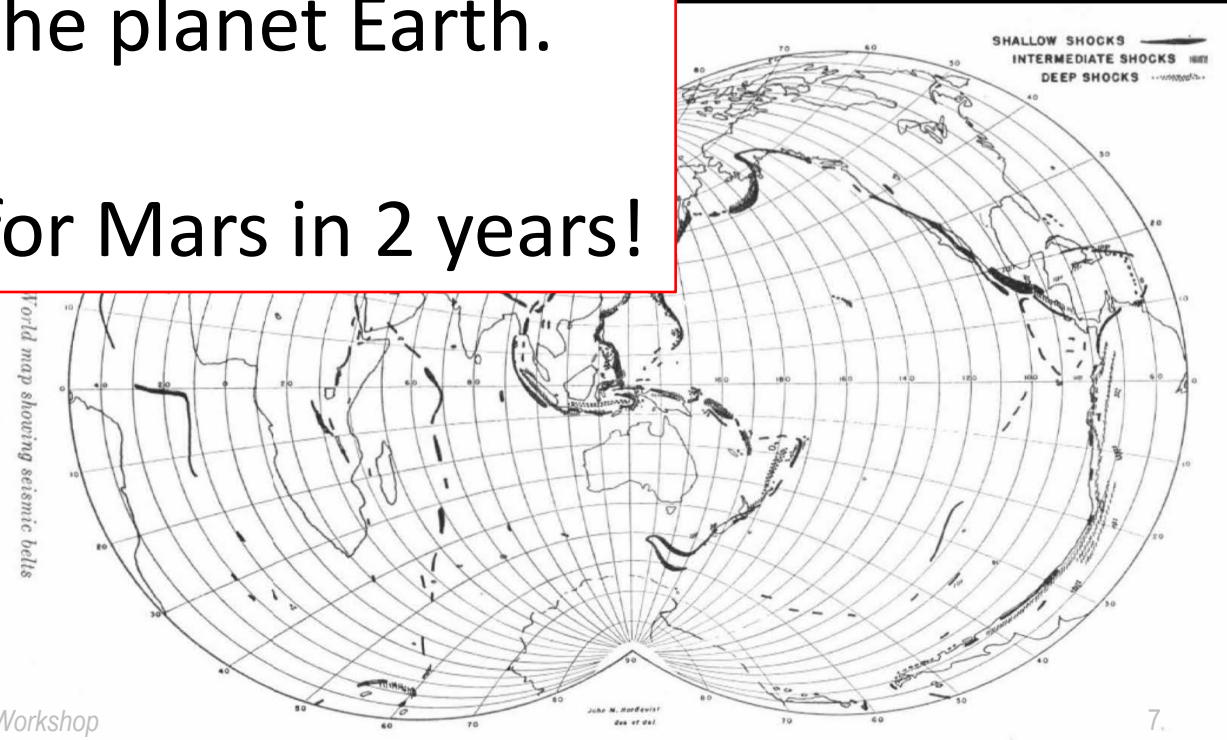
Gutenberg and Richter, 1941

"Seismicity of the Earth"

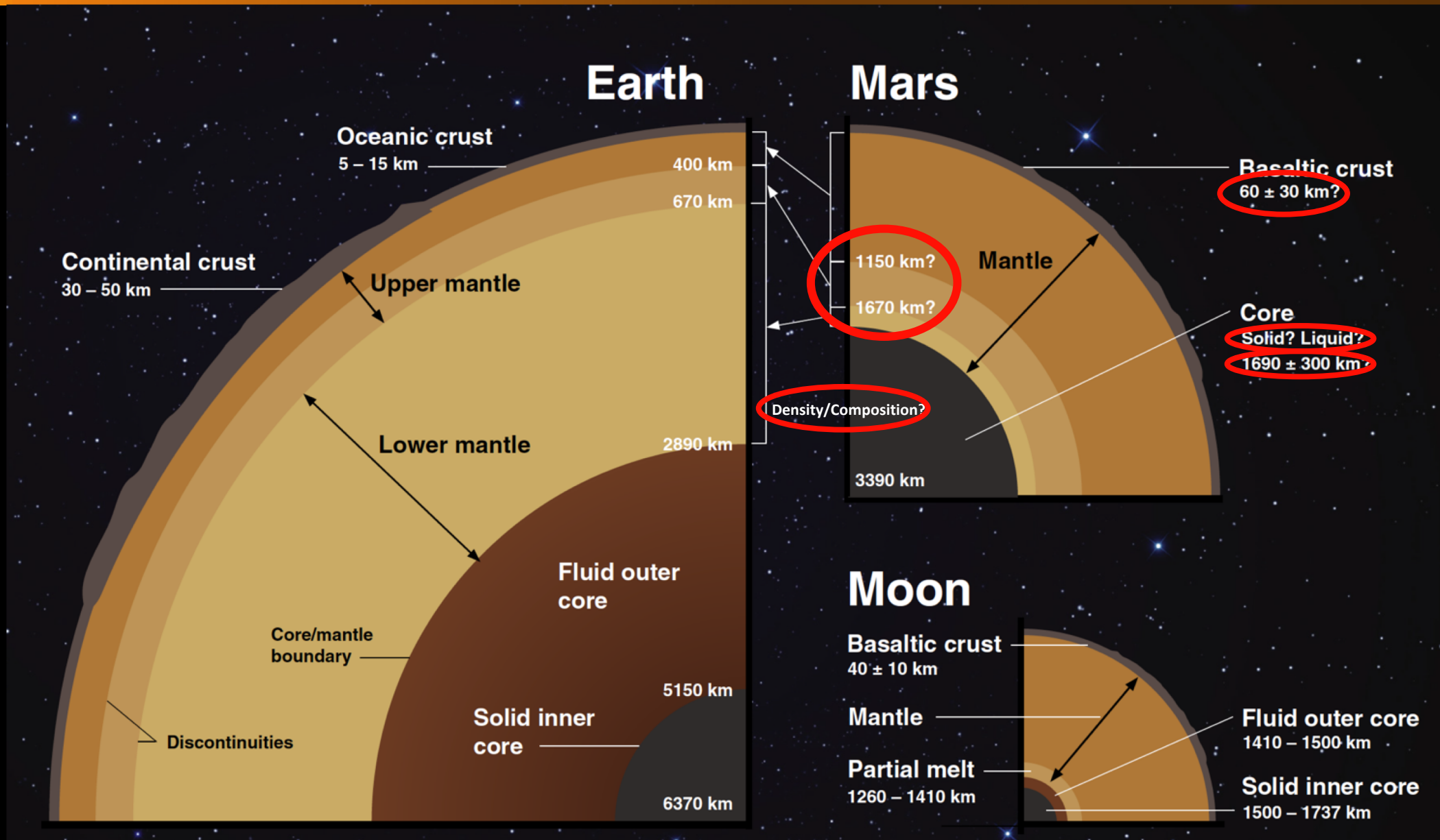
In 50 years, seismologists went from the first detection of an earthquake to the basic understanding of the planet Earth.

