Case Study: Mid-Latitude Volcanics

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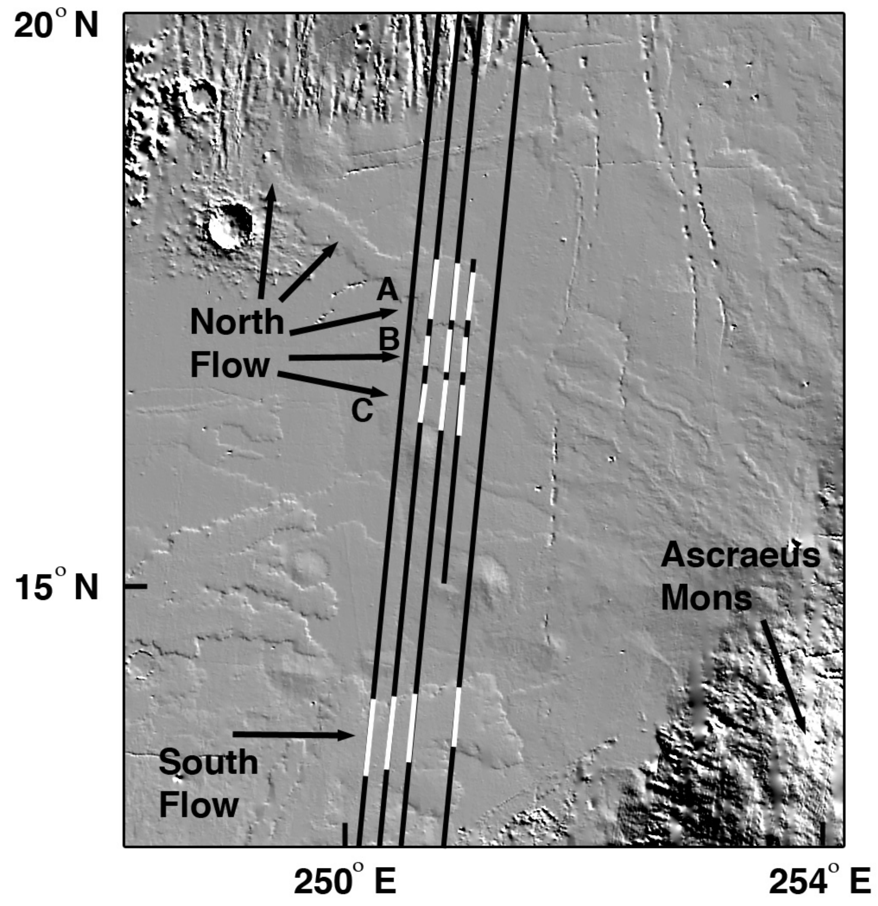
Lava Flows in the Tharsis Region

- Plains west of Ascraeus Mons are the site of numerous lava flows [Carter et al. 2009].
- Flows come from 1) The rift zone linking Ascraeus and Pavonis Mons and 2) southern Alba Patera region.
- Flows are between 20-70 m thick, and models show that they may have been emplaced as thick individual flows [*Baloga et al. 2003*].



