A seismic investigation of the subglacial environment along Thwaites Glacier, West Antarctica

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QuickTime™ and a decompressor are needed to see this picture.

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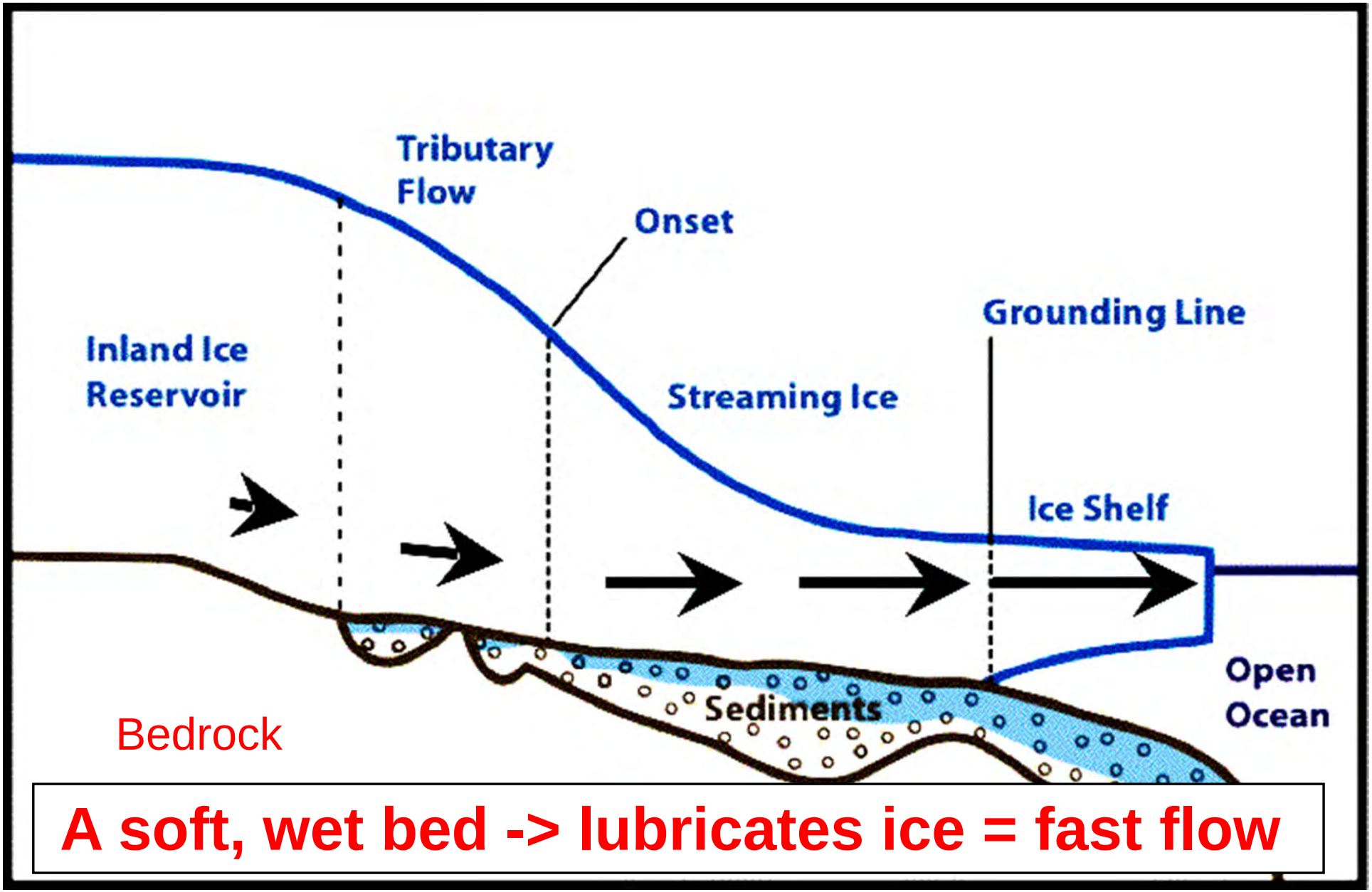
[2]Antarctic Research Center, VUW
[3]UTIG, University of Texas
[4]University of Kansas
[5]CReSIS

