

# Sounding snow and ice with UWB-radar

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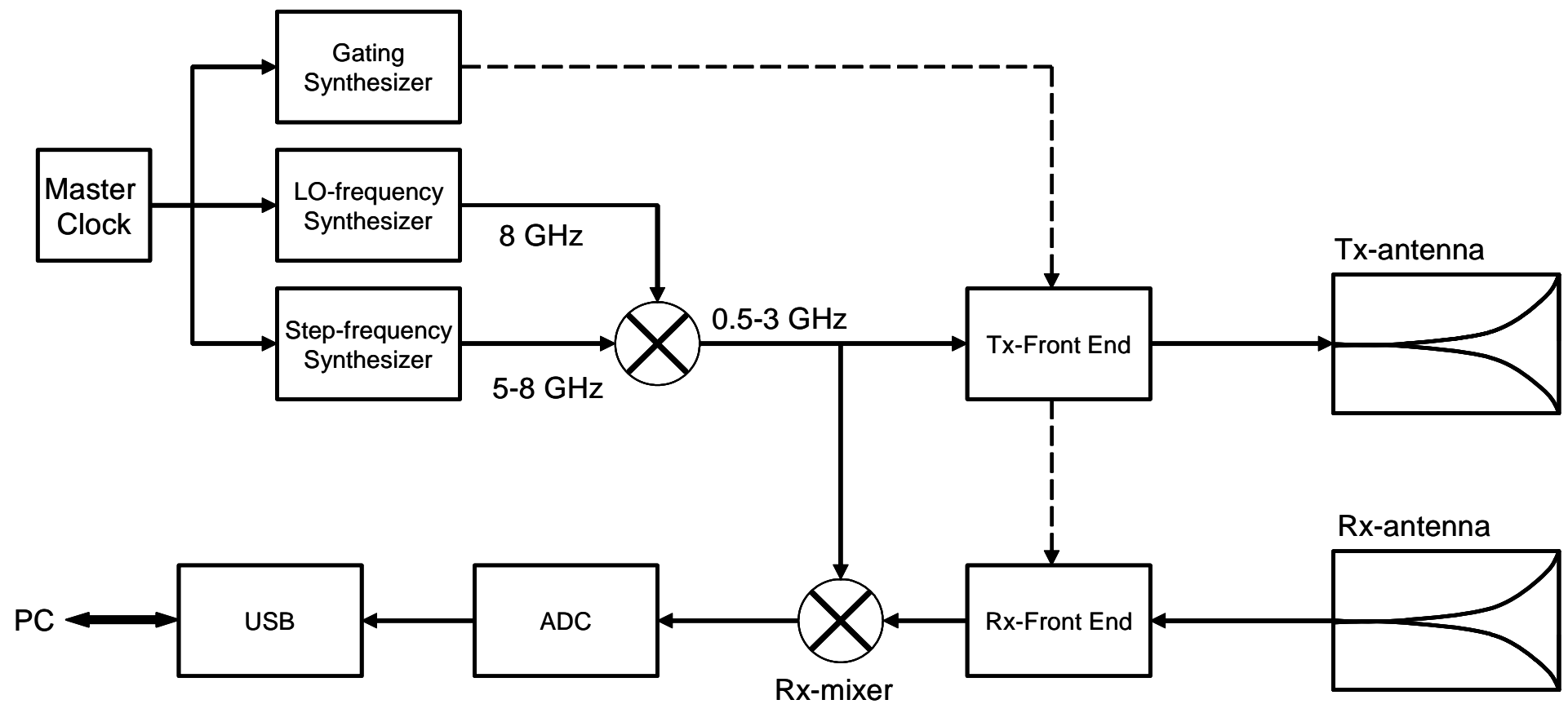
# Topics

- UWB-radar system
- Kongsvegen – Field site
- Glacier facies seen by radar
- Results Antarctica





# HUBRA UWB-Radar







# Radar Technical Data

- Gated FMCW Radar
- Frequency [500 MHz – 3 GHz]
- Center frequency 1.75 GHz
- Sweep time = 10 ms
- IF-bandwidth = 500 kHz
- IF-sampling frequency = 1 MHz
- Number of frequencies = 10 000
- Gating frequency = 1.523 MHz
- Vivaldi antennas
- Radar trace collected every 20 cm
  
- (Polarimetric)