InSight plans to do this for Mars in 2 years!

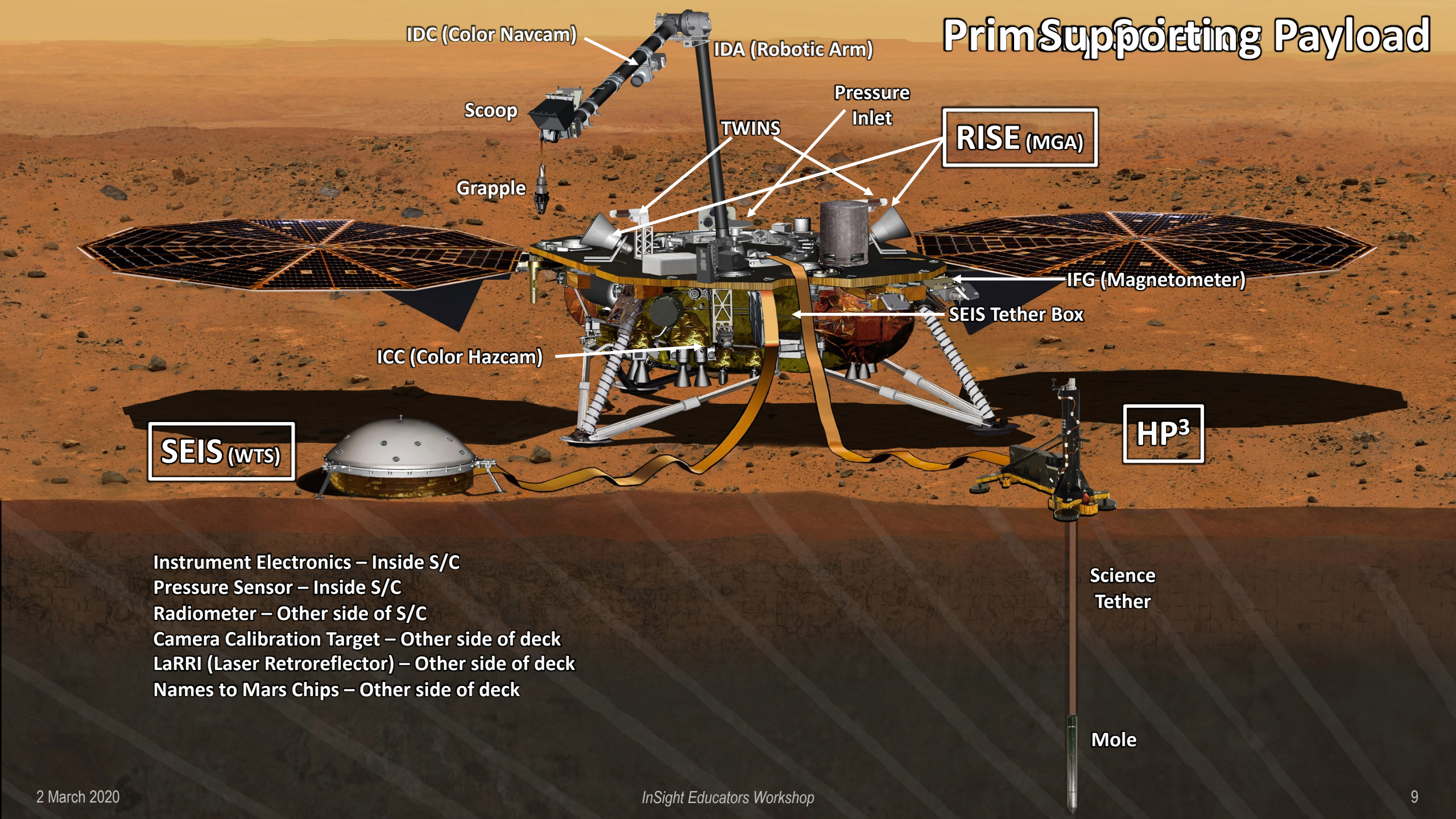
Wood-Anderson seismometer



Mars Structure Compared to Earth and Moon



Prim Supporting Payload

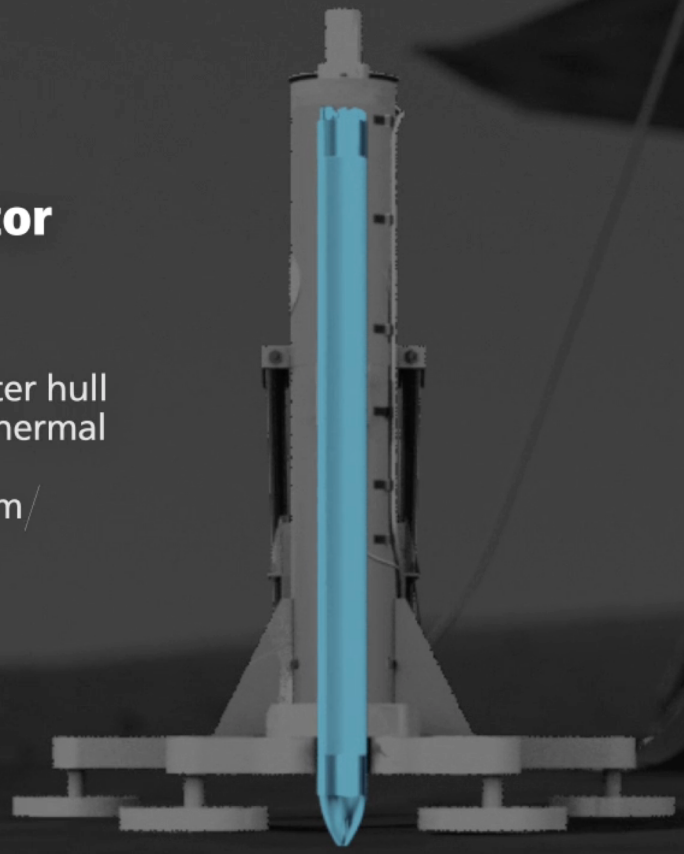


Instrument Electronics – Inside S/C
Pressure Sensor – Inside S/C
Radiometer – Other side of S/C
Camera Calibration Target – Other side of deck
LaRRI (Laser Retroreflector) – Other side of deck
Names to Mars Chips – Other side of deck