CReSIS
Center for Remote Sensing of Ice Sheets

Observations of the Subglacial Environment

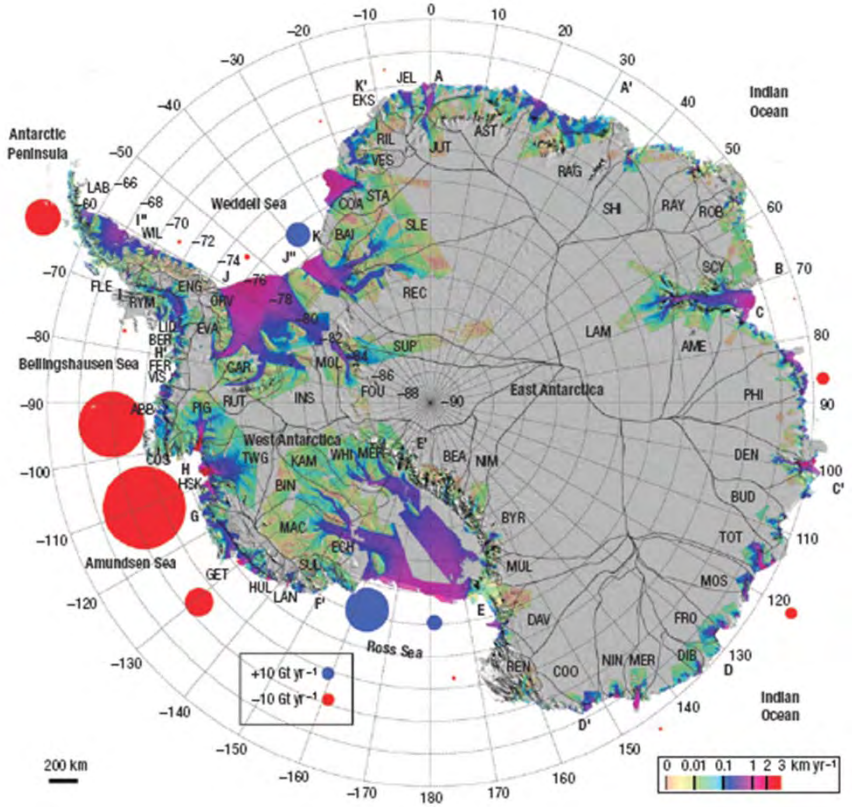


A soft, wet bed -> lubricates ice = fast flow

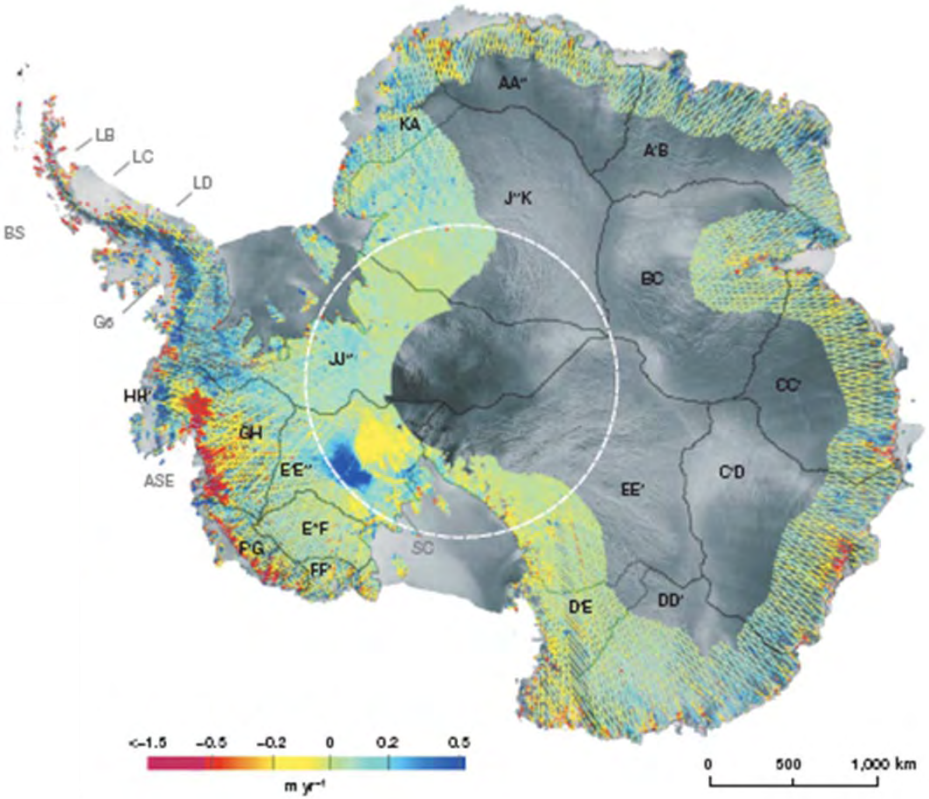
Outline

- Overview of the Amundsen Sea Embayment (ASE)
  - Where & Why
- Active seismic data
  - What we collected
- Amplitude analysis of the ice bottom reflection
  - How we interpret the data
- Results & Interpretations
  - Preliminary analysis
- Future Directions
  - Where we are headed

