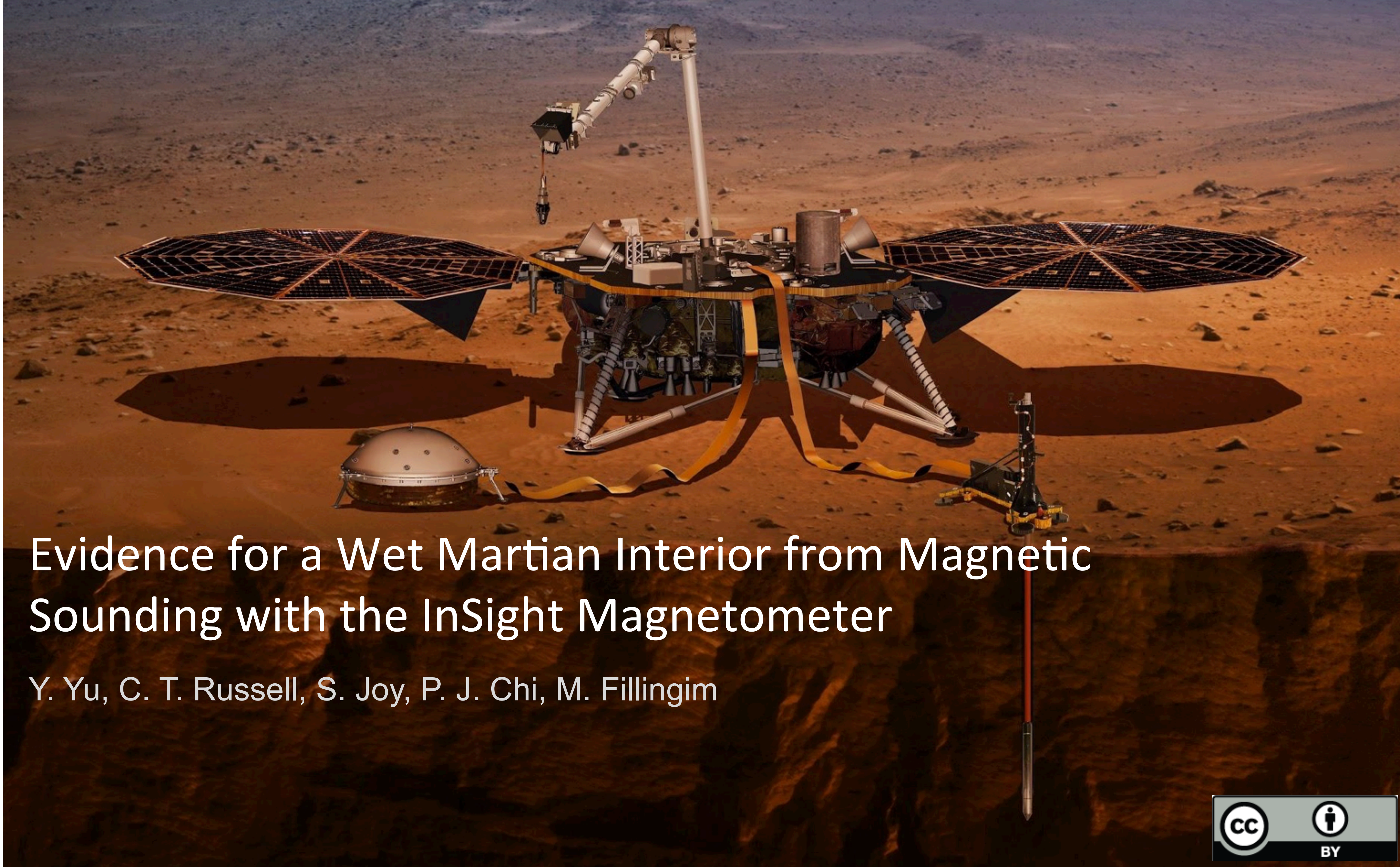
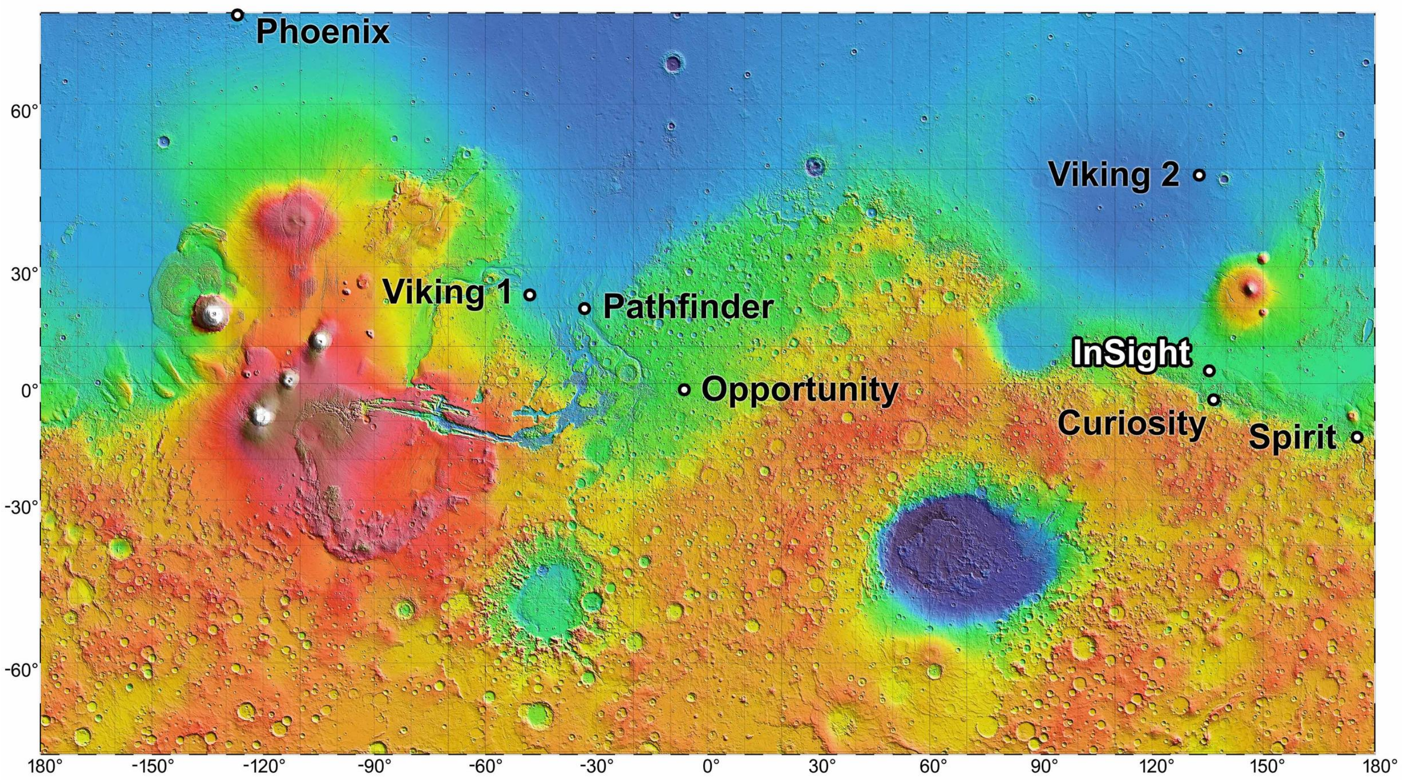