Measuring Heat Flow on Mars

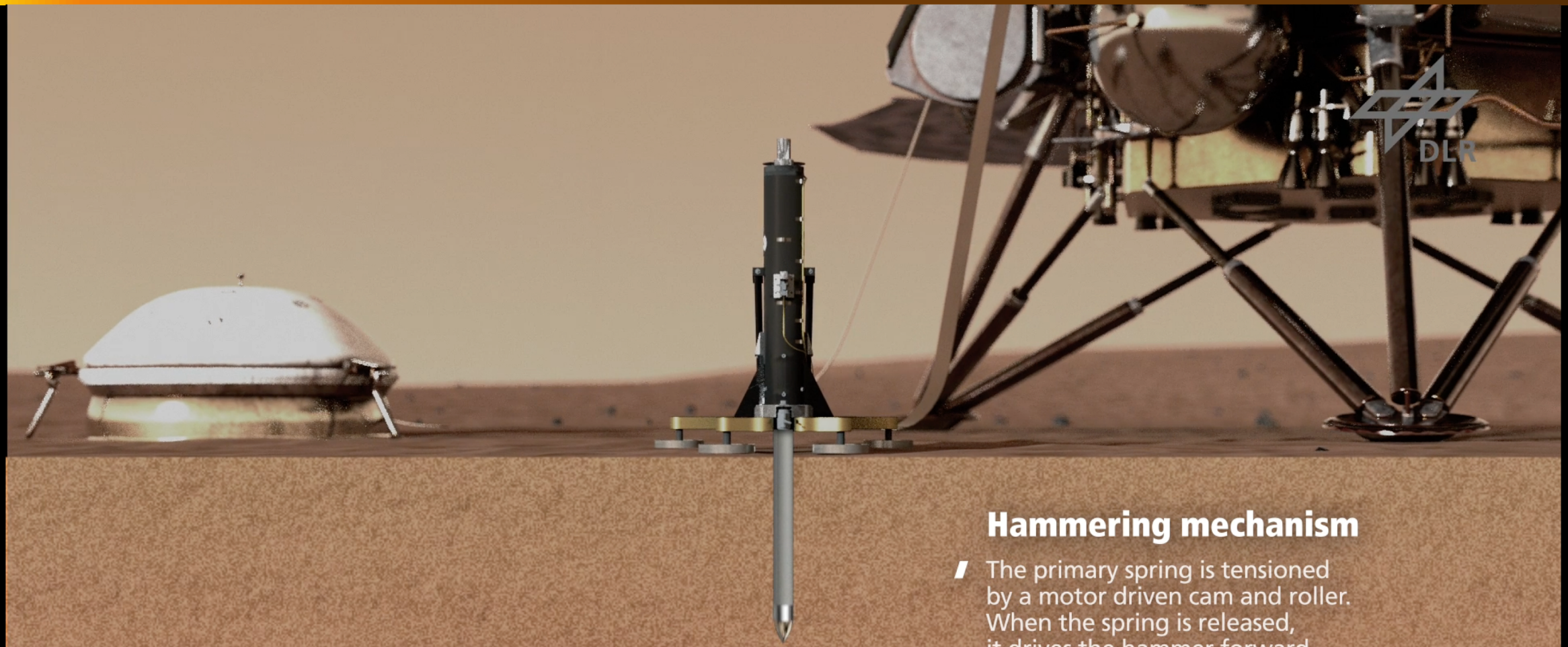
‘Mole’ penetrator

- Tilt meter
- Heated foils in the outer hull to measure the soil’s thermal conductivity
- Hammering mechanism