# HUBRA UWB-Radar

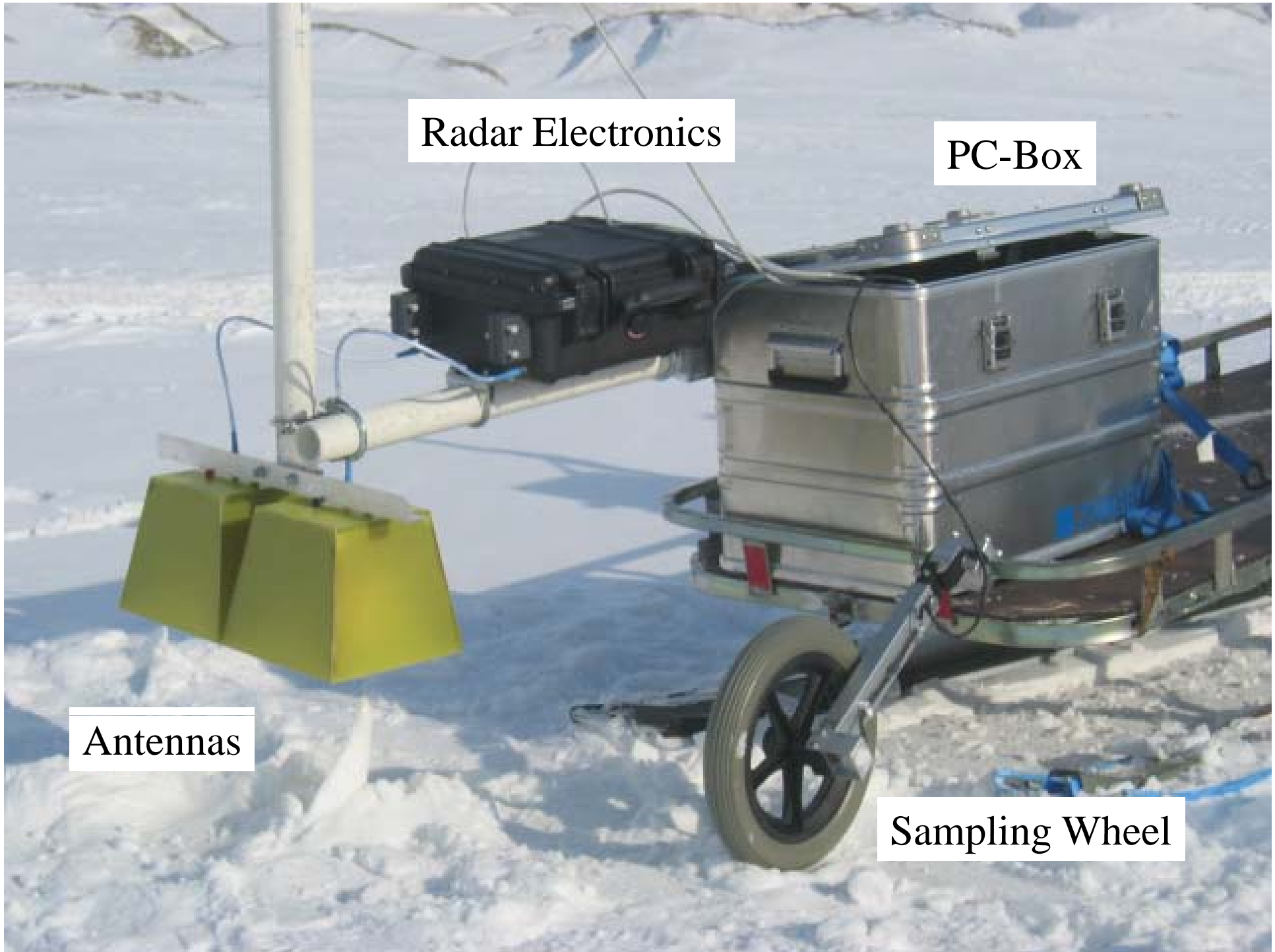


Radar Electronics

PC-Box

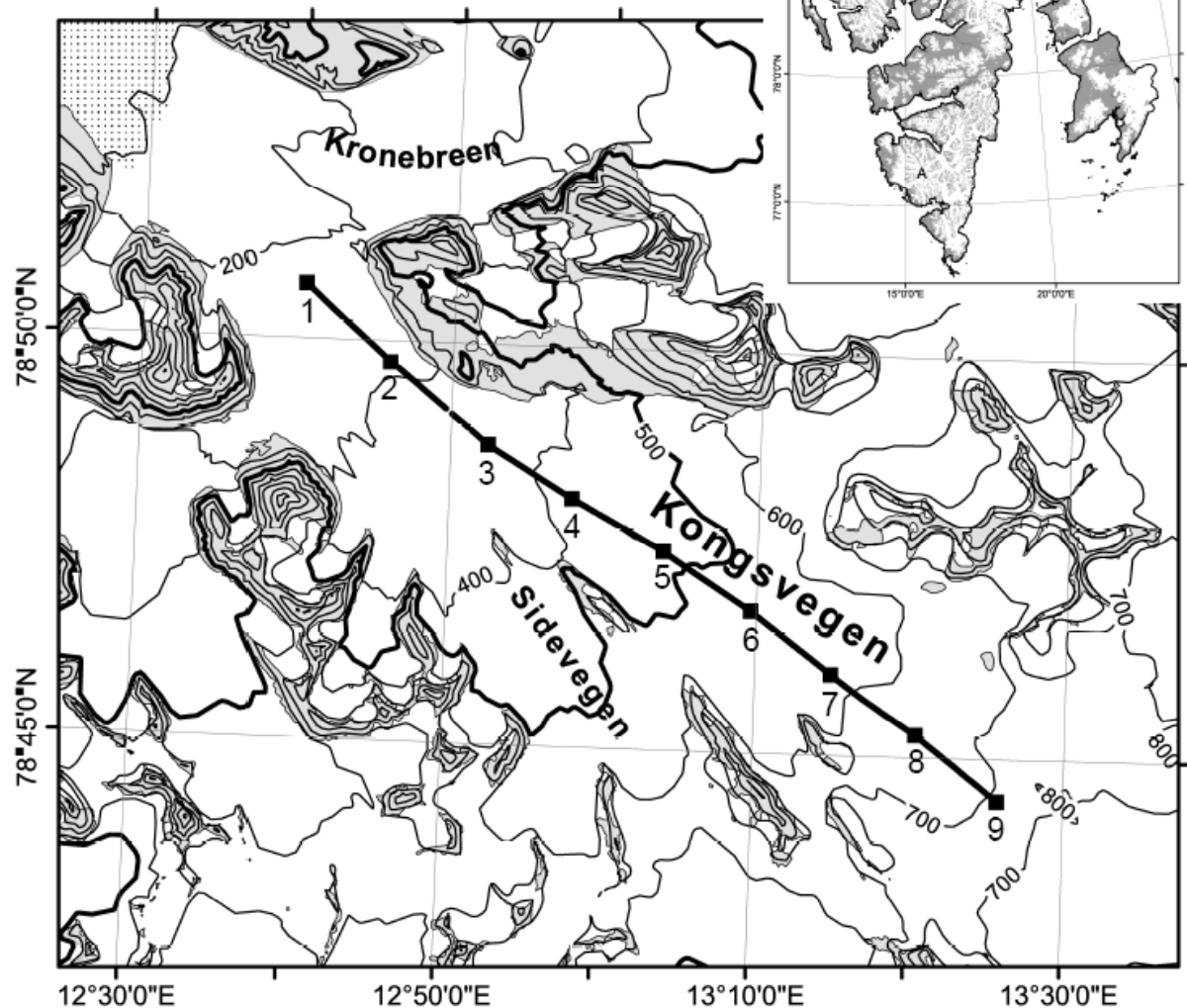
Antennas

Sampling Wheel

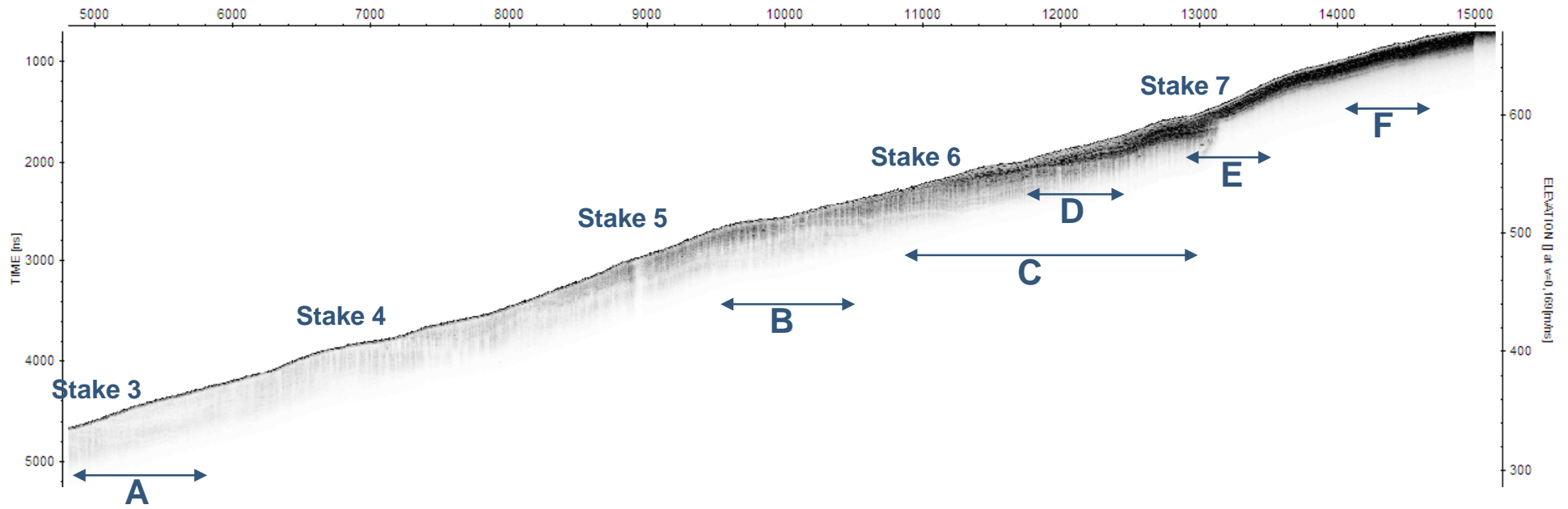
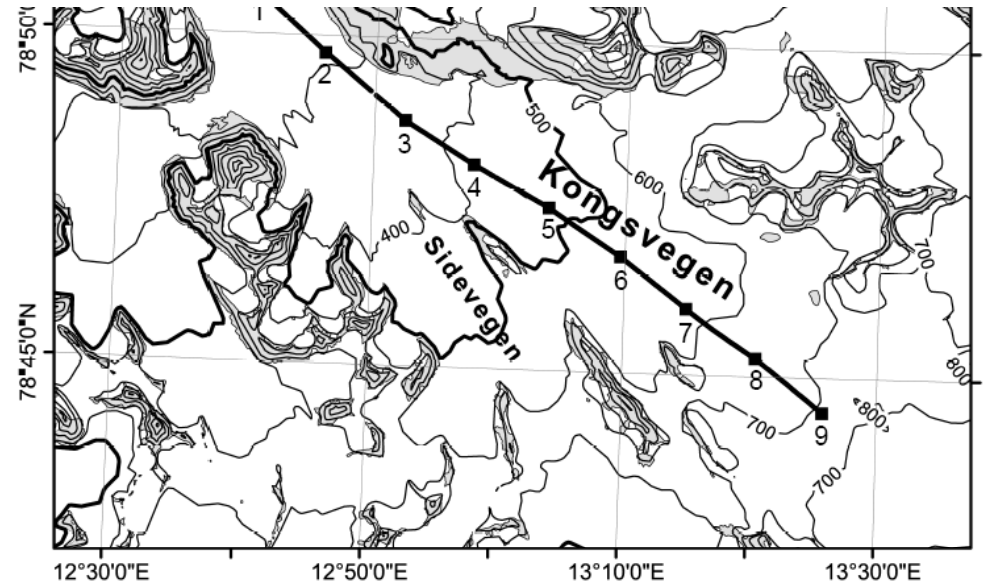


# Kongsvegen – Svalbard

- Poly thermal glacier
- Cold surface layer
  - ~ 60 m thick
- Surface altitude
  - 0 to 800 m a.s.l.
- The glacier covers an area
  - ~100 km<sup>2</sup>