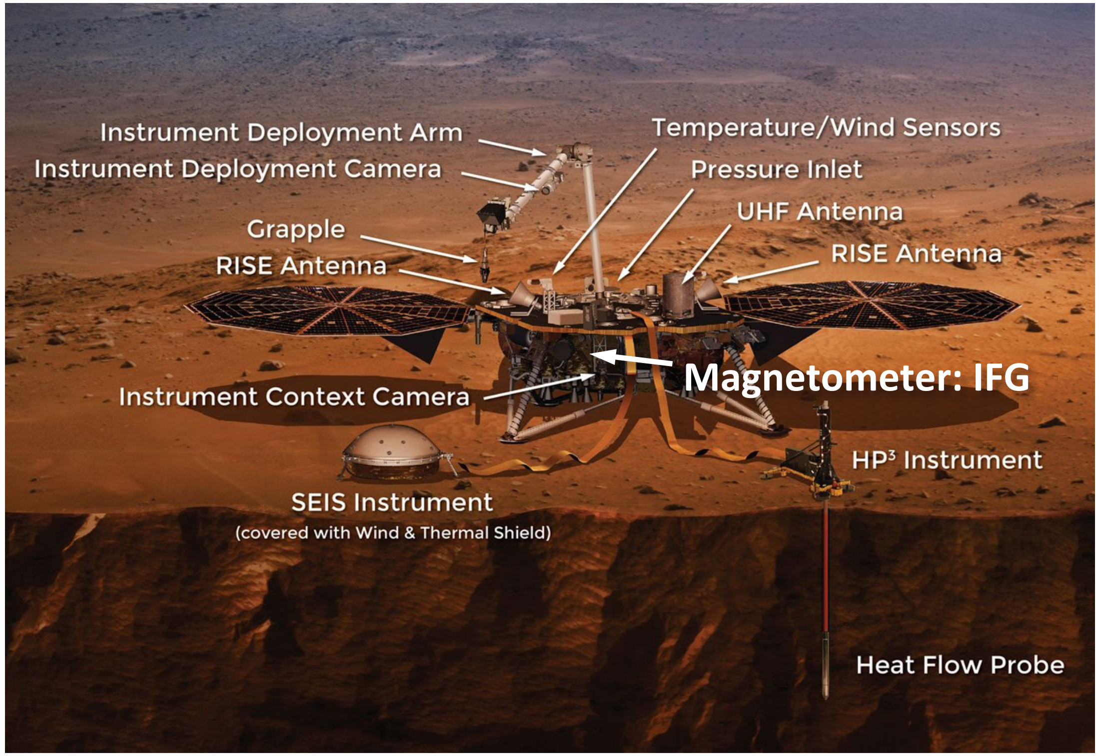
Evidence for a Wet Martian Interior from Magnetic Sounding with the InSight Magnetometer

