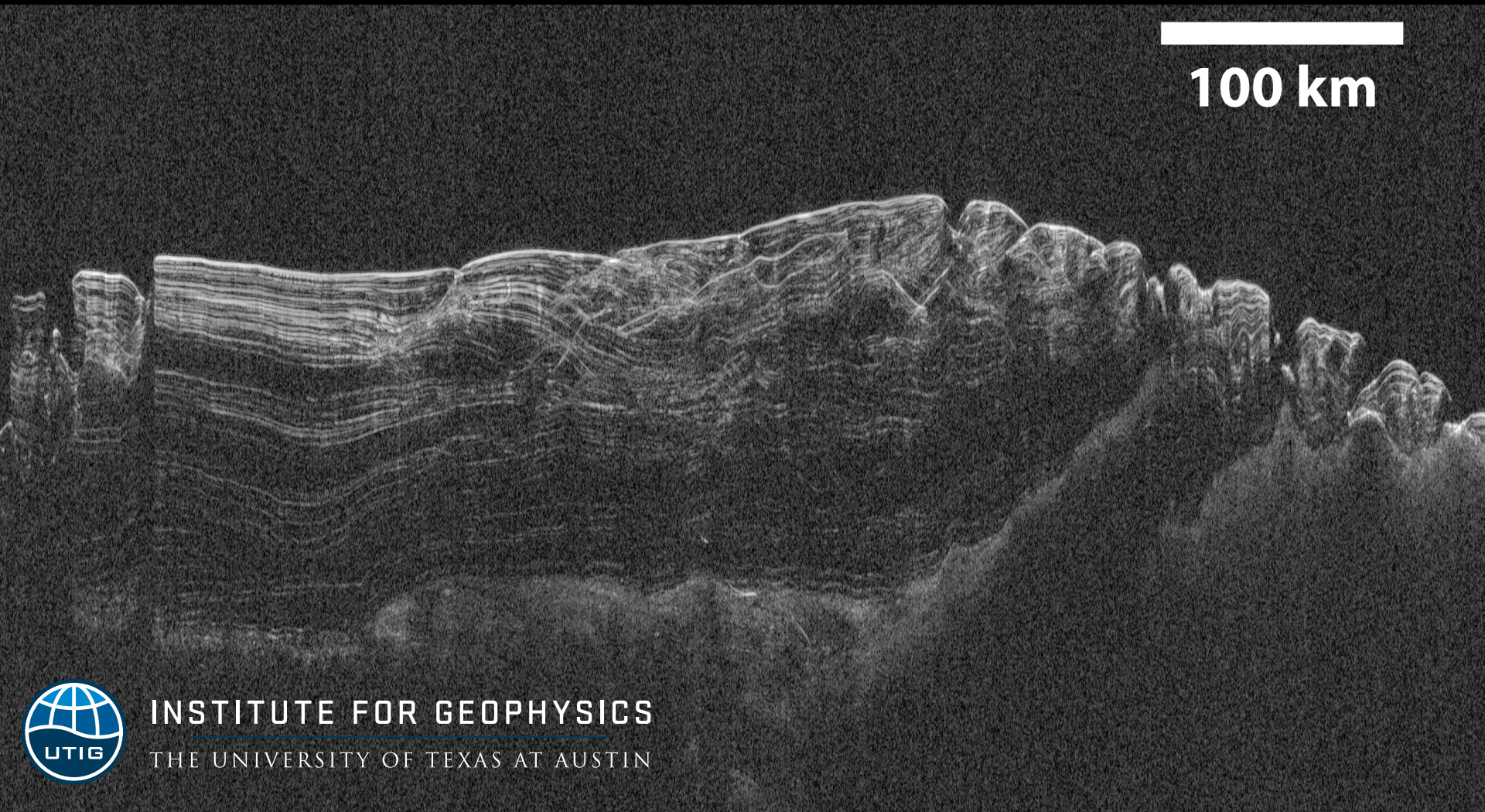
What Causes Radar Reflections?