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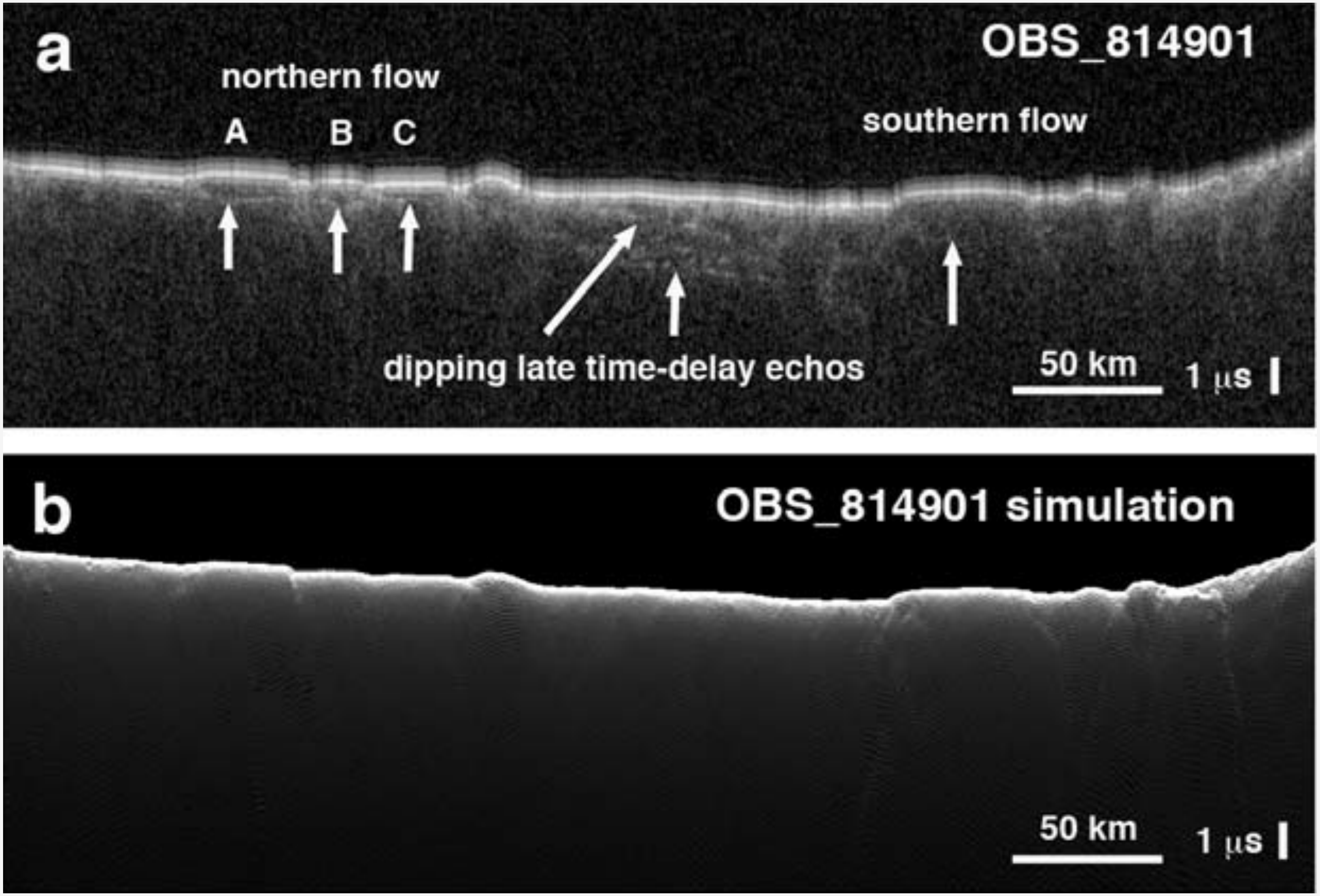


Flow dielectric properties-permittivity

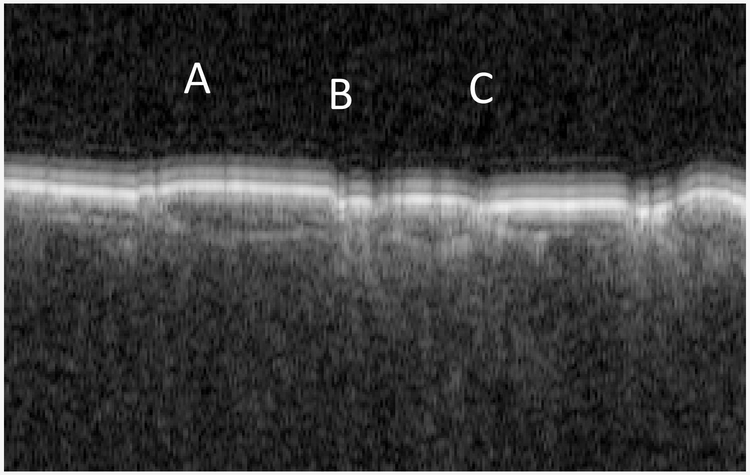
- SHARAD data can be used to measure the permittivity of the flows.