Y. Yu, C. T. Russell, S. Joy, P. J. Chi, M. Fillingim

Introduction of InSight Mission

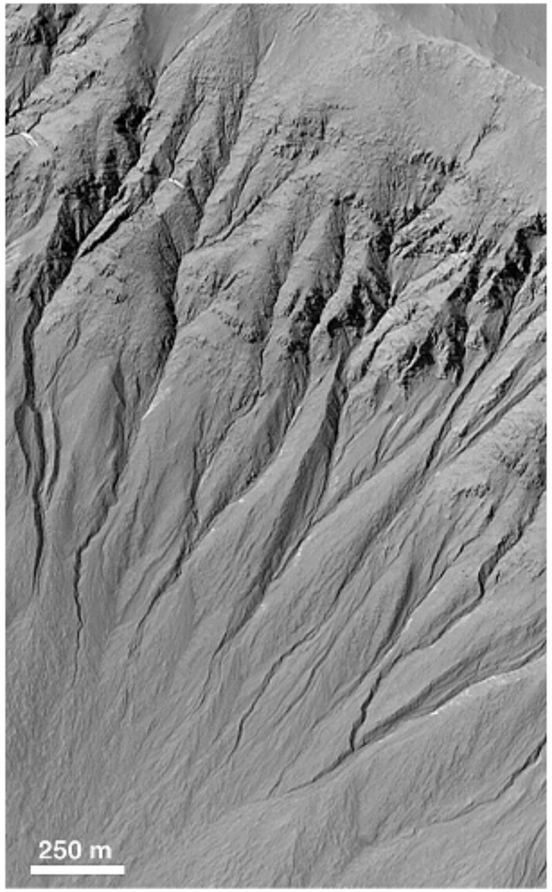
- InSight landed in Elysium Planitia (4.5°N, 135.6°E) on November 2018.
- InSight carries the first surface magnetometer (IFG), making continuous magnetic measurements from the Mars surface available.
- The IFG sensor mounted under deck, facing deployed SEIS, as s supporting instrument for SEIS without magnetic cleanliness program.
- Continuous data at 0.2 Hz or 2 Hz are available. Data at 20 Hz need to be requested.