Changes in the ASE

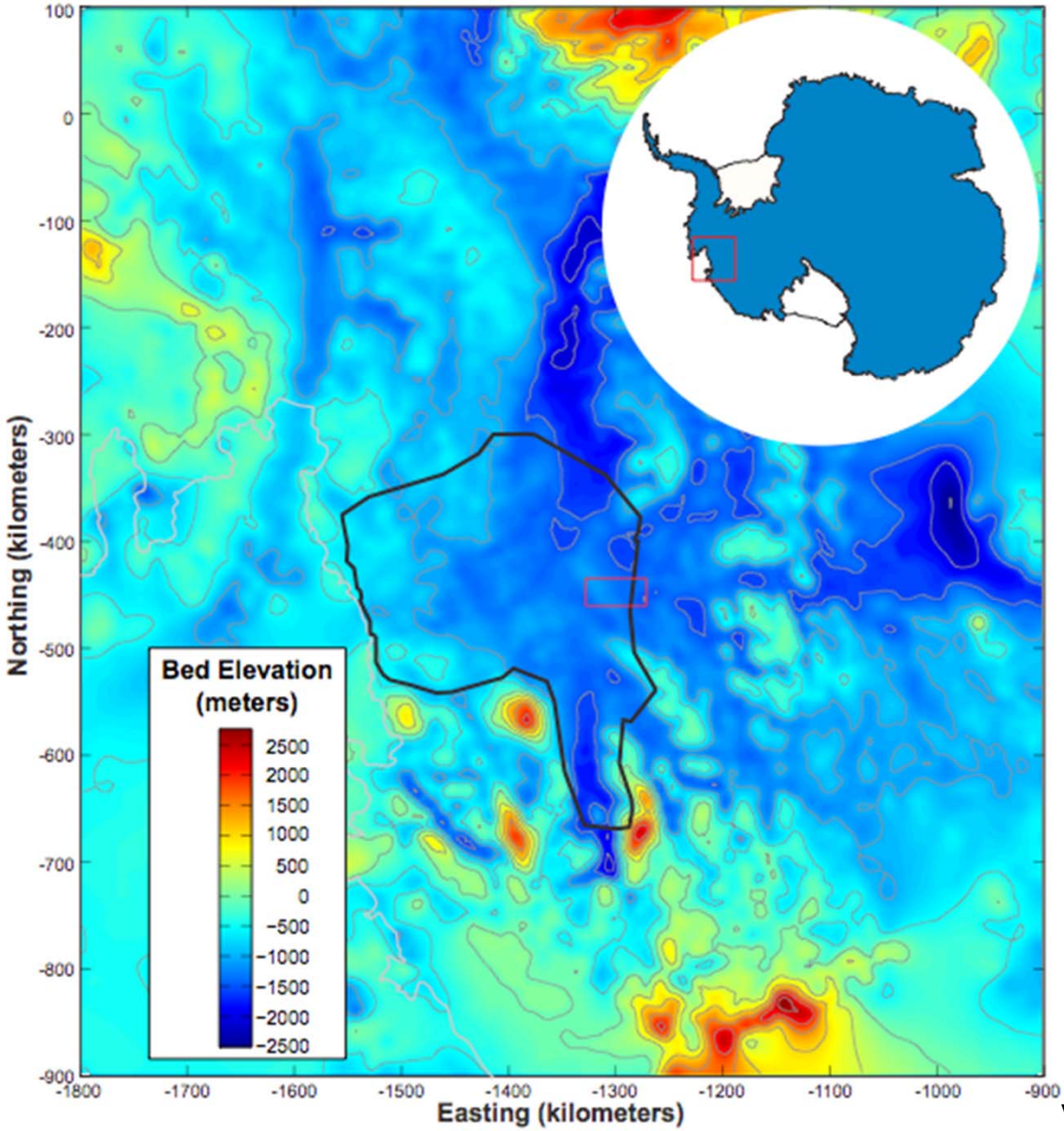


Rignot et al. (2008)