Dan Lalich



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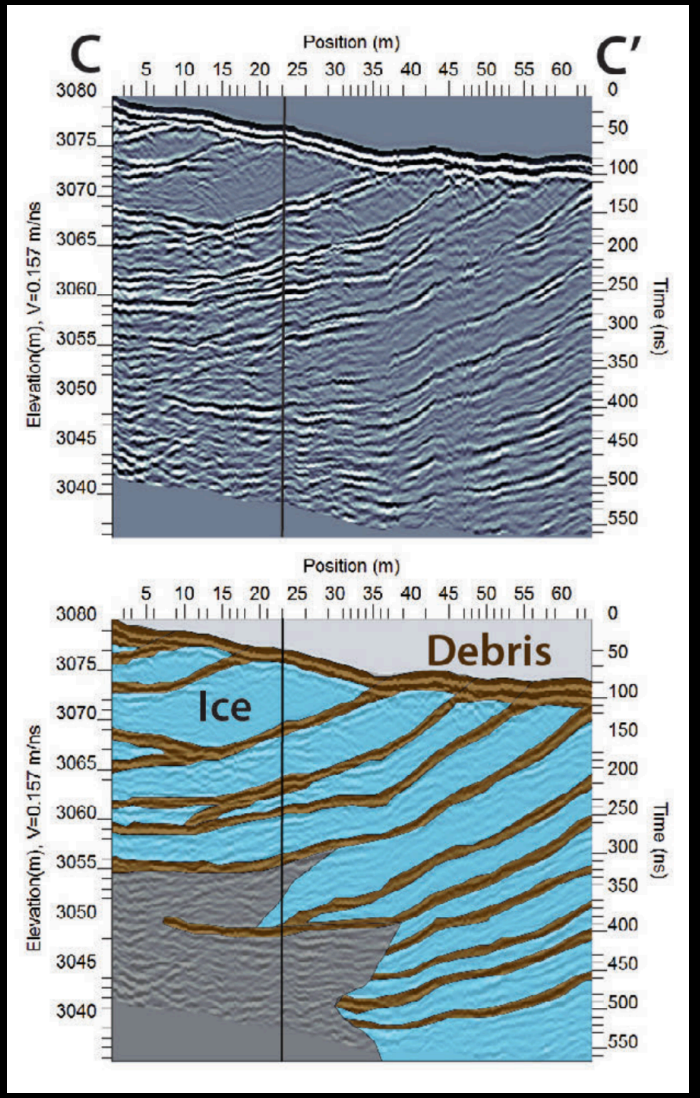
The Short Answer

- Radar reflections are caused by an abrupt change in subsurface permittivity
- Permittivity is a complex number, the real part is called the dielectric constant
- The higher the permittivity contrast between two materials, the brighter the reflection

$$R = \left| \frac{n_1 - n_2}{n_1 + n_2} \right|^2$$

Radar Reflections in Ice: Earth

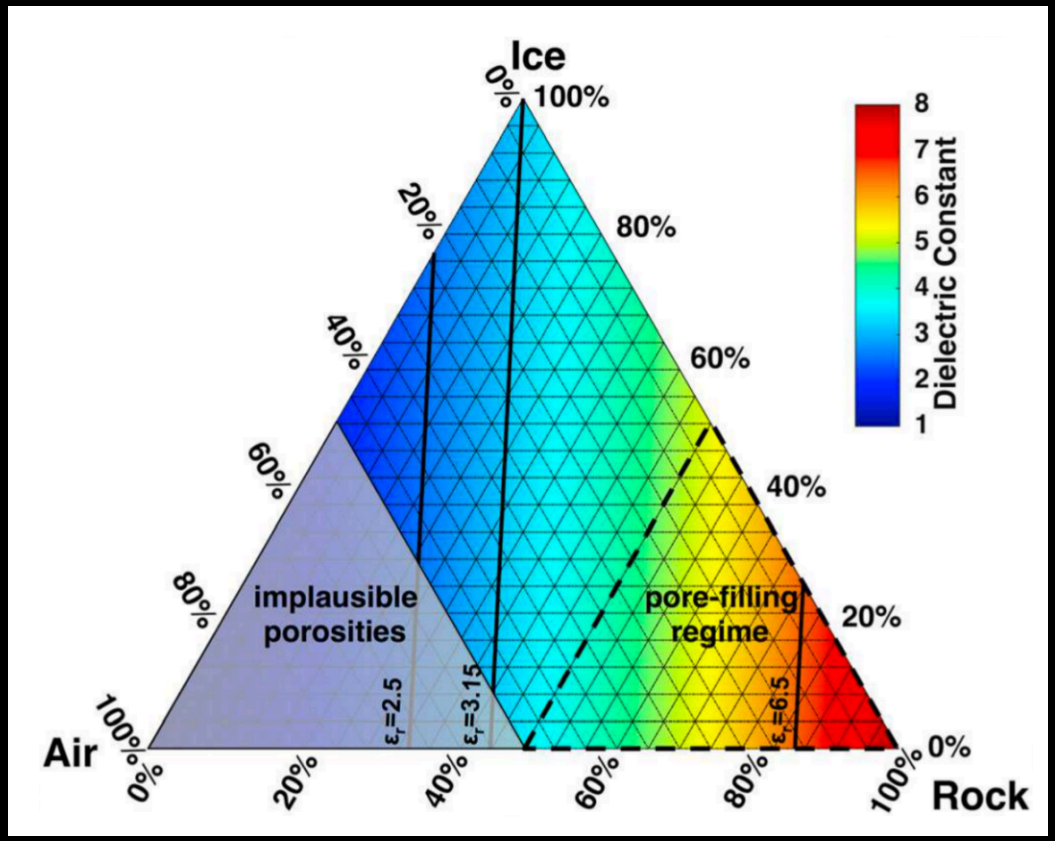
- Bed contact and debris bands
- Density variation
- Ice crystal orientation
- Small impurity content, particularly affecting conductivity (e.g. from volcanic acids)