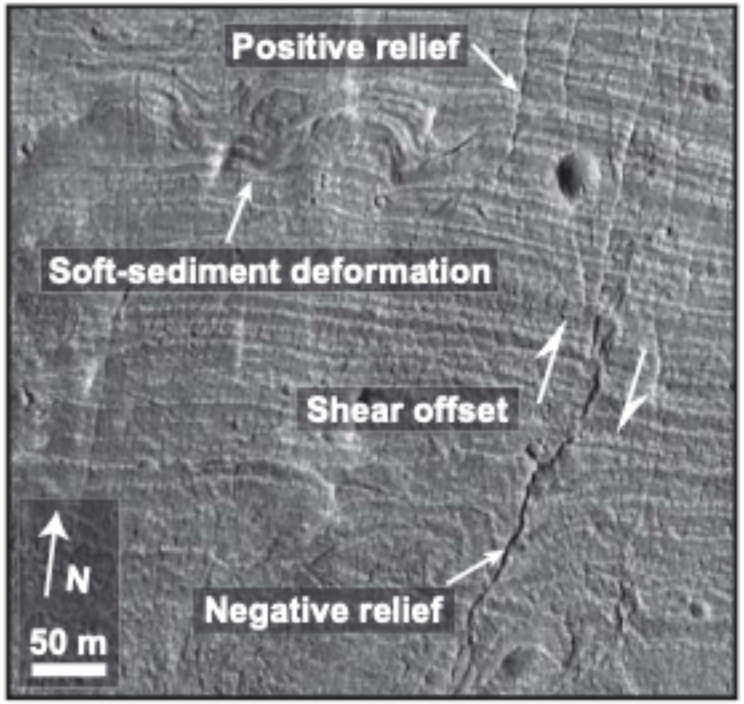


Introduction of Evidence of Liquid Water on Ancient Mars

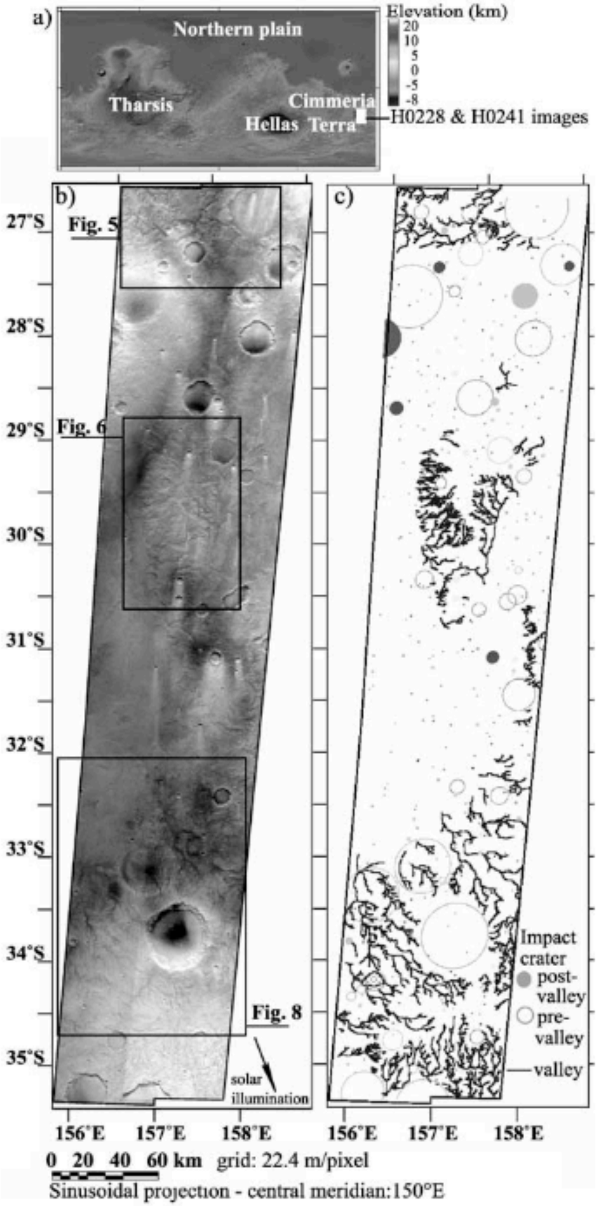
- Valley networks
- Soft sediment deformation
- Gullies



Mars Orbiter Camera (MOC) image of gullies, near 37.3°S, 168.0°W (Malin er al, 2000).



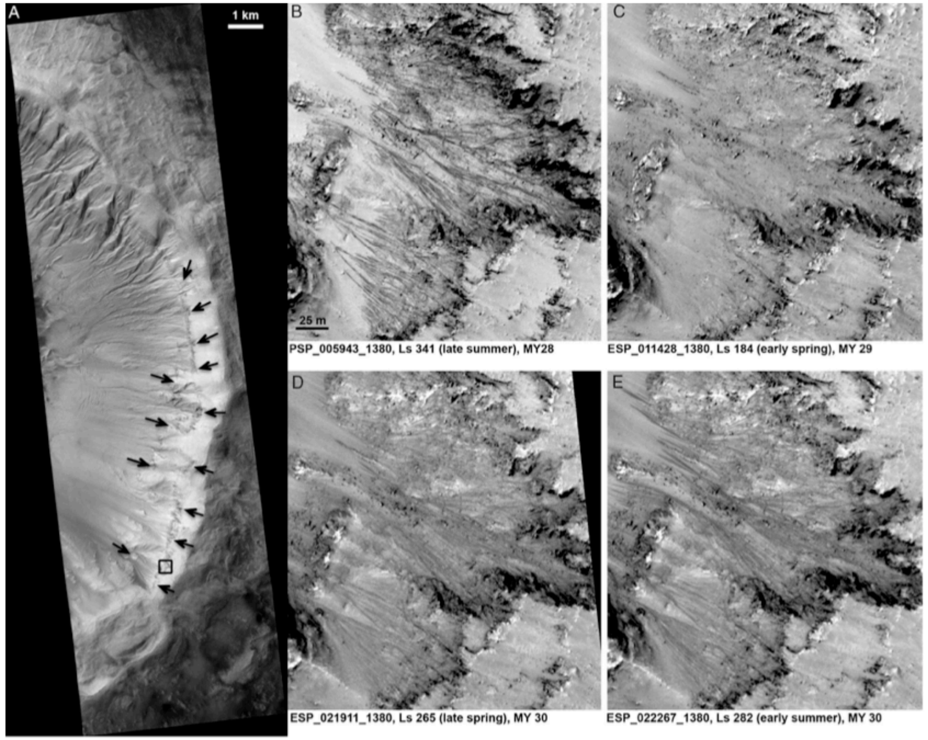
Soft-sediment deformation structures in Capen crater observed by HiRISE (Okubo et al, 2009).