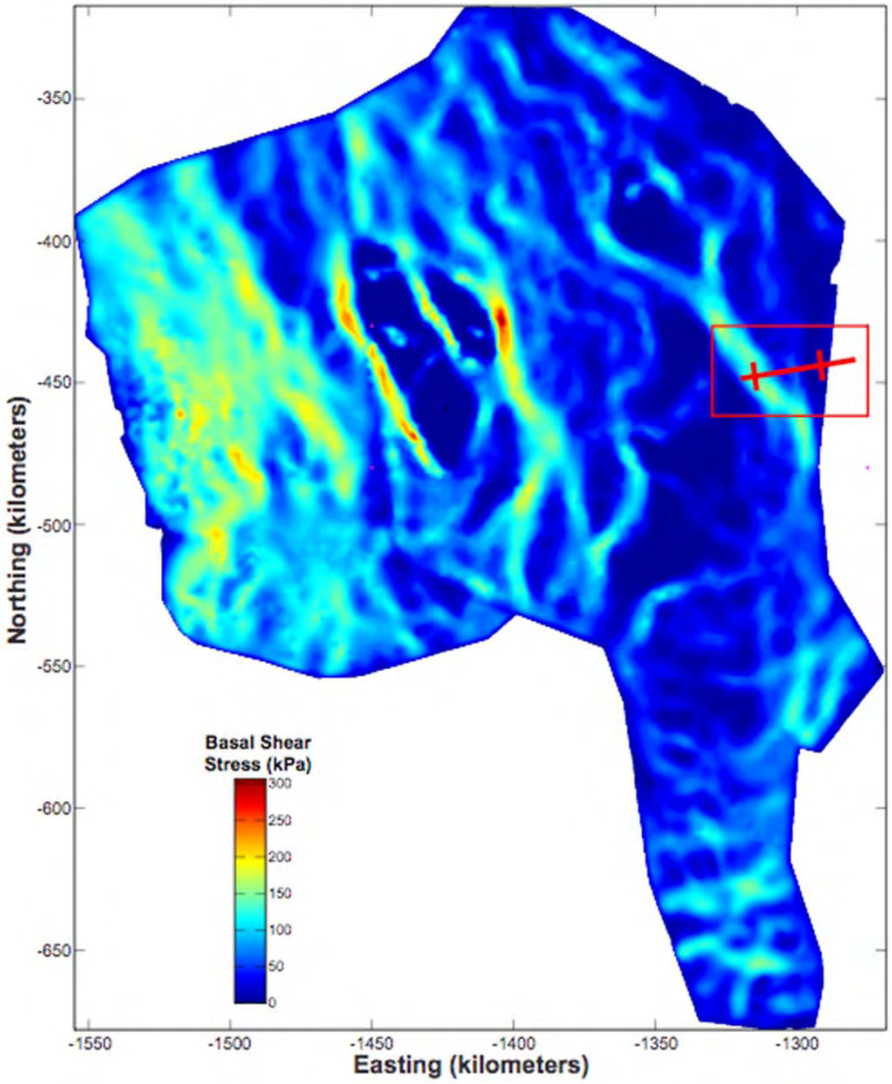
Pritchard et al. (2009)