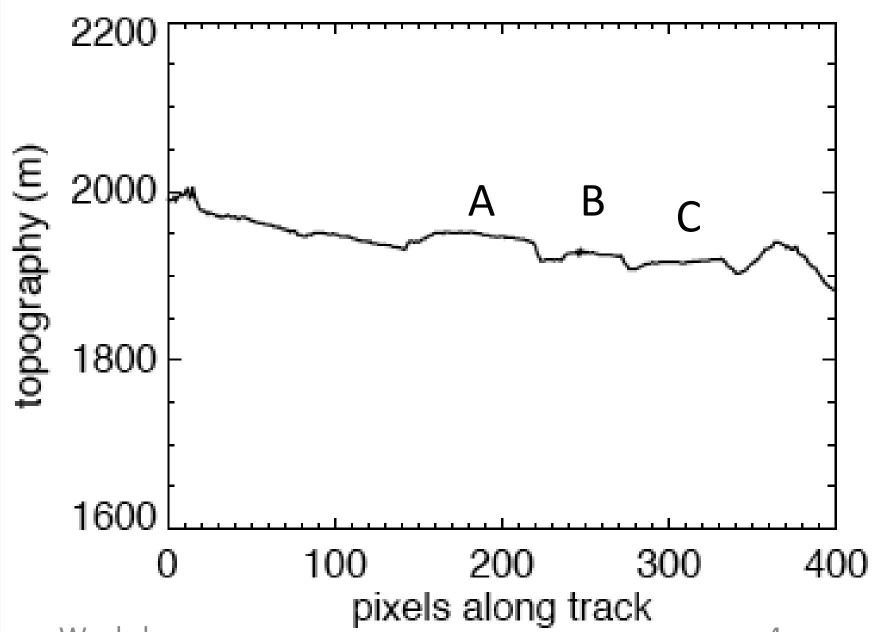
$$\varepsilon' = \left(\frac{c\,\Delta t}{2h}\right)^2$$

- Permittivity values measured for these flows are high. Northern flow: 12.2. Southern flow: 9.8
- These calculations assume that the plains units on either side of the flows form a smooth interface underneath the flows.
- Empirical formula can be used to estimate density (e.g. *Campbell [1996]*):

$$\varepsilon' = 1.96^{\rho}$$

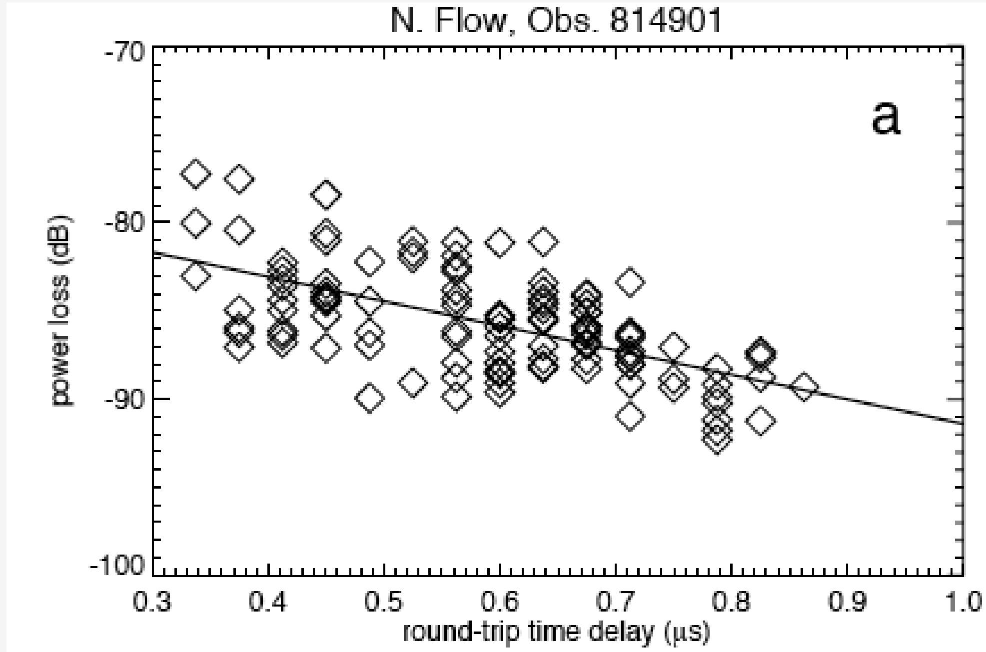
- Computed density values range from 3.4 to 3.7 g cm^{-3}