DLR

Measuring Heat Flow on Mars

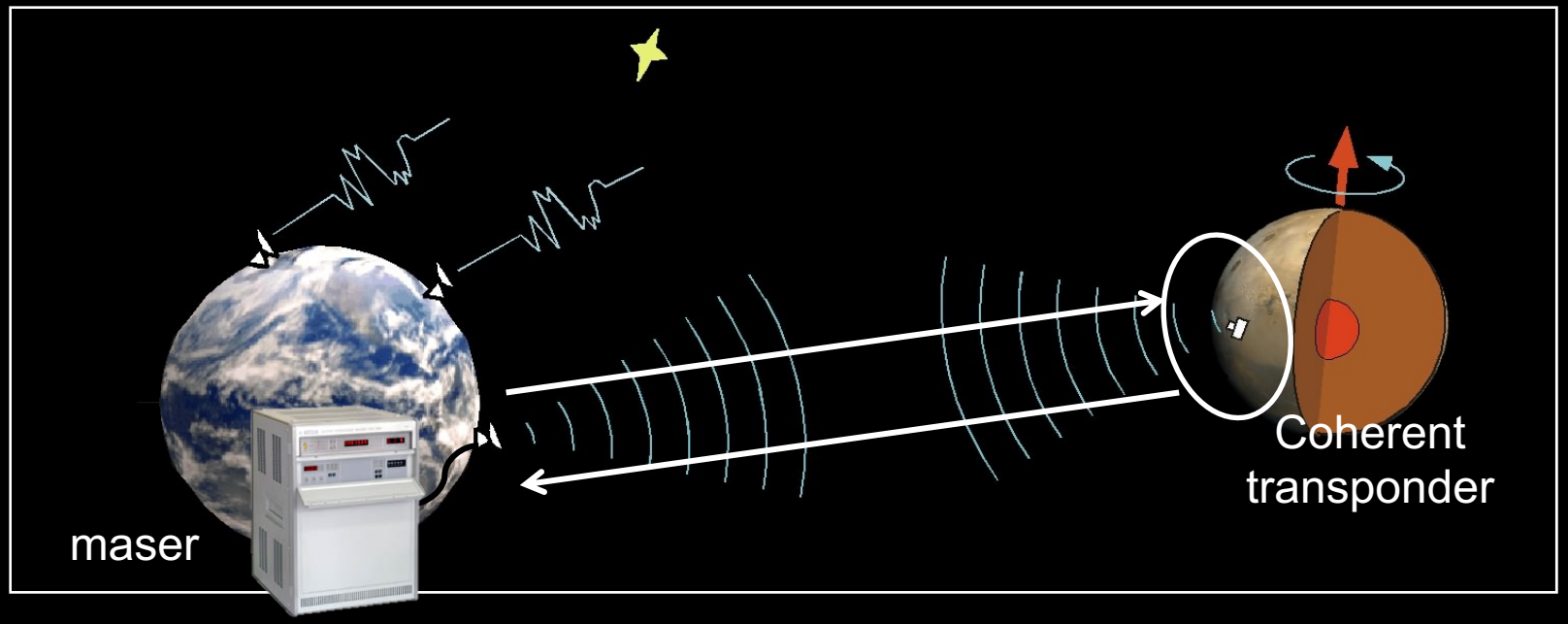


Hammering mechanism

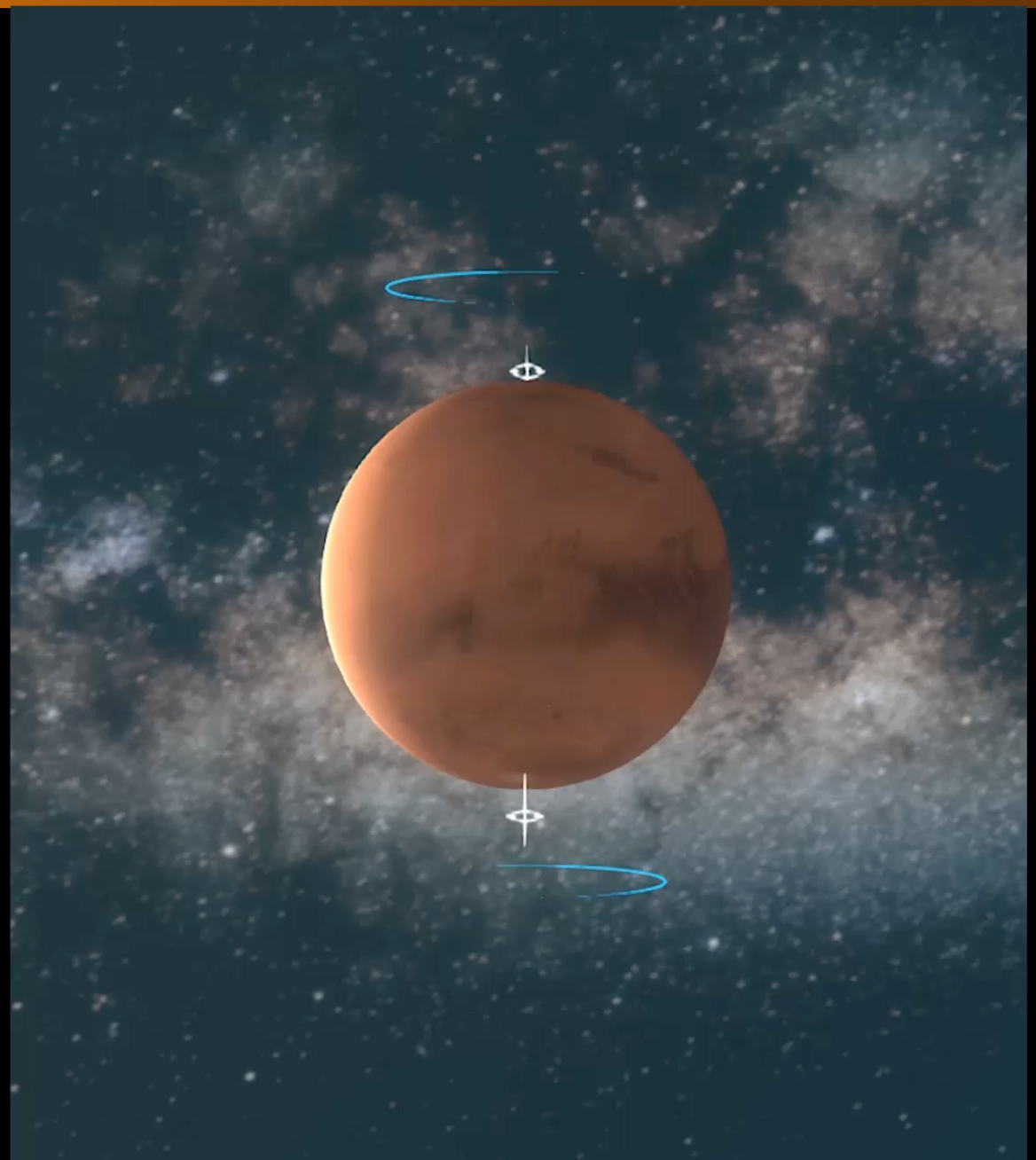
- The primary spring is tensioned by a motor driven cam and roller. When the spring is released, it drives the hammer forward
- The recoil is absorbed by a second spring, and the friction on the hull

Precision Radio Tracking – RISE

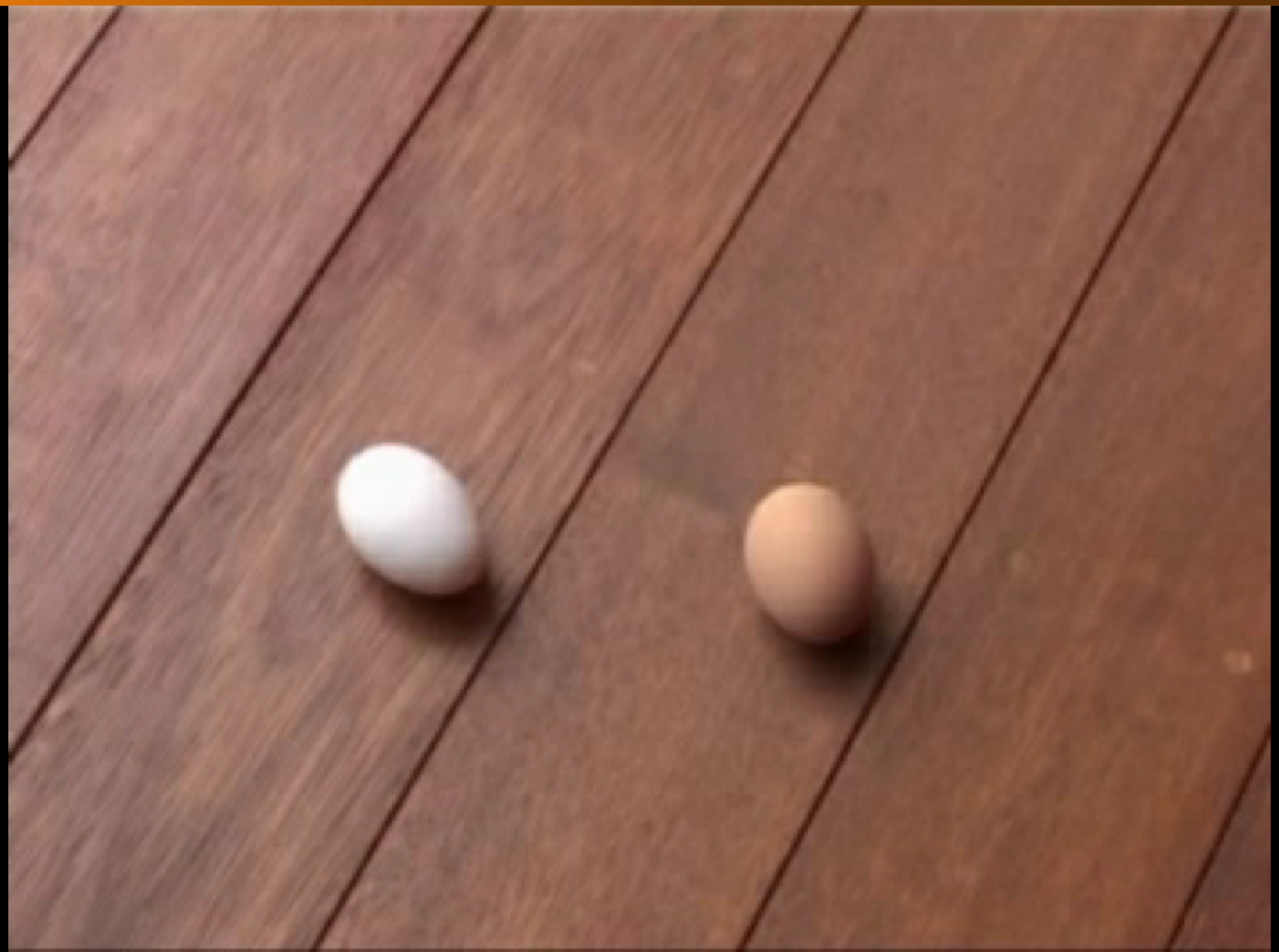
- Measurement of the timing and Doppler shift of the X-band radio signal between the Earth and InSight allow us to track the location and motion of the lander to an accuracy of better than 10 cm in inertial space.
- By tracking the lander location for about an hour each day, we will be able to determine the direction and motion of the rotation vector of Mars.