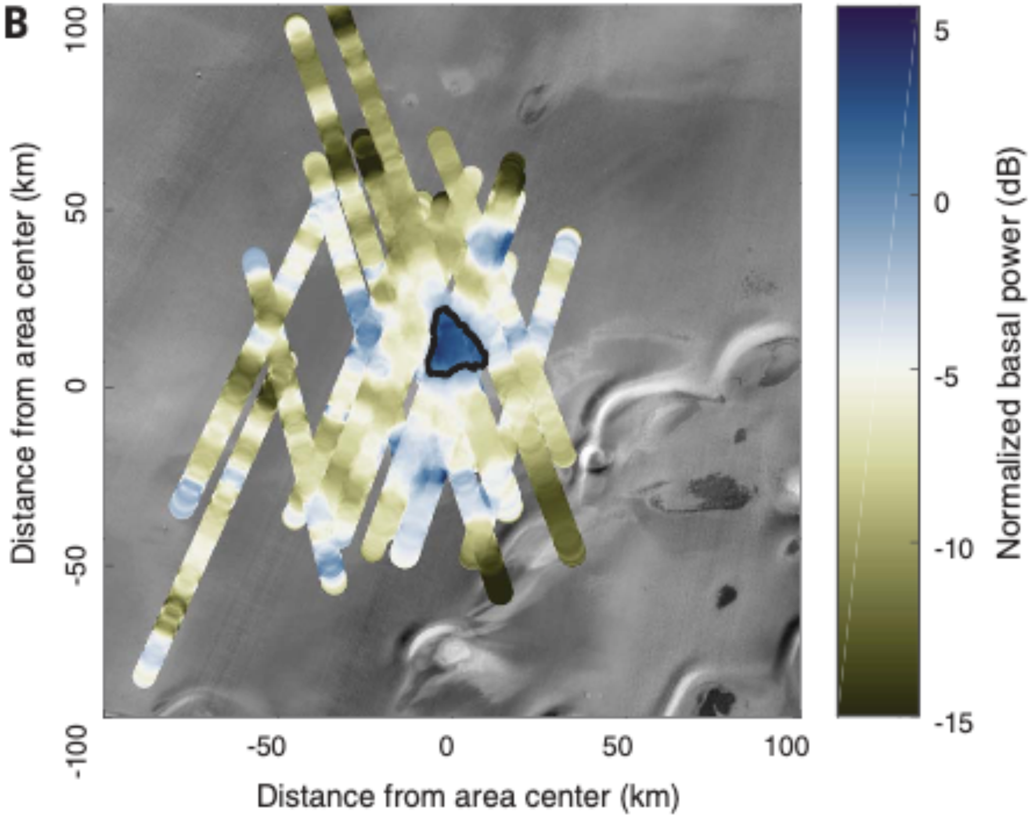
Valley Network observed by Mars Express HRSC (Ansan et al, 2008).

Introduction of Evidence of Liquid Water on Present Mars

- Anomalously bright subsurface reflections observed by MARSIS Radar within a wide zone centered at 193∘E, 81∘S
- Seasonal recurring slope lineae (RSL) highly correlated with multi-scale fractures