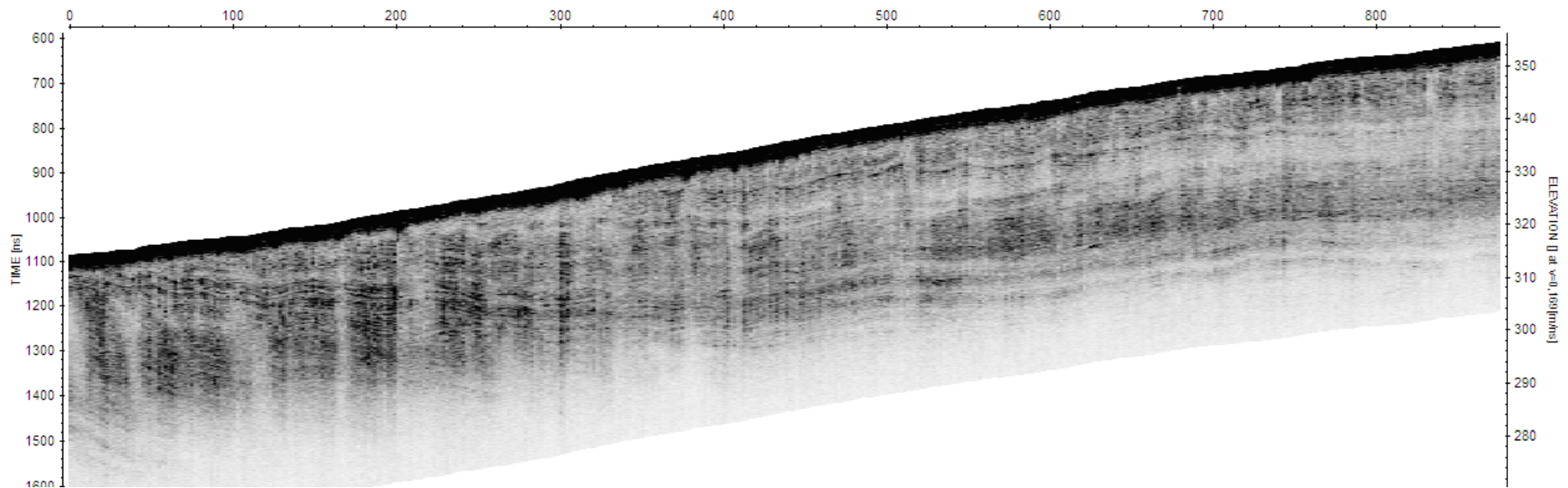
# Center Line Profile





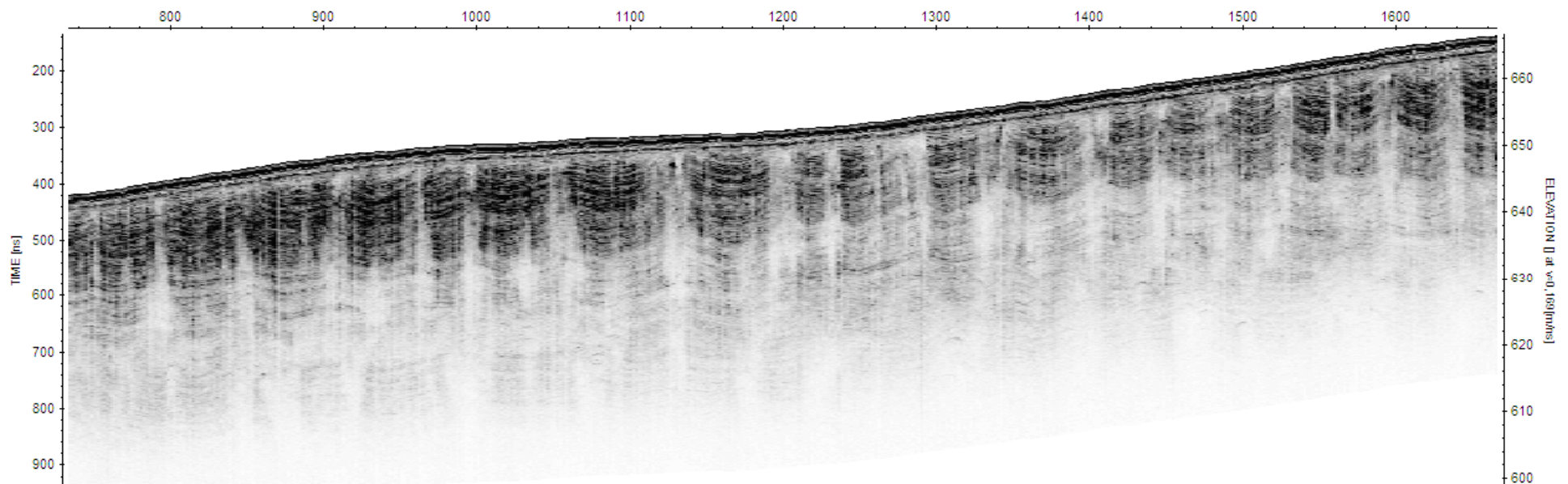
## Profile A – Abalation Ice

- Horizontal layering is likely from older SI accumulation, now melting out.



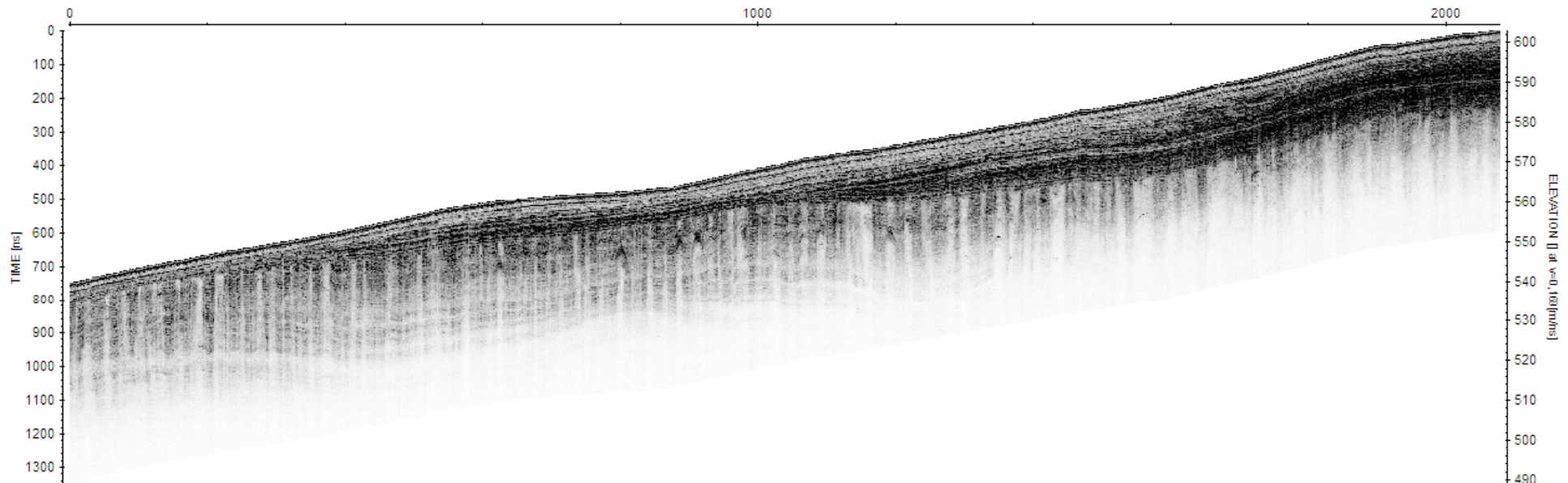
## Profile B – "Herringbone Zone"

- Older SI accumulation, but here the horizontal layering is disturbed by vertical structures.
- Spacing, and location on the glacier, suggests that these are from crevasses known to have opened around 1948 and subsequently closed in the 1960s, in connection with a so-called glacier surge.

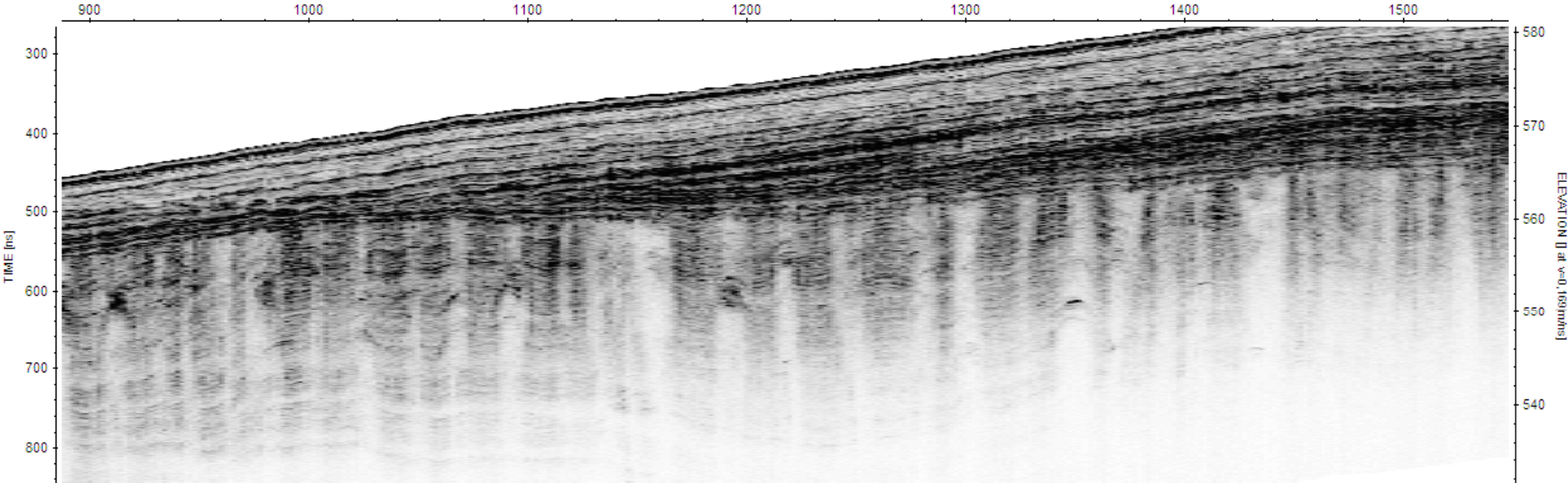


## Profile C – Superimpose Ice Zone

- similar to profile B but here the lower herringbone SI unit, is overlain by continuous SI layers.
- Interpreted to have formed after the crevasses were closed since SI formation would be greatly reduced when water forming in the snowpack could drain into the crevasse networks.