Flow dielectric properties-loss tangent

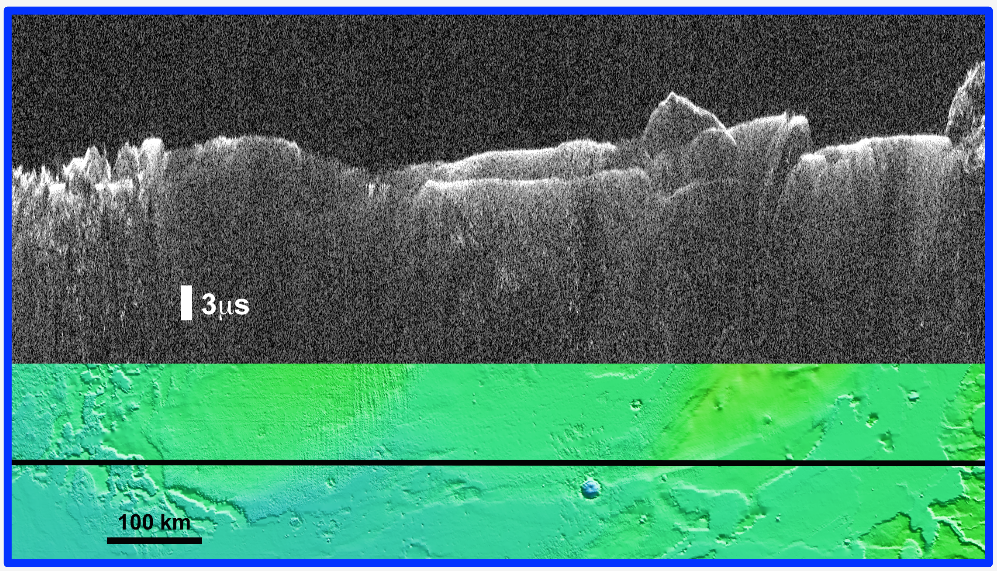
- The loss tangent of the flows ($\tan \delta = \varepsilon'' / \varepsilon'$) can also be computed by measuring the power loss as a function of round-trip time delay (e.g. *Campbell et al., [2008]*).
- Loss tangent values range from 0.01-0.03.
- These values fall in the middle of the range measured for terrestrial and lunar basalts (e.g. *Carrier et al., [1991]; Ulaby et al., [1988]*).
- Flows cannot have large amounts of radar absorbing minerals.