Radar Reflections in Ice: Mars

- SHARAD is too low resolution to see density variation in the near-surface
- No flow means crystal orientation probably isn't a factor
- Uniformly low conductivity, no recent volcanic activity, etc.
- But we know the PLD are dusty…

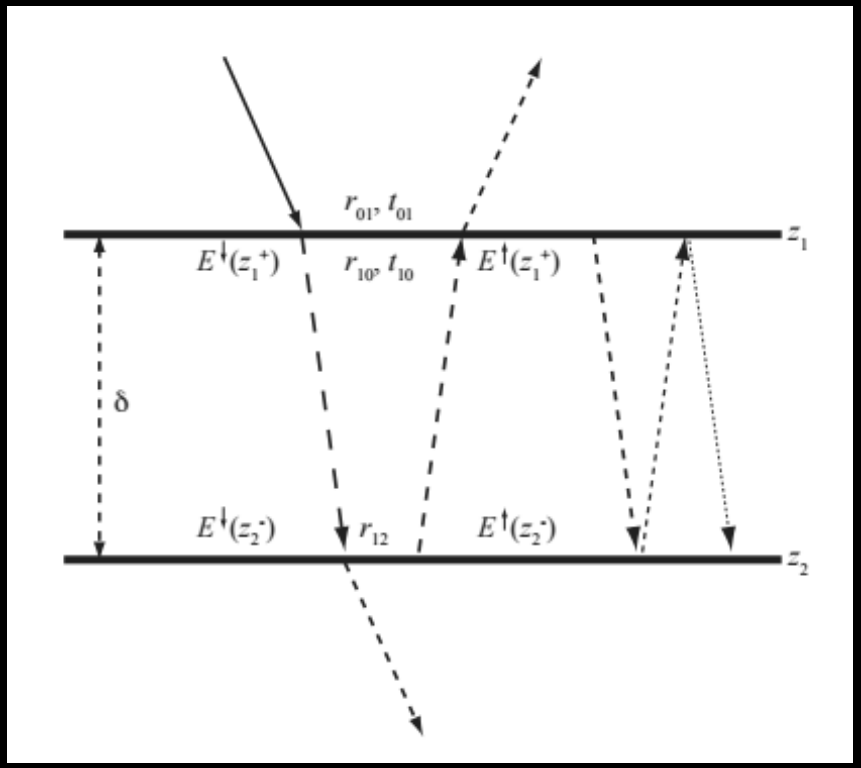
Dust Content and Permittivity



Bramson et al. 2015

We Have a Resolution Problem

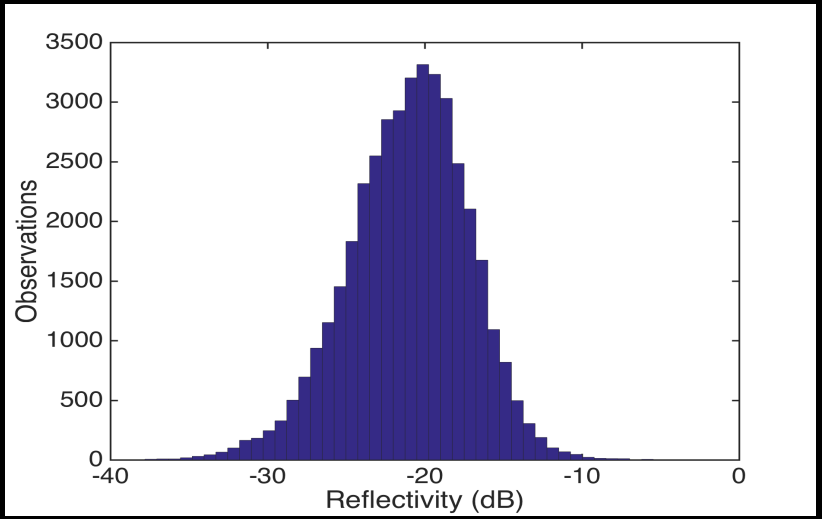
- Layers can be 10s of cm thick, but SHARAD's vertical resolution is ~8.5 m at best