Bed Elevations in the ASE



Holt et al. (2006)
Vaughan et al. (2006)

Basal Shear Stress along Thwaites Glacier (TG)



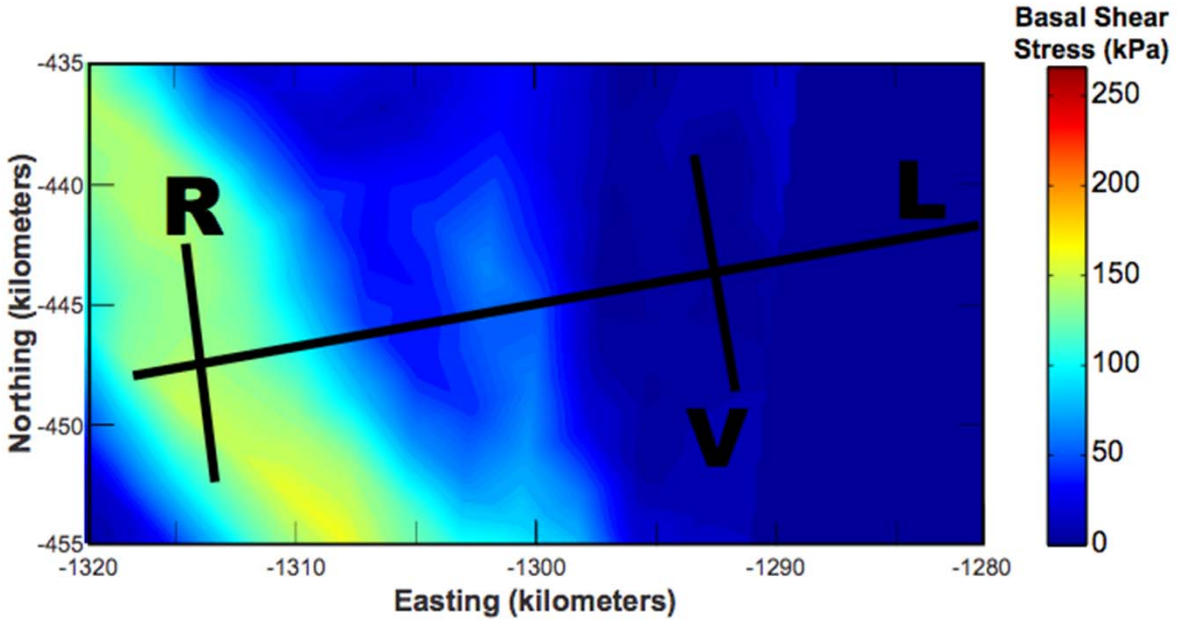
Joughin et al. (2009)