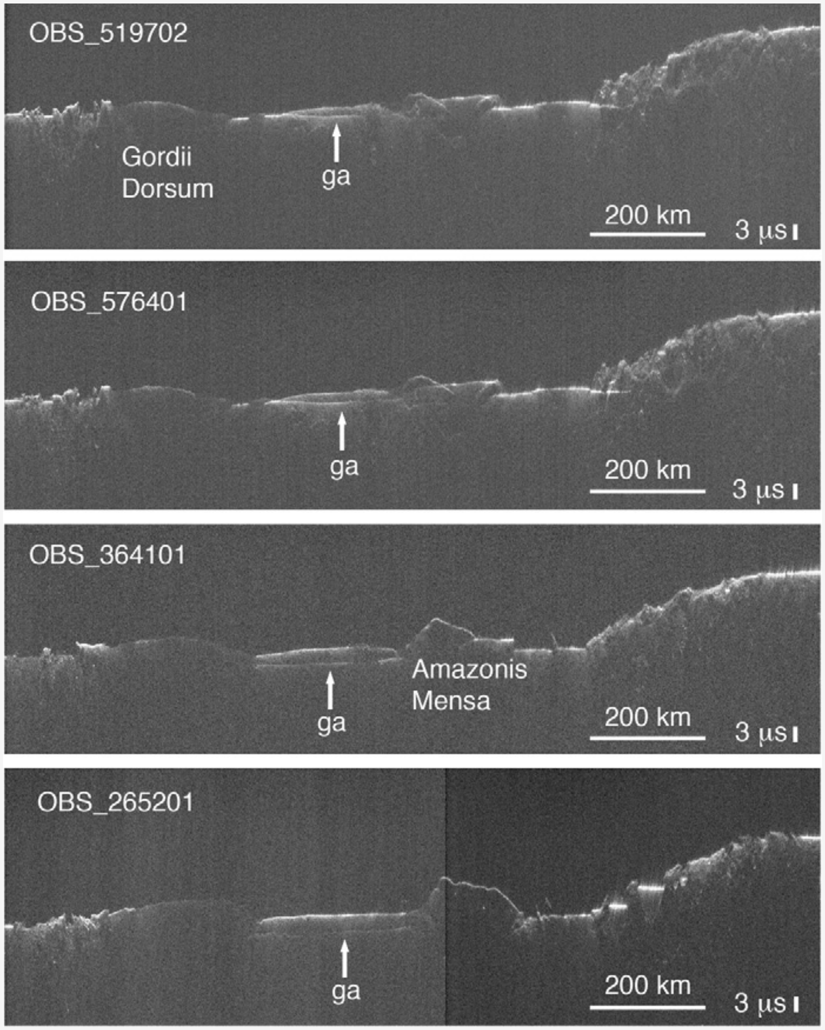


$$\tan \delta = \frac{\varepsilon''}{\varepsilon'} = \sqrt{\left[2 * \left(\frac{\lambda}{4\pi c \Delta t} \ln(L)\right)^2 + 1\right]^2 - 1}$$