Precession of Mars

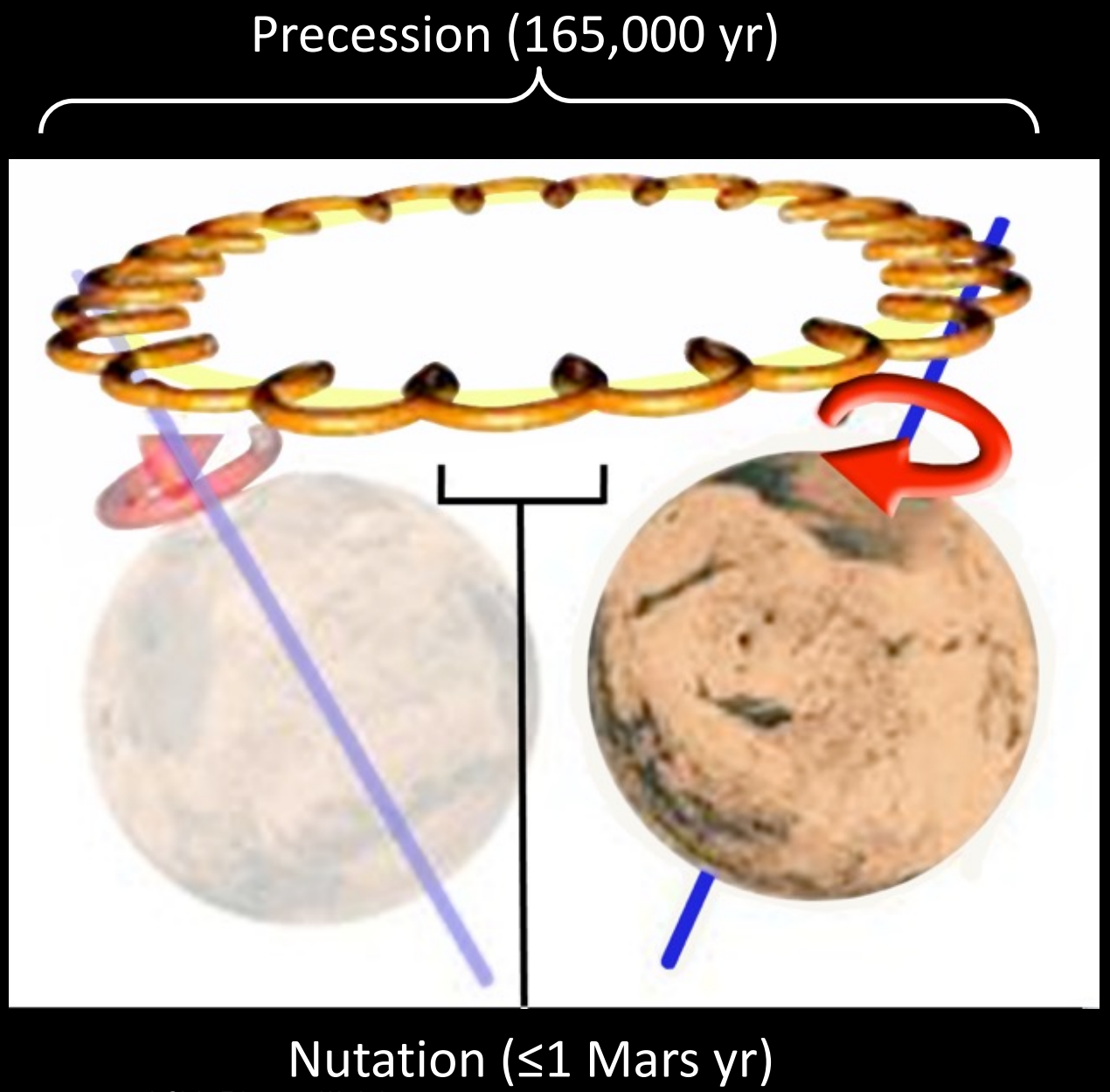


Nutation of Mars



Precision Radio Tracking – RISE

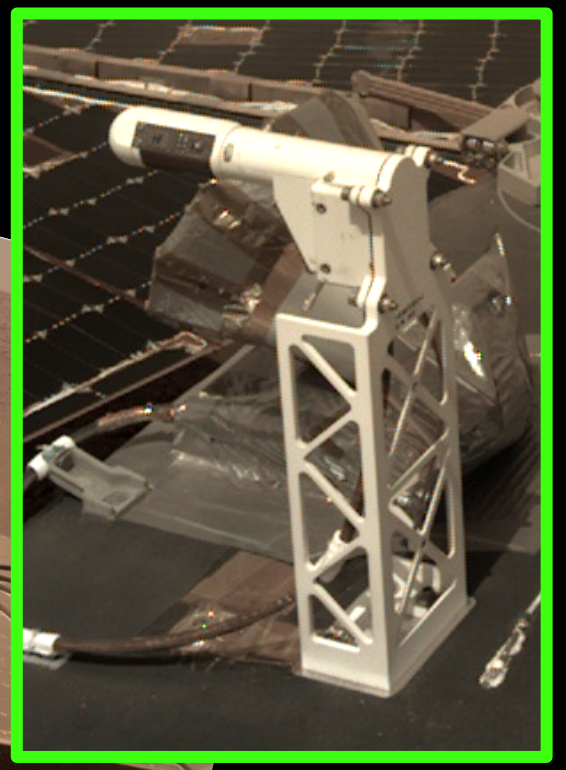
These two measurements taken together allow us to calculate the size and density of the metallic core of Mars.