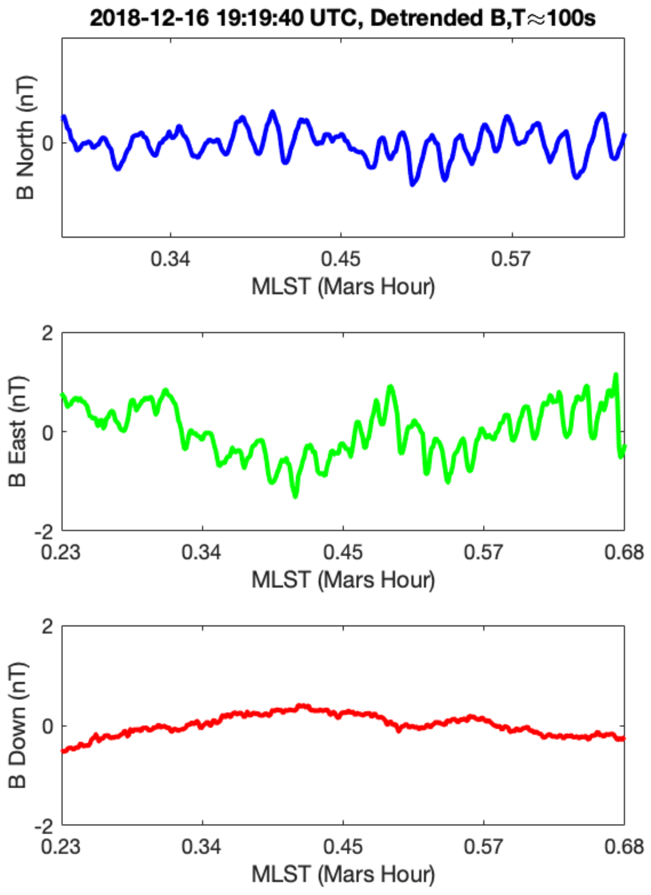


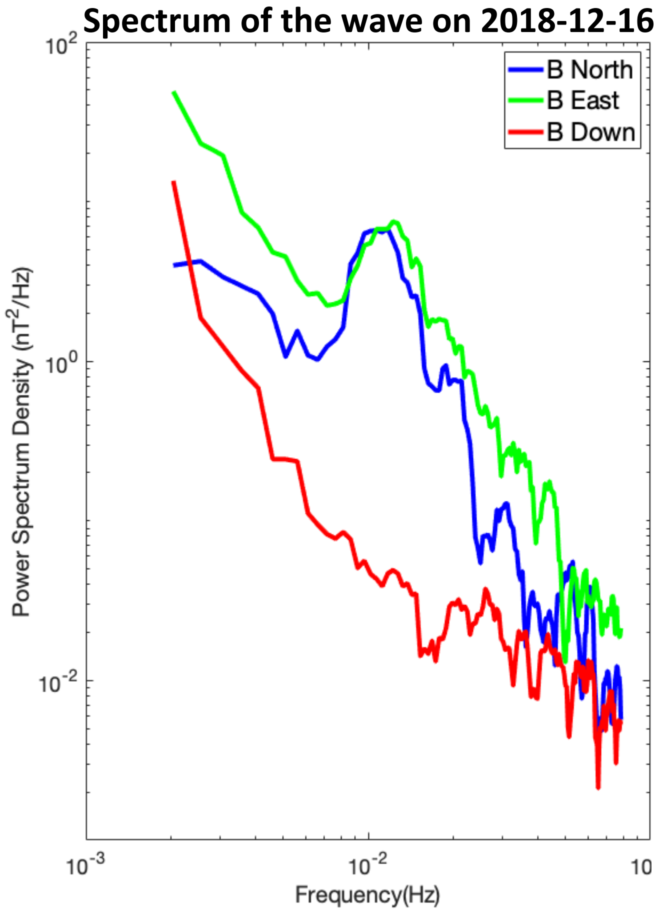
Impact crater with abundant seasonal RSL at 41.6°S, 202.3°E in Newton Basin (MacEwen et al, 2011).

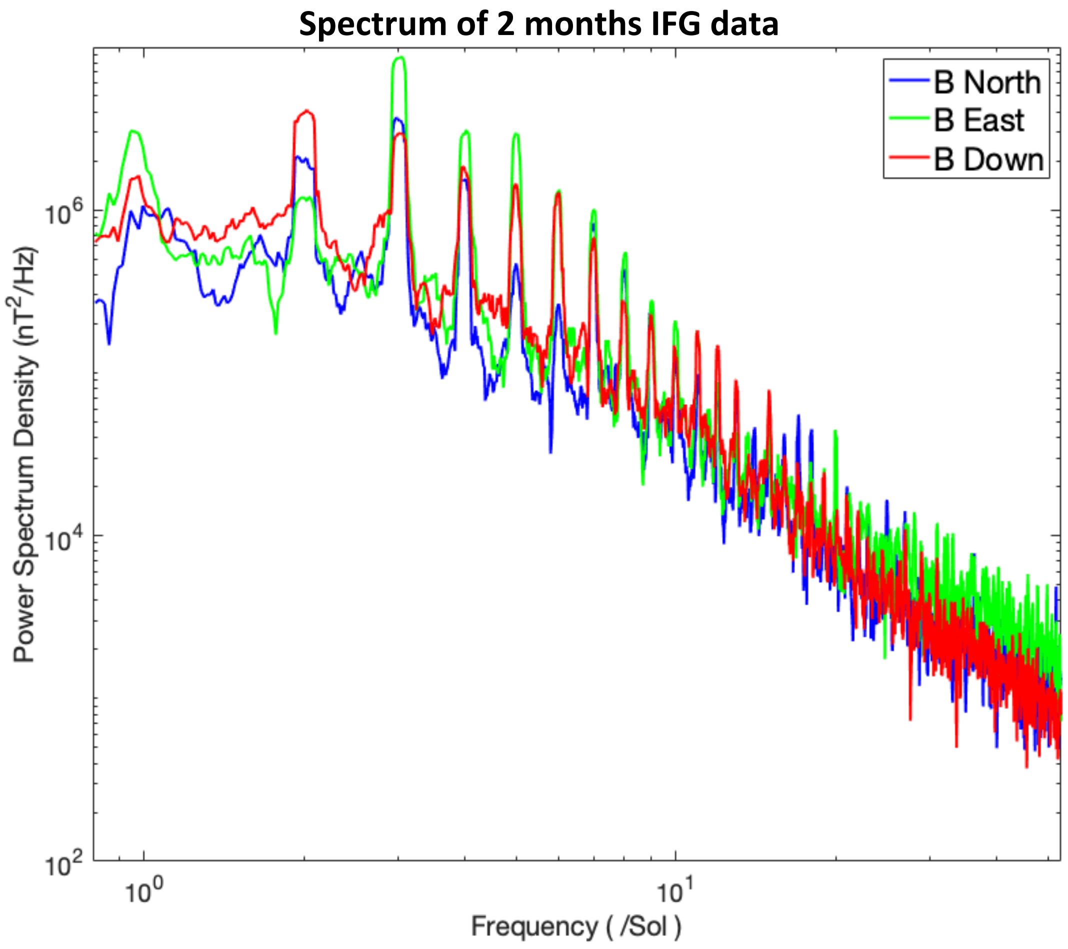


Bright area of radar signals outlined in black(Orosel et al, 2018).