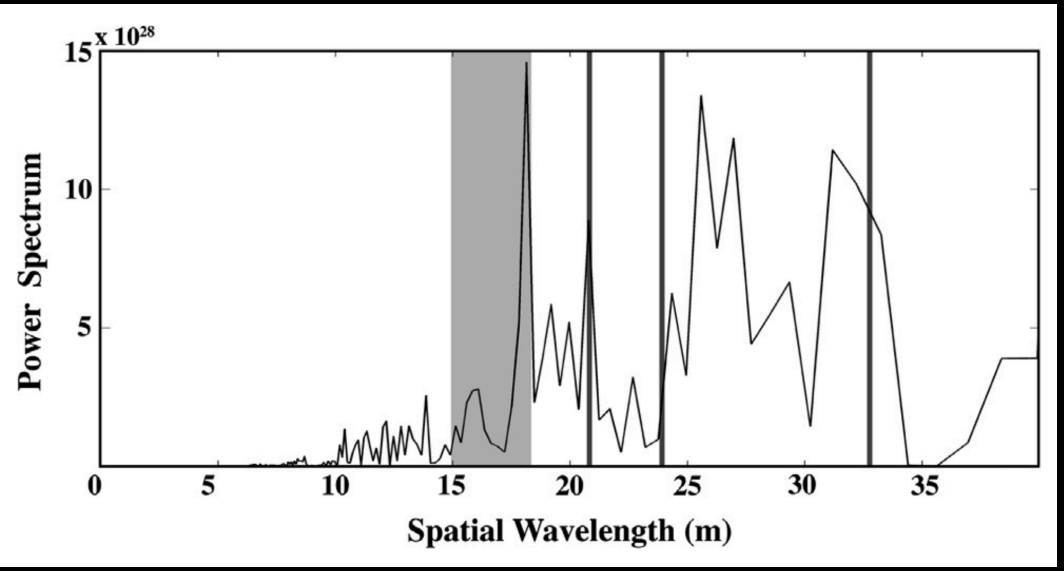


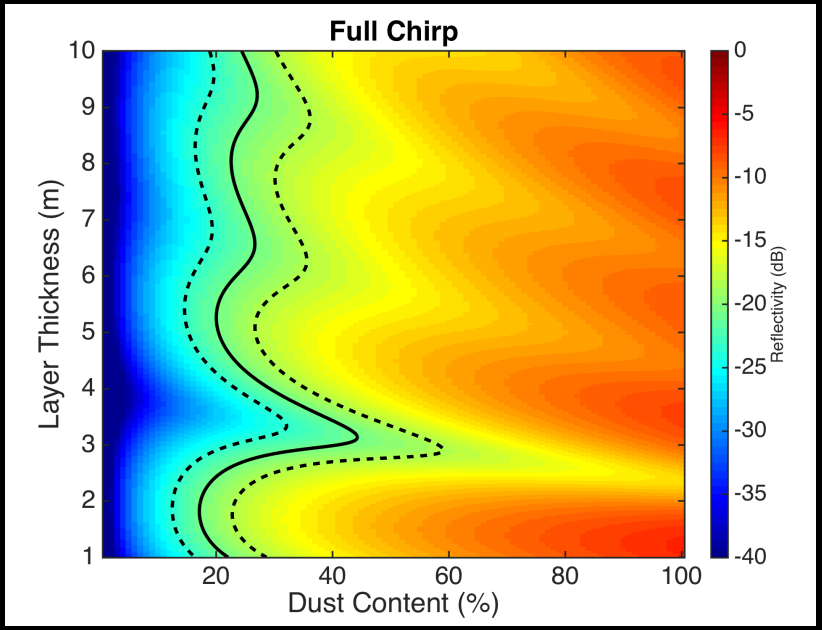
MacGregor et al. 2011

Reflectors and Marker Beds

- Some evidence suggests marker beds might be responsible for SHARAD reflections in the NPLD







Christian et al. 2013

Problems

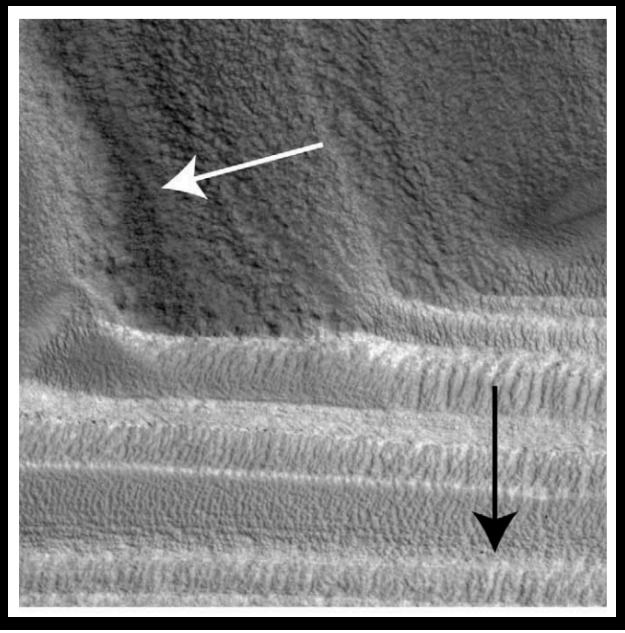
- Radar reflections don't necessarily have to correspond to one layer, and interference is an issue
- We have been unable to correlate specific layers with specific reflectors
- What about the SPLD?