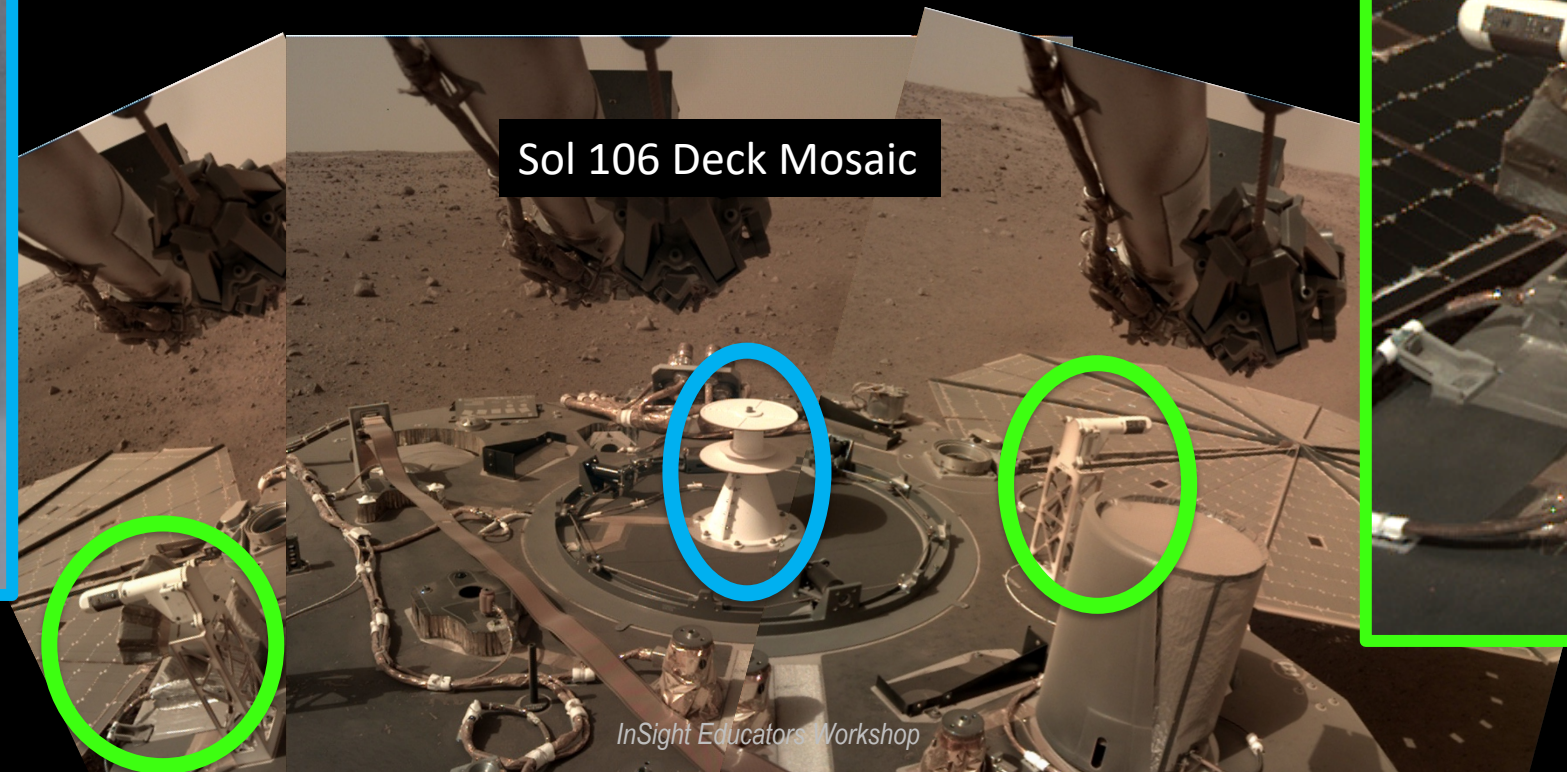


InSight's Weather Station

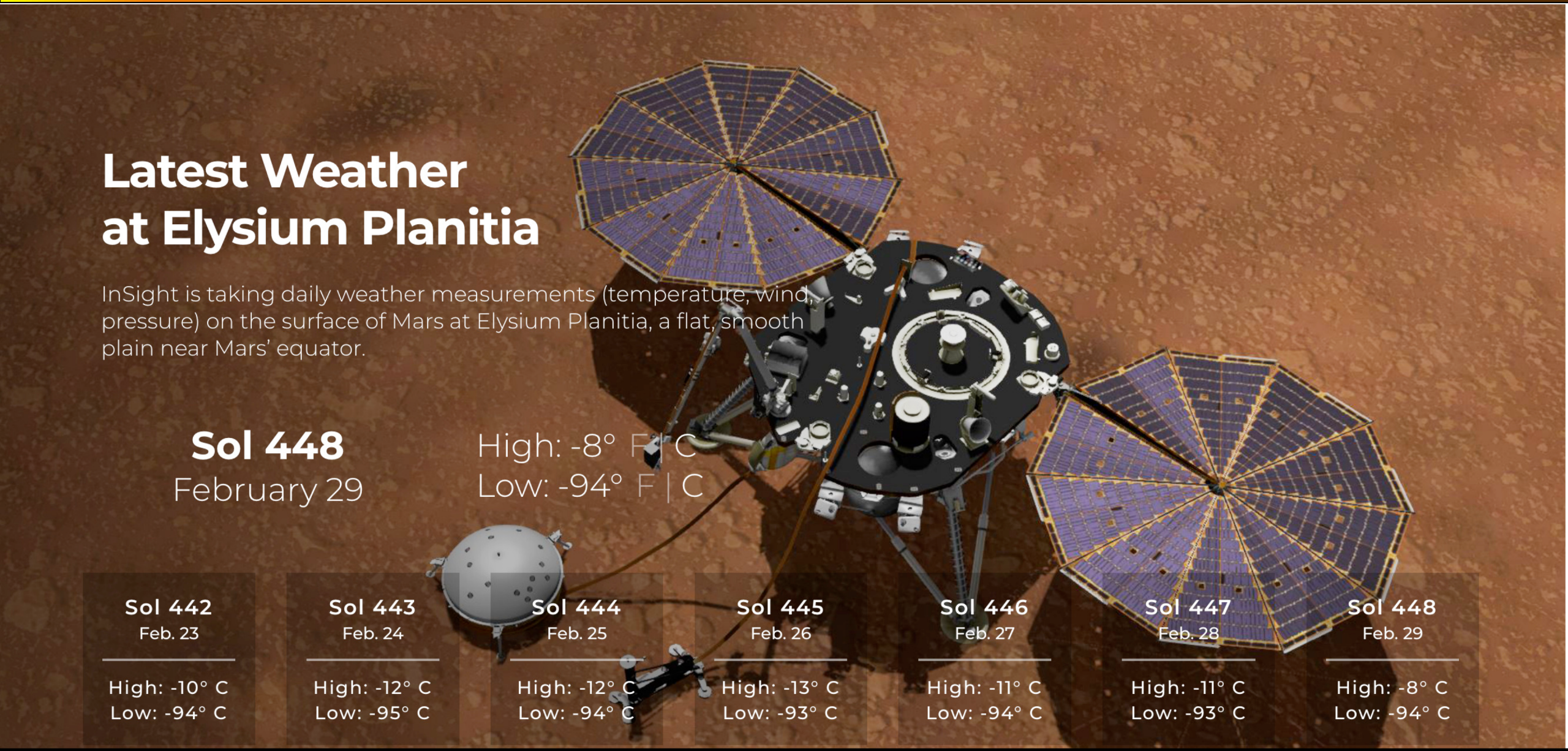
Pressure Sensor

TWINS (Temperature & Wind for InSight)