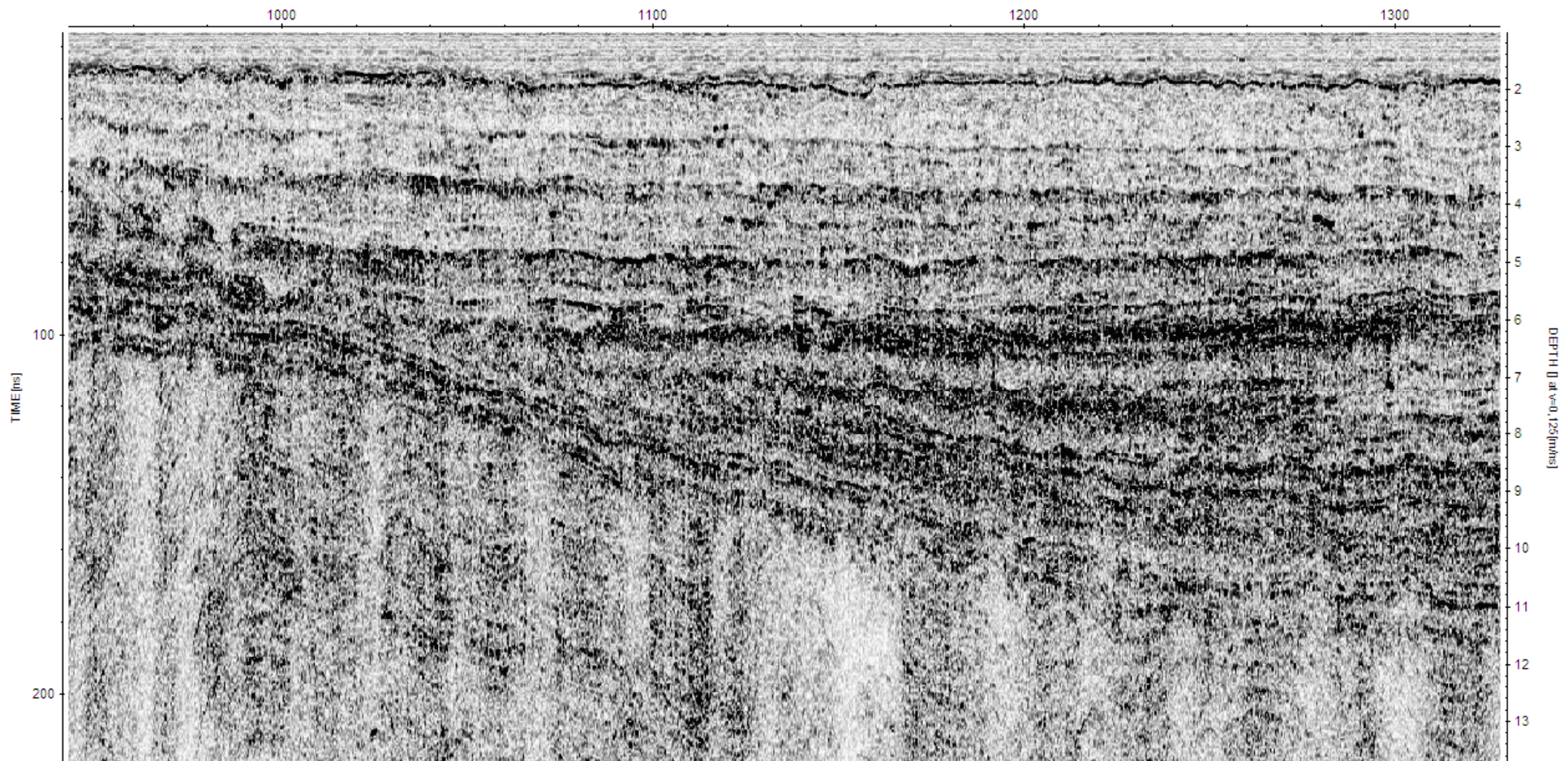


# Profile D – Close-Up



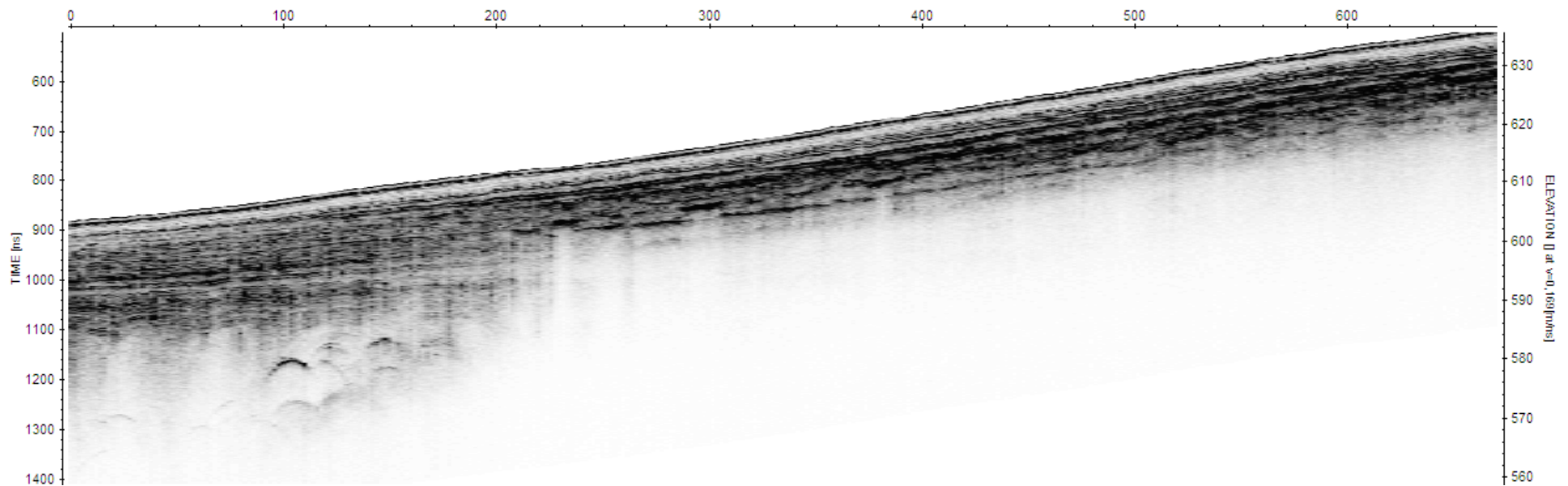


# Even Closer



## Profile E – Transition between SI and Firn

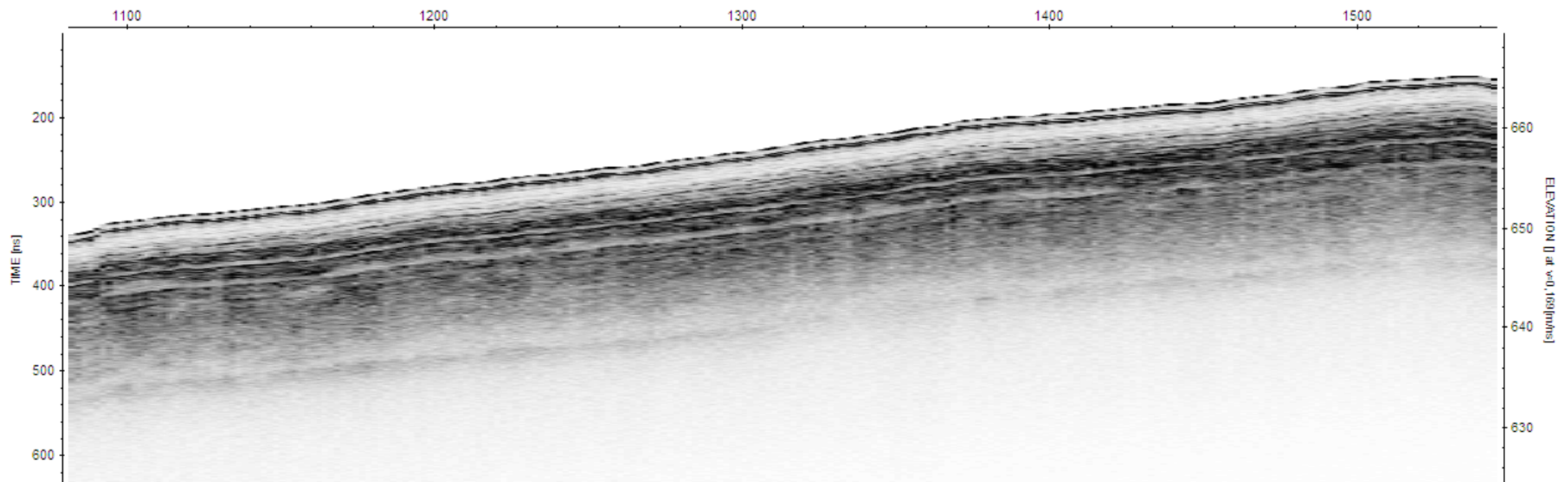
- Despite similar appearance in radar, drilling show that the layers are ice to the left and alternating layers of firn and ice to the right.





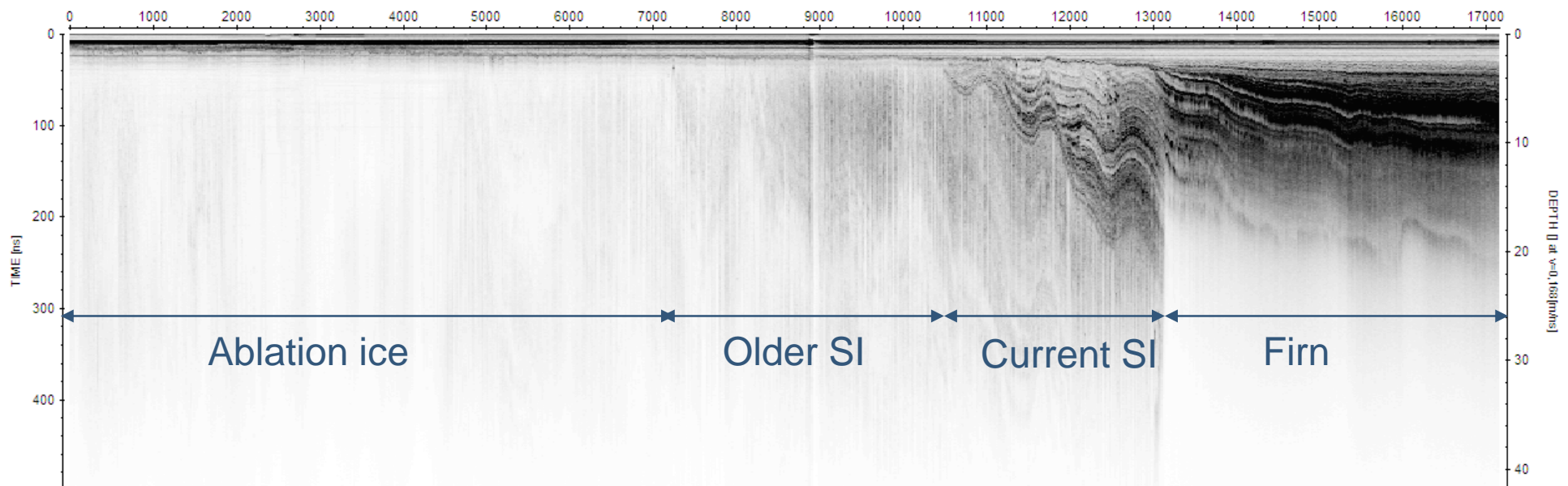
## Profile F – Firn Area

- Ice layers are thinner and less continuous, and there are thicker layers of firn.
- At about 20-25 m depth (200-250 ns) a bright reflector signals the transition to firn and ice which are at the melting point.
- Here the firn likely contains significant quantity of water, extinguishing any reflectors below.