- It's unlikely that all reflectors represent the same type of layer/boundary

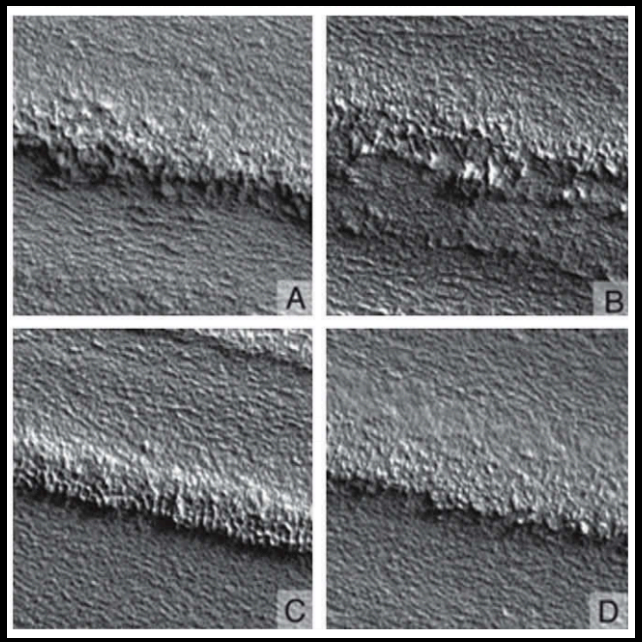
Summary

- Reflections are caused by changes in permittivity
- Different processes for Earth vs. Mars
- PLD reflectors are likely caused by changes in dust content
- NPLD reflectors might correspond to marker beds
- Lots of problems still, mostly linked to disparate resolutions

Optical Layers

- Albedo can be unreliable
- Most successful method is combination of albedo and protrusion





Fishbaugh et al. 2010