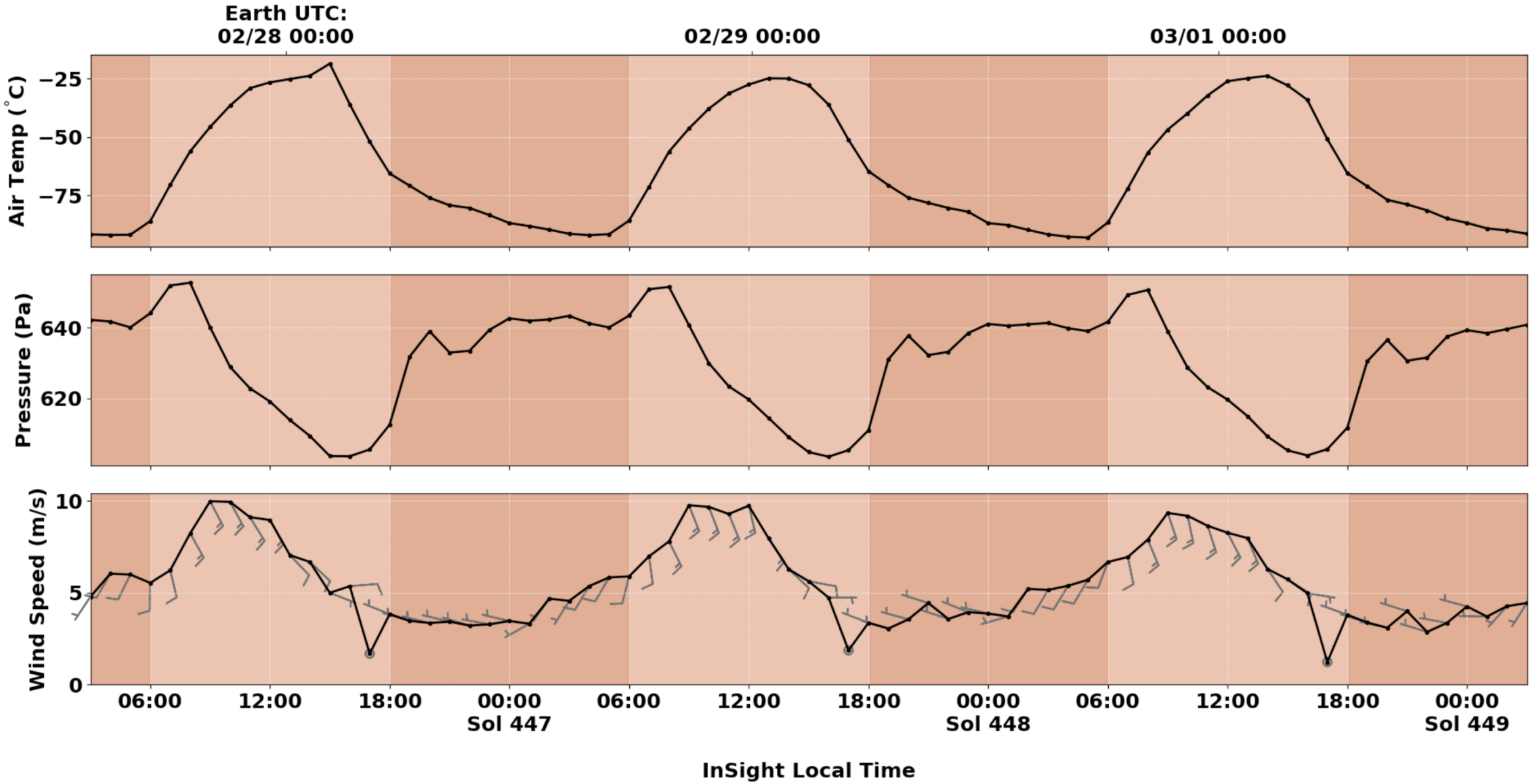




Daily Weather Report – Yesterday's Weather on Mars



Pressure, Temperature and Wind Plots



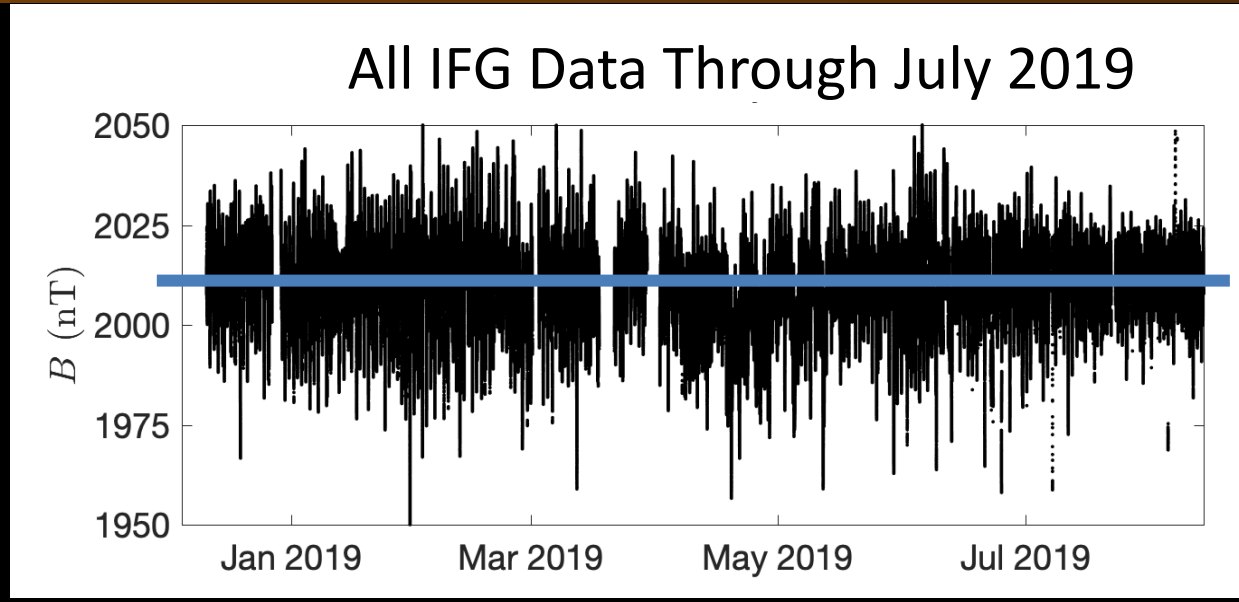
First Magnetic Measurements from the Surface of Mars