Evidence for a Wet Martian Interior

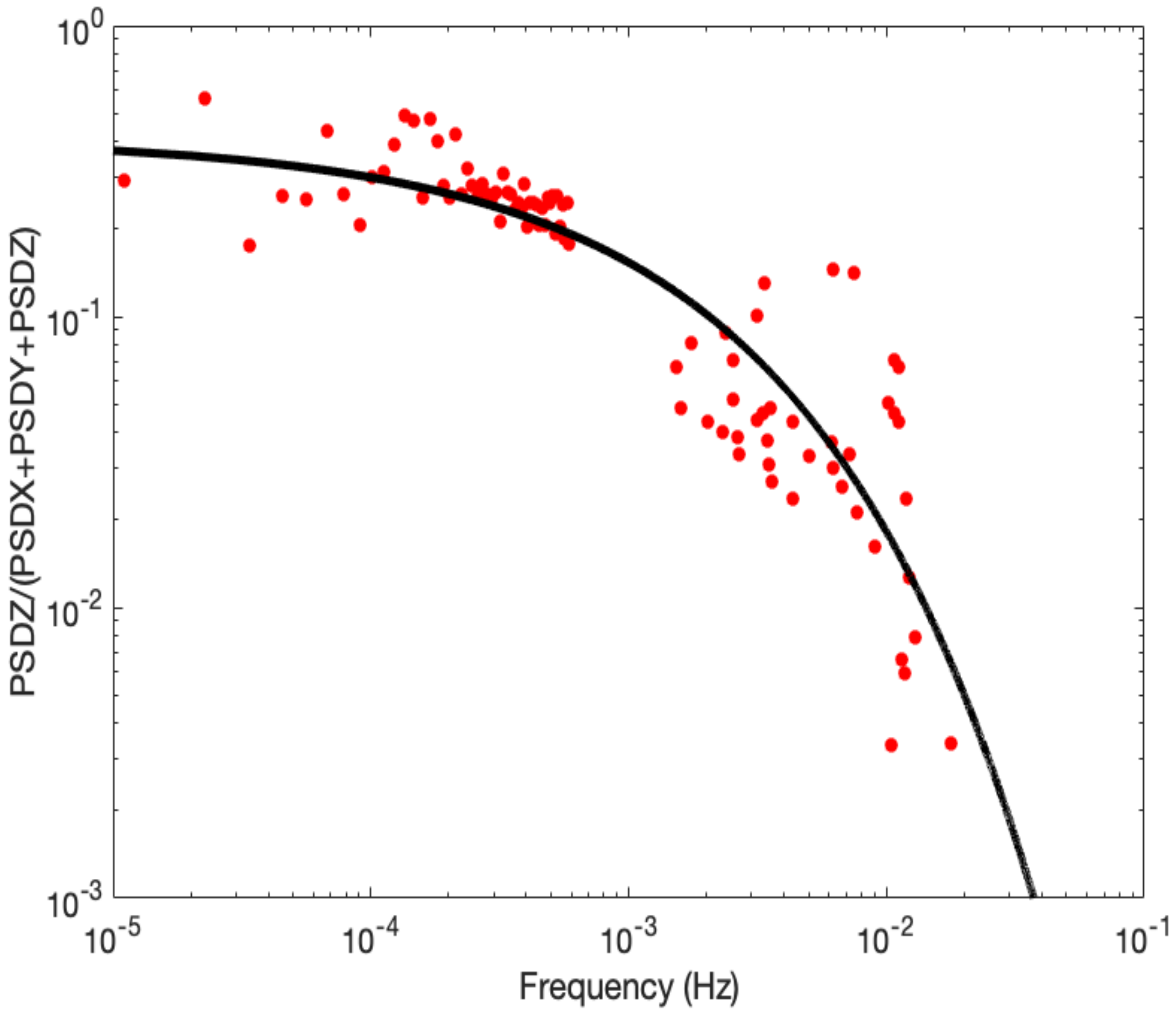






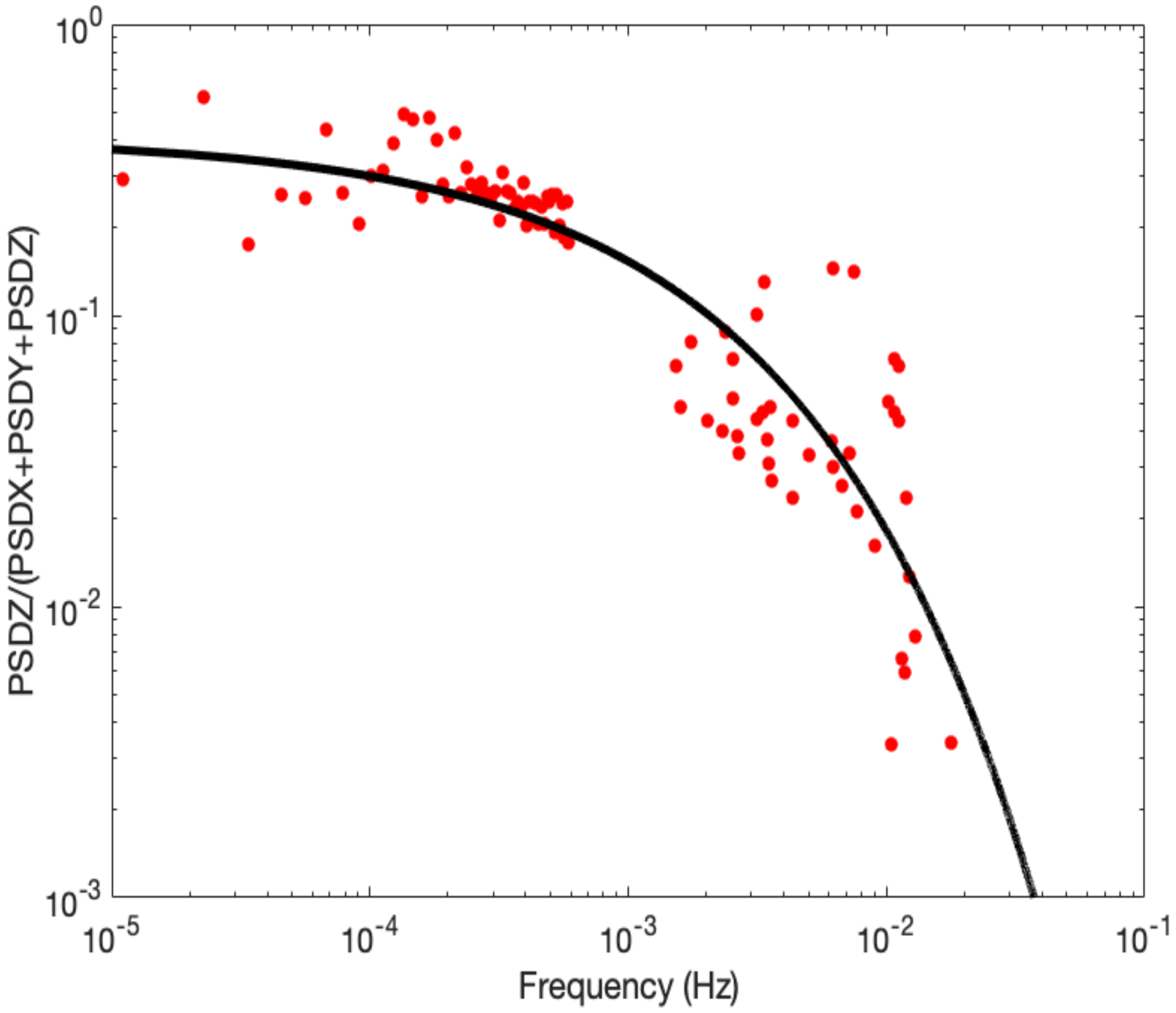
- It is found that the pulsation waves which last from hundreds of seconds to tens of minutes are significant only in the two horizontal directions, while at the frequency of daily variation and its harmonics all three components are significant.

Evidence for a Wet Martian Interior



- The attenuation of B_Down at high frequency is consistent with an electrically conducting body beneath the lander in which a current flows over a skin depth at the interface between the conducting and non-conducting materials.
- In order to do so, the conducting layer must be thicker than the skin depth that is necessary to reflect the wave. The skin depth= $(\omega\mu\sigma/2)^{-1/2}$, which depends on the frequency and conductivity.
- Thus, higher frequency waves have a thinner skin depth in an electrically conducting medium, which means the higher frequency waves are more easily reflected if the thickness of the conducting layer exceeds the waves' skin depth.

Evidence for a Wet Martian Interior



Estimate the thickness of salty water

- Wave amplitude attenuates inside the conducting body as:
  $A = A_0 \exp(-x/d) = A_0 \exp(-x(\omega\mu\sigma/2)^{1/2})$
  where the skin depth $d = (\omega\mu\sigma/2)^{-1/2}$

- Based on the method of images and boundary conditions, we fit the points by:
  $\text{ratio} = c_1 \cdot e^{-c_2\sqrt{f}}$. In this case, if it is terrestrial
  seawater with a electrical conductivity of 4.5 S/m, the estimated minimum thickness (skin depth) of the salty water: h≈ 3.3 km.
- The depth for liquid water might be several kilometers (Mellon and Phillips, 2001).

Conclusion

- While IFG's purpose on InSight was to decorrelate magnetic signals from the seismic record, the magnetometer has provided much important information about the crust.
- We observe ULF waves from 100s to 1000s period. We speculate the main source is the current sheet perturbations in the induced magnetotail. They are ideal for sounding the crust. The observed reflection of the 100s to 1000s waves is consistent with at least 3.3 km of the salty water. The property of the water doesn't change with the heliocentric distance.