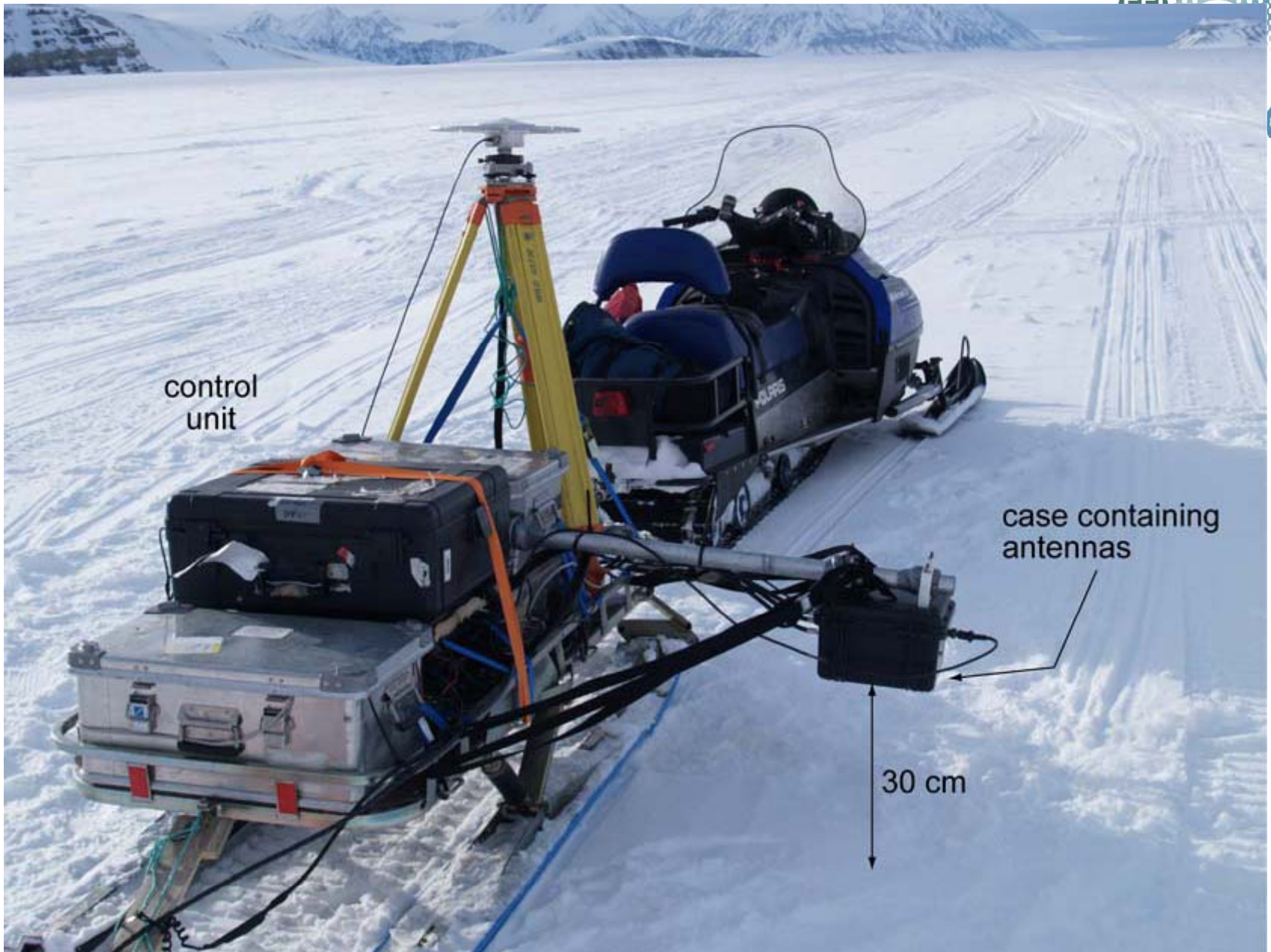




# Dividing the Profile into Zones





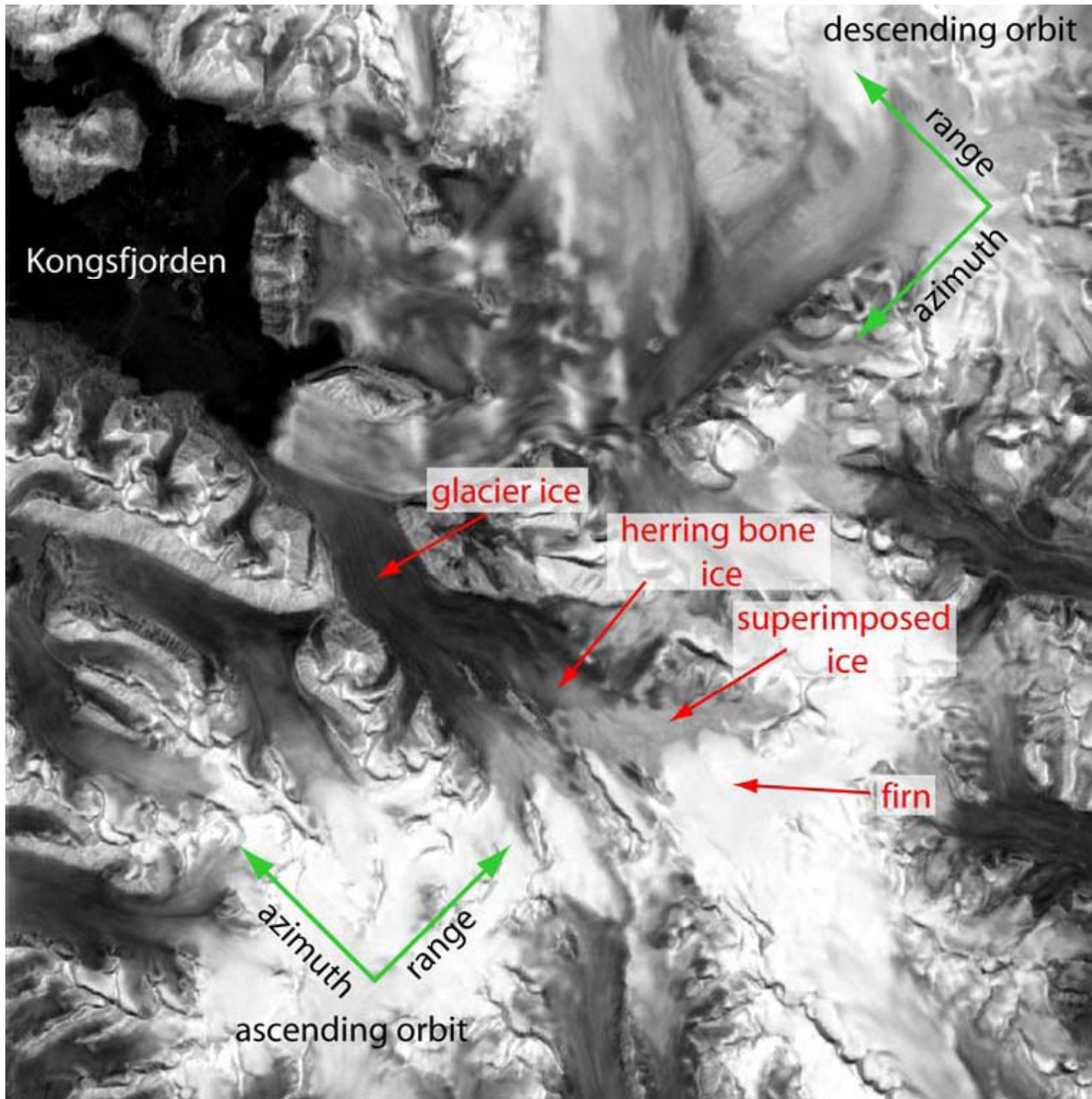


control  
unit

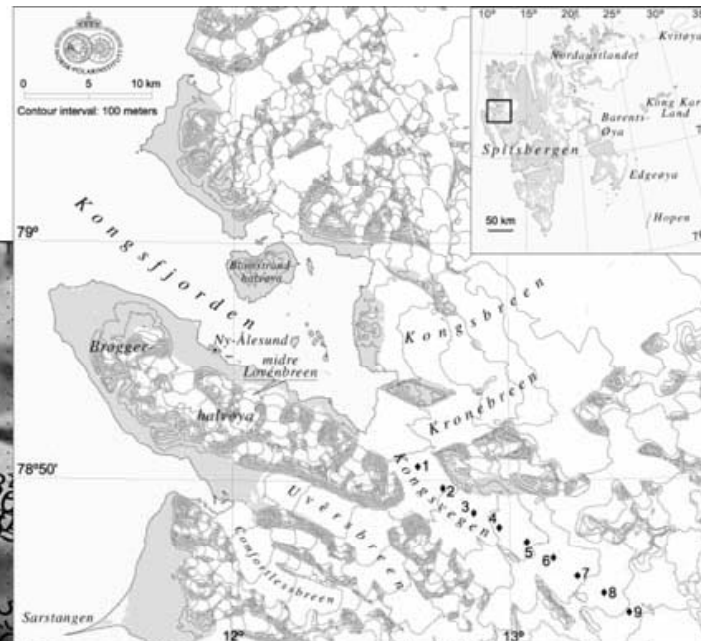
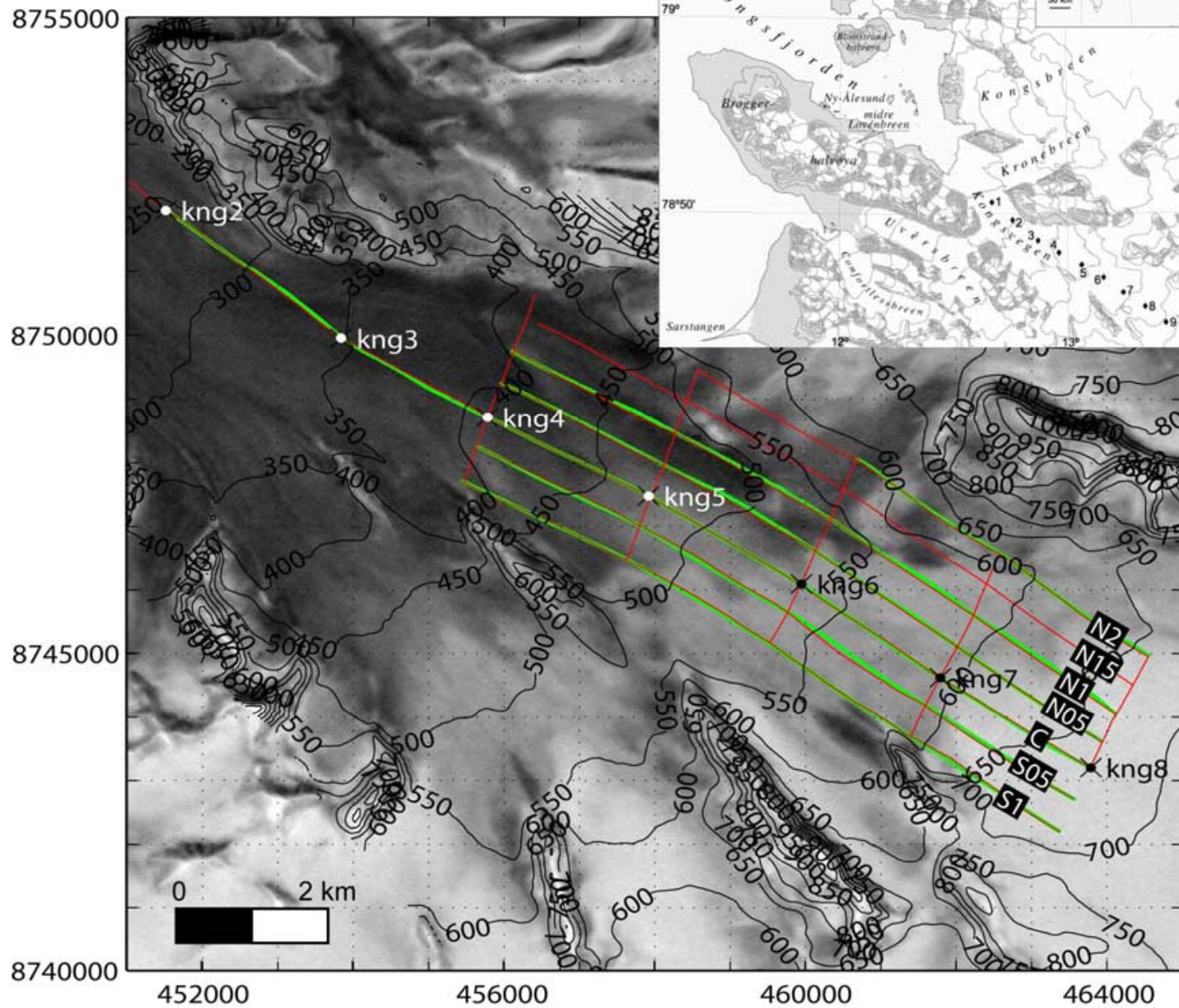
case containing  
antennas