Seismic Data Collection

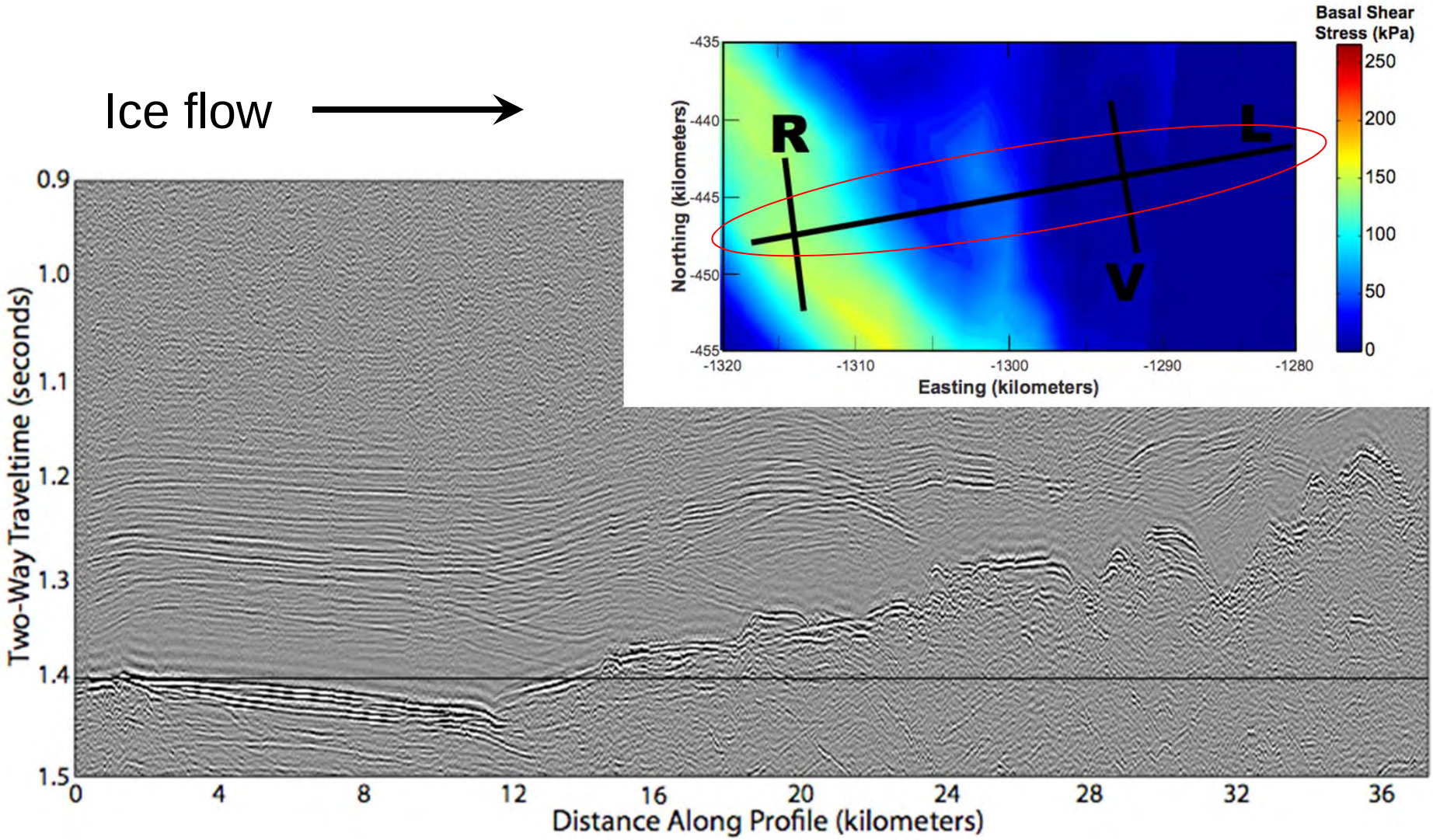
- 60km collected in 2008/09
  - Along Flow - L (40km)
  - Across Flow - V (10km), R (10km)
- 4 to 8 fold data collected
- Incidence angles from 0 - >45°

Basal Shear Stress

Joughin et al. (2009)