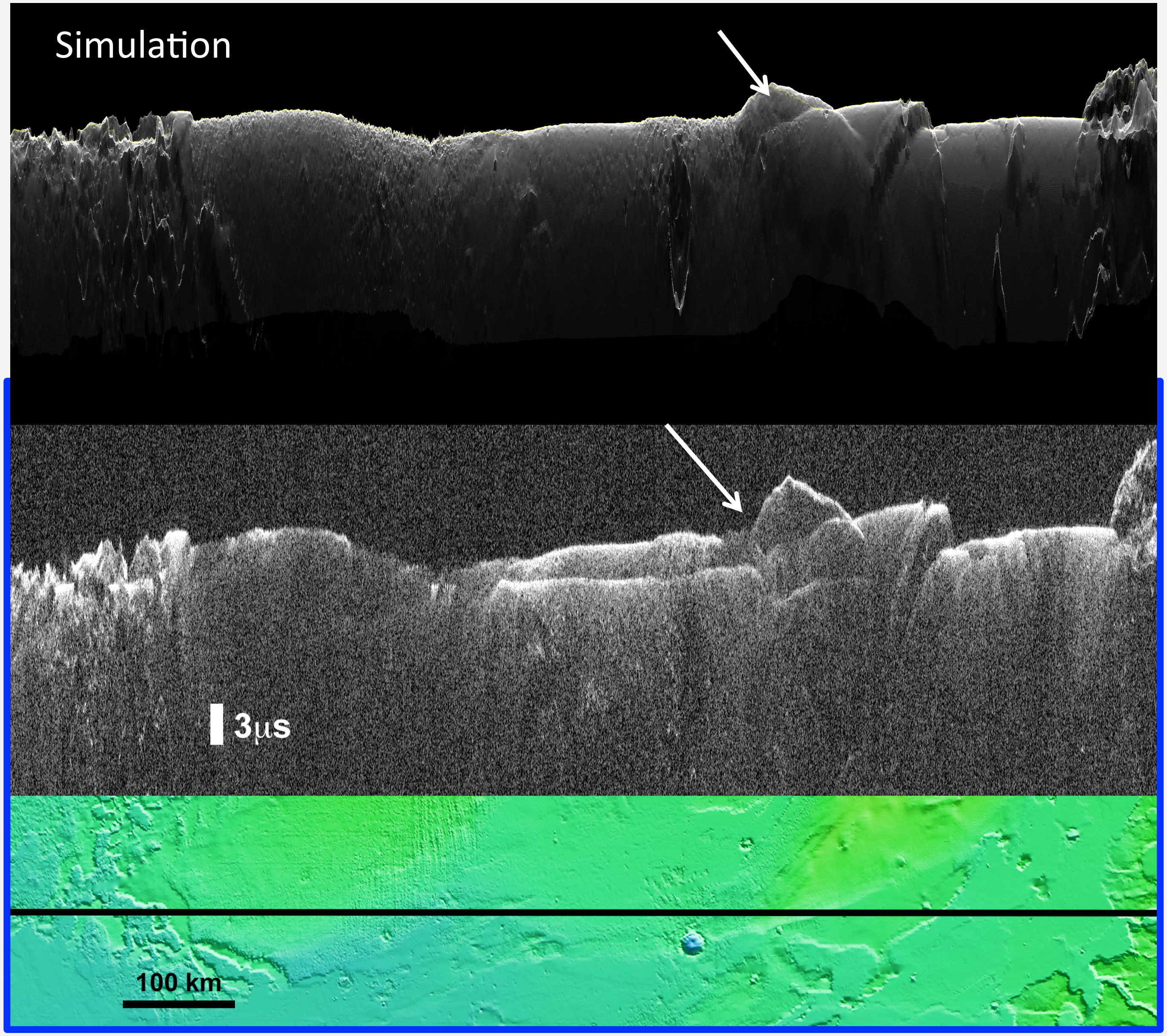
Medusae Fossae Formation

- SHARAD also detects interfaces beneath up to 750 m of the Medusae Fossae Formation, a low density deposit [Carter et al. 2008; 2013].



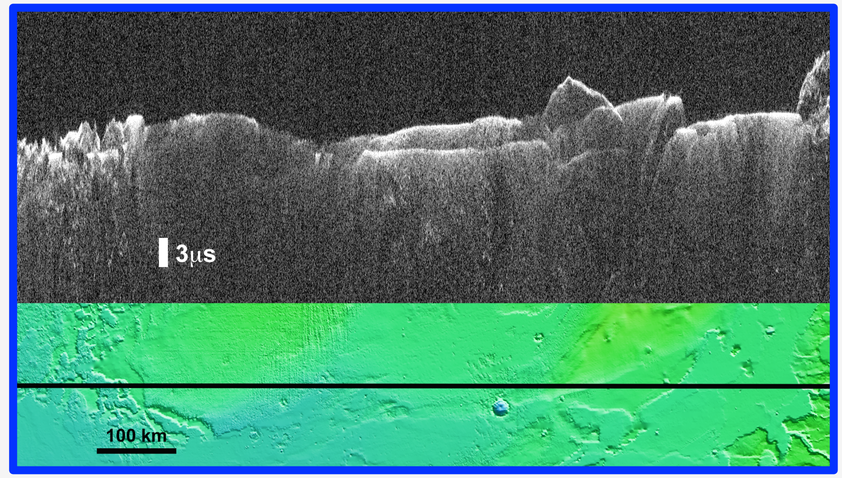


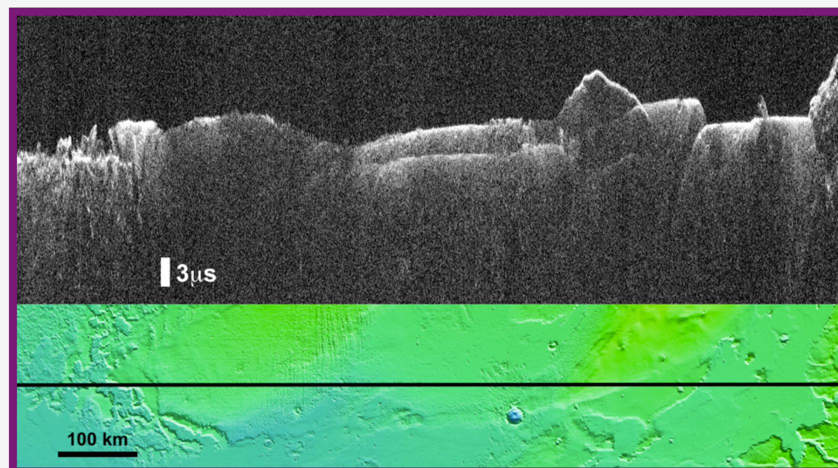
Note the clutter!



Medusae Fossae Dielectric Properties

- Assumption of a flat subsurface interface is perhaps less valid than for lava flow example.
- Assuming flat plains extend beneath the deposit, the permittivity would be ~3-4.
- Loss tangent was measured using MARSIS data. Range of 0.002-0.006 [Watters et al. 2007].
- Measuring loss tangent with SHARAD can result in scatter plots as the subsurface power is spread in range.





Summary

- In mid-latitudes, dielectric properties lead to a wide range of subsurface interface depths, with an apparent maximum (to date) around 750 m for the Medusae Fossae Formation.
- Clutter is an issue in many locations. Good news is that with clutter simulations we are often able to find subsurface interfaces in fairly cluttered regions.
- The ability to measure dielectric properties varies considerably from region to region in mid-latitudes. Depends on variety of depths sampled, assumptions possible from other data sources, SNR of data, local properties such as internal scattering and nature of interface.