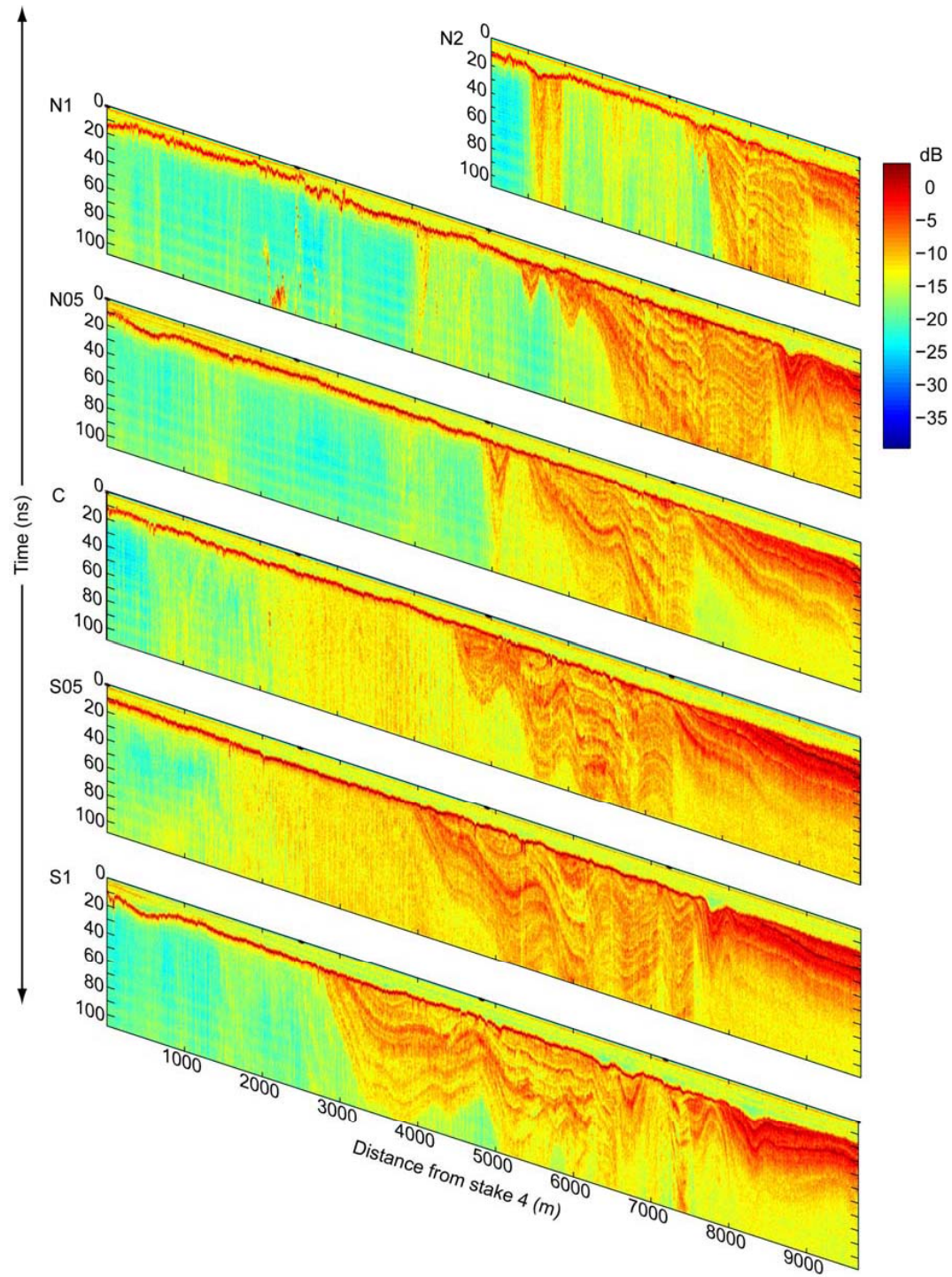
30 cm







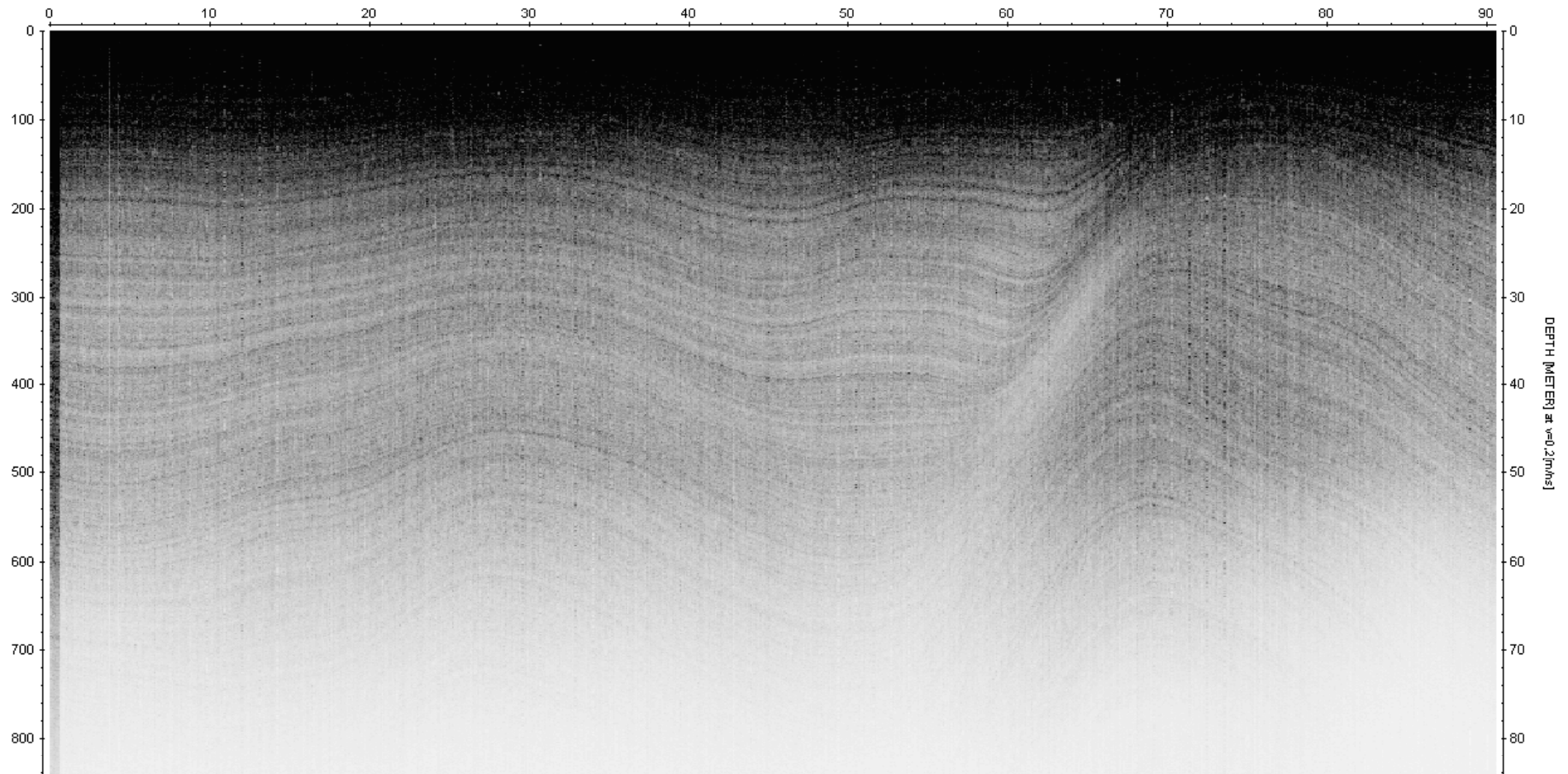




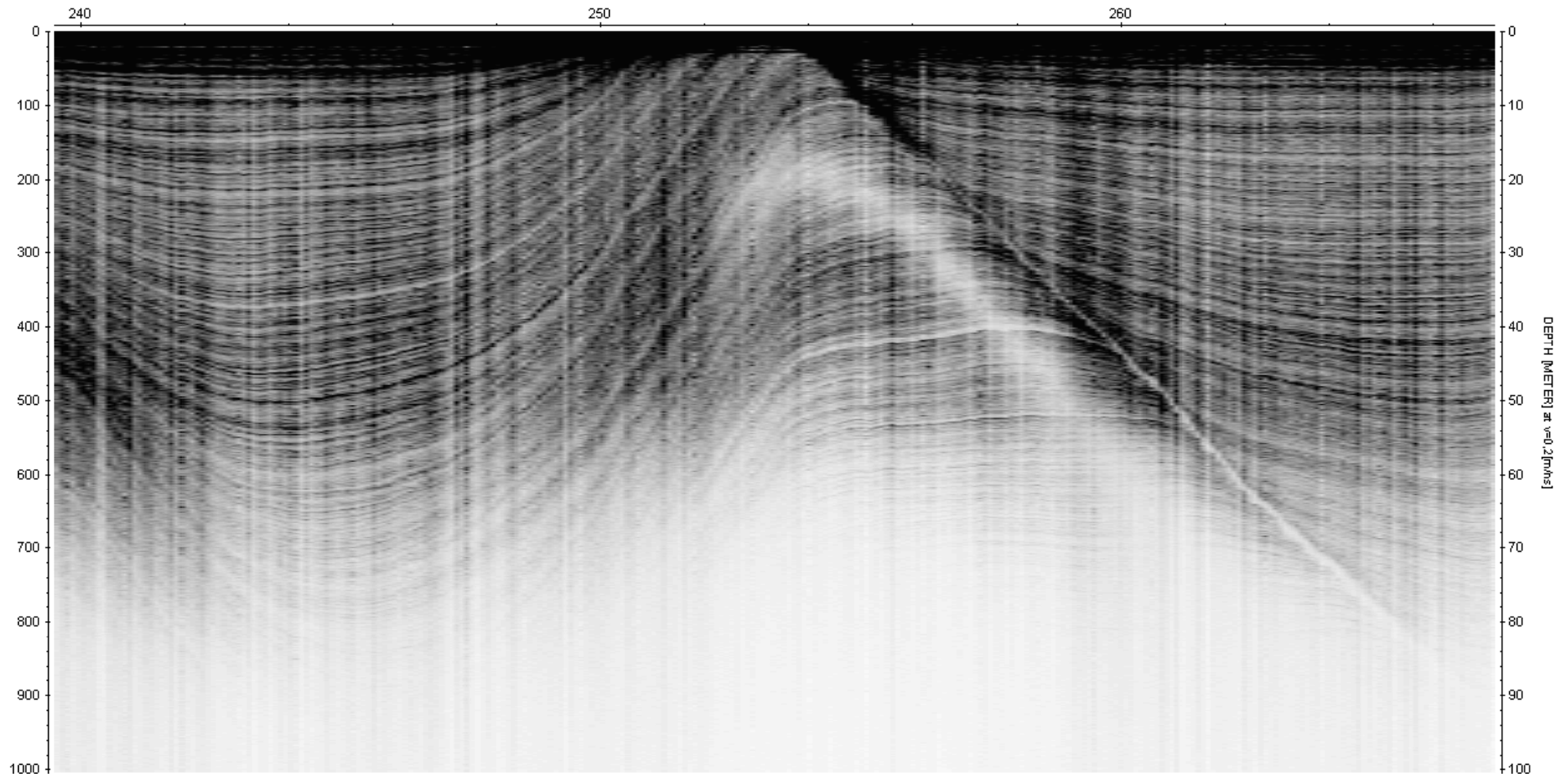




# Example 1 – Antarctica

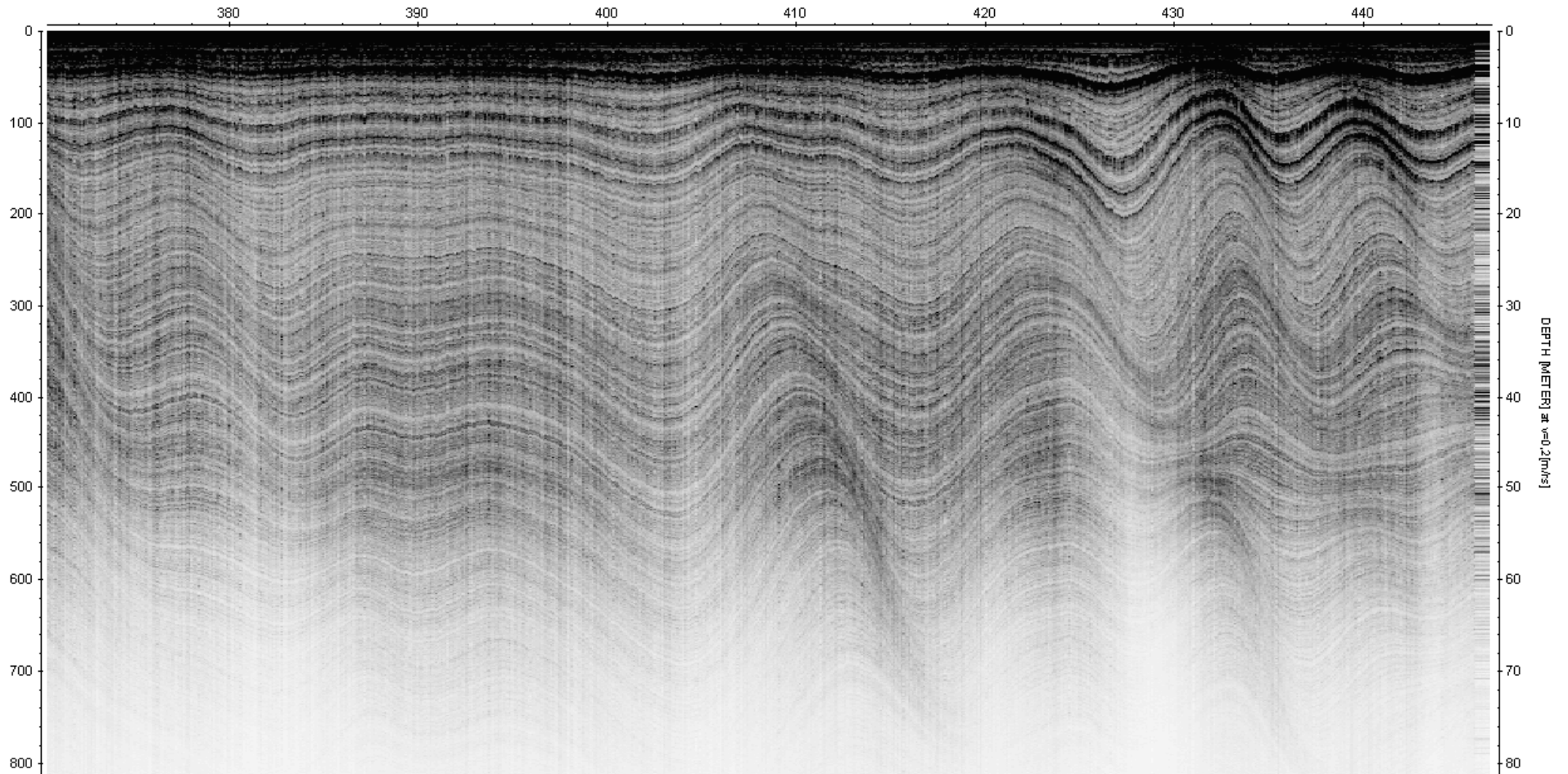


# Example 2 – Antarctica

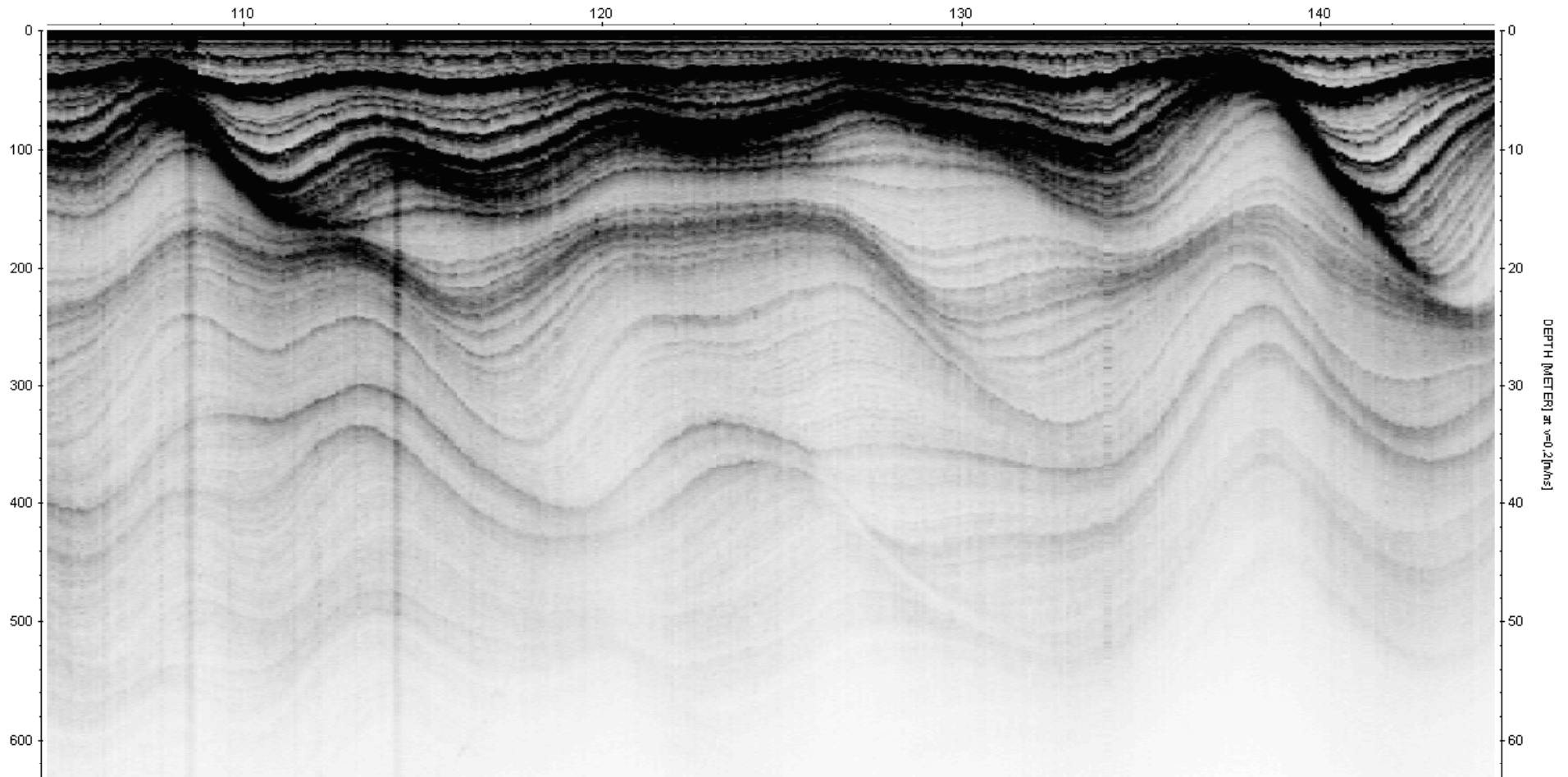




# Example 3 – Antarctica

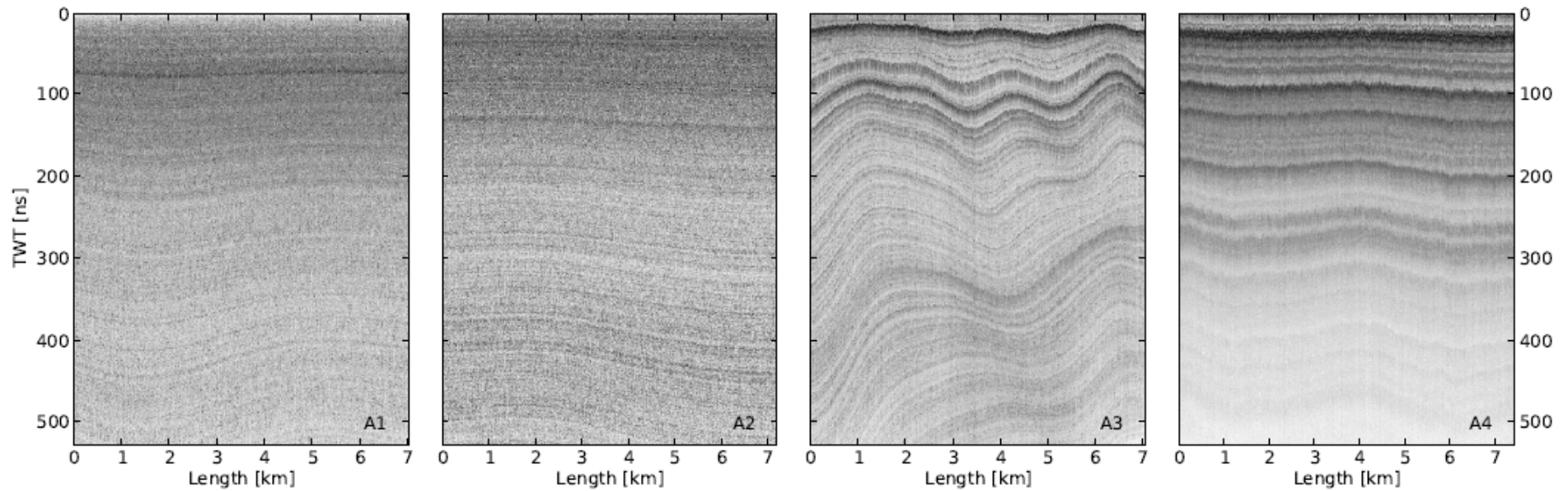


# Example 4 – Antarctica

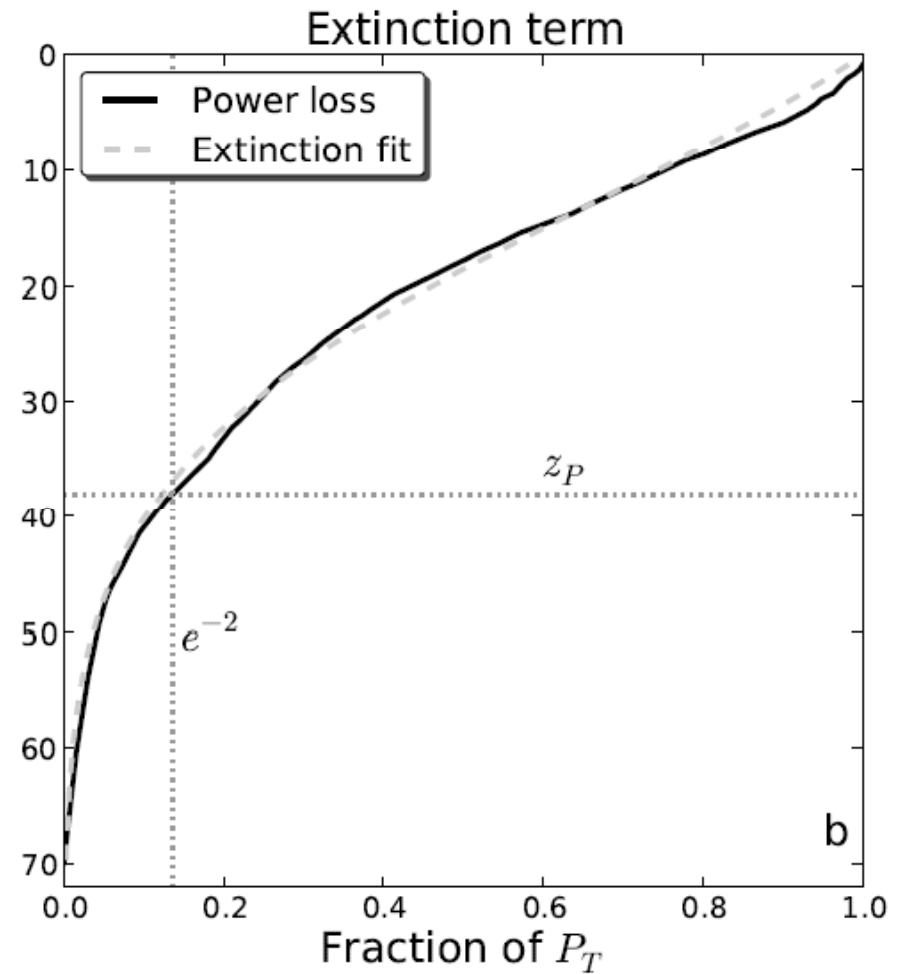
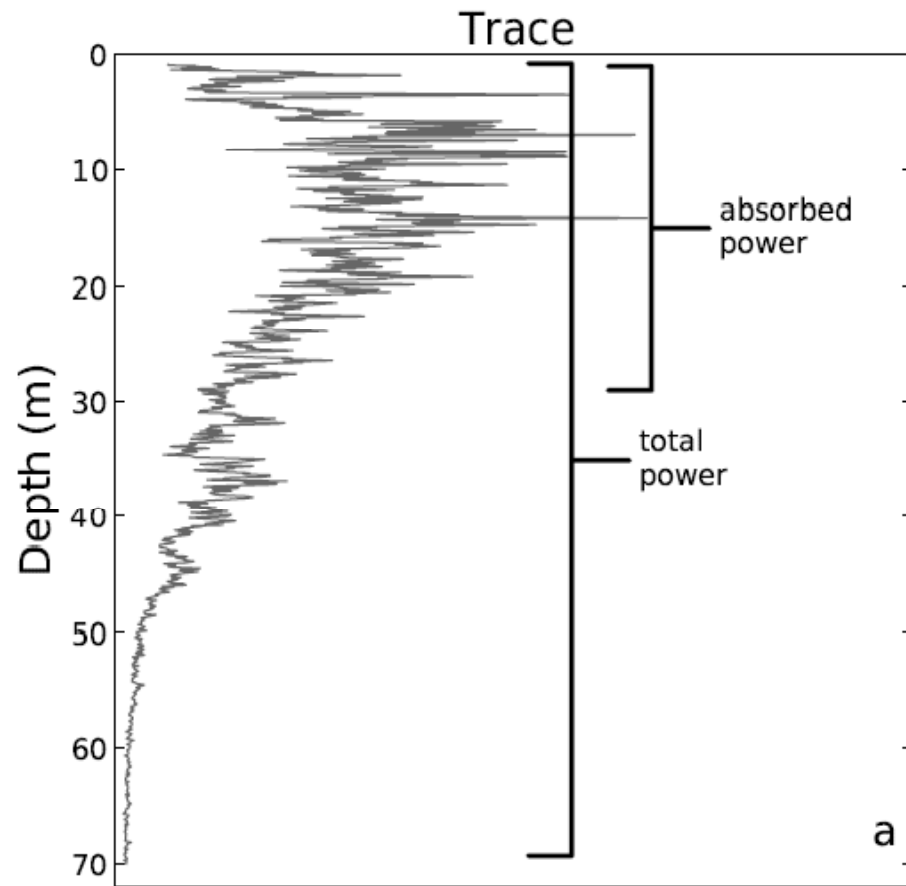




# Penetration studies (from Müller et al)



# Extinction



# Phase Center