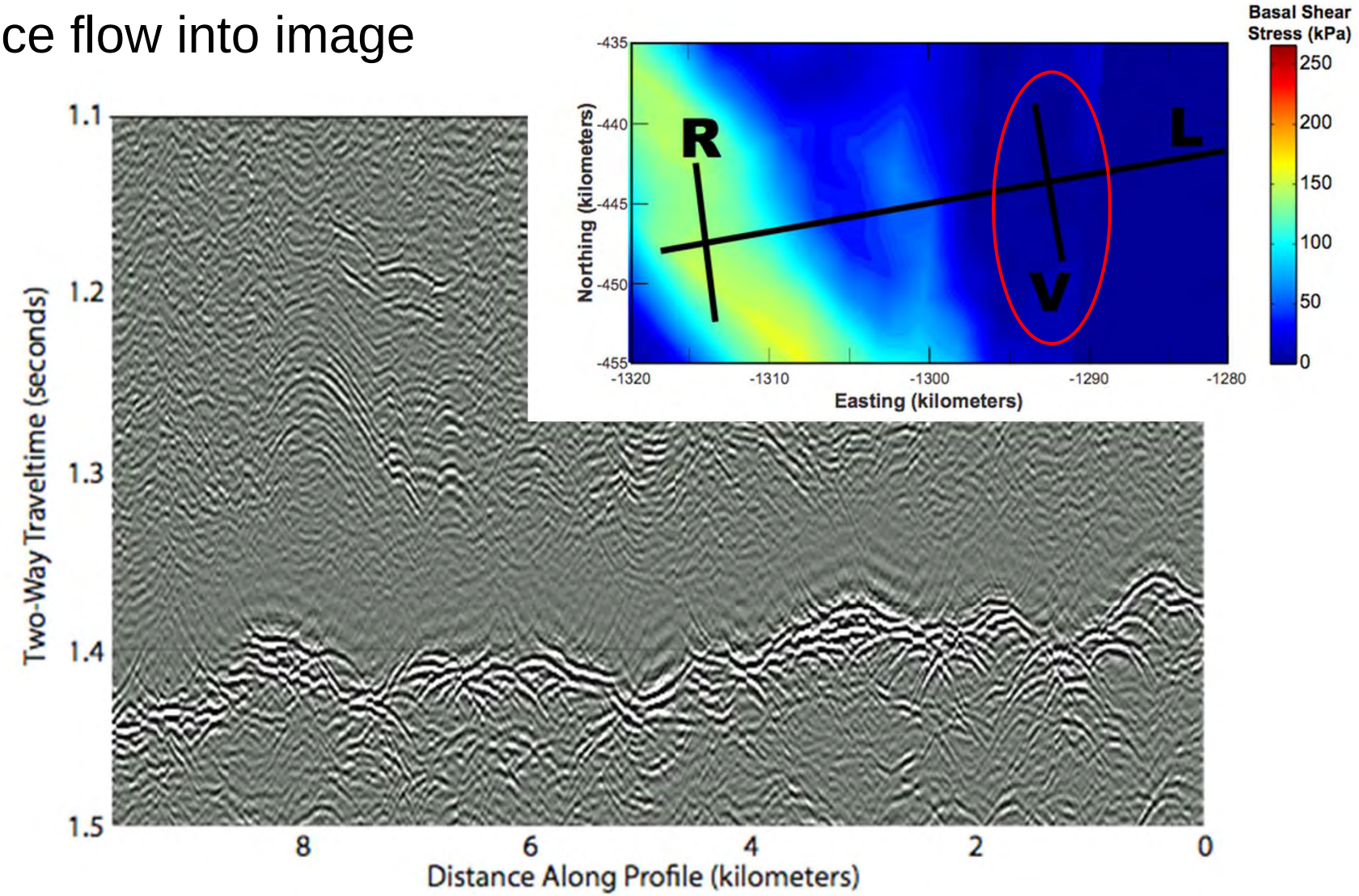


L Line - Seismic Data