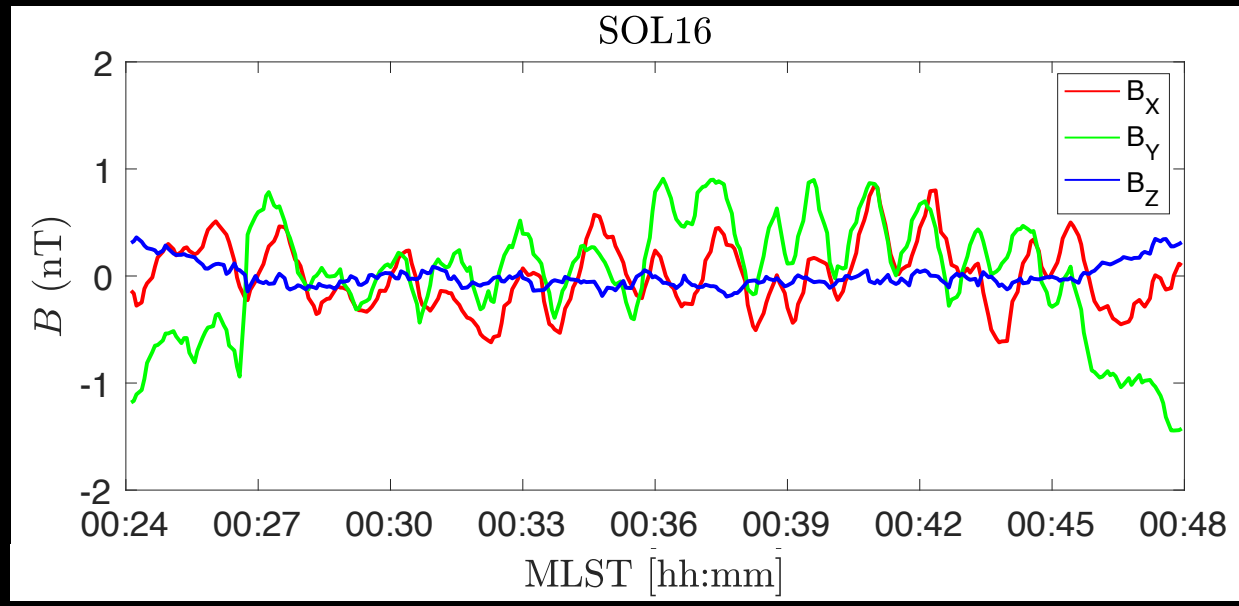
- The constant magnetic field at the landing site is about 10X stronger than measured from orbit

  ⇒ significant crustal variations at spatial scales <150 km.

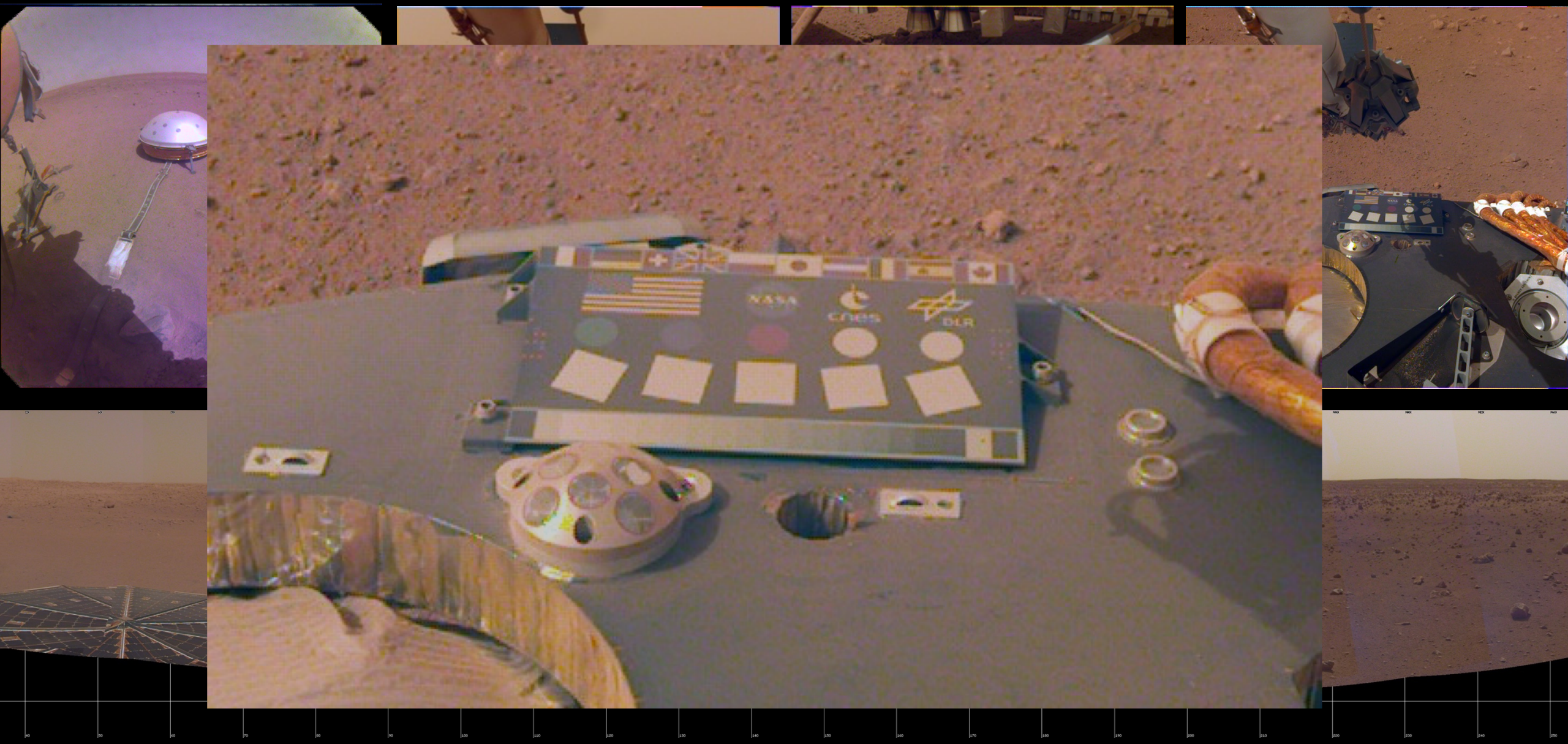
- Midnight pulsations are observed that are probably due to electric currents in the ionosphere of Mars.

  ⇒ may be used to probe the conductivity of Mars as a function of depth.





Pictures! (4127 Images as of Sol 448, 1 March, 2020)



Thanks for listening!

See all the latest pictures and weather (posted as soon as the data hits the ground!) plus other InSight news at

mars.nasa.gov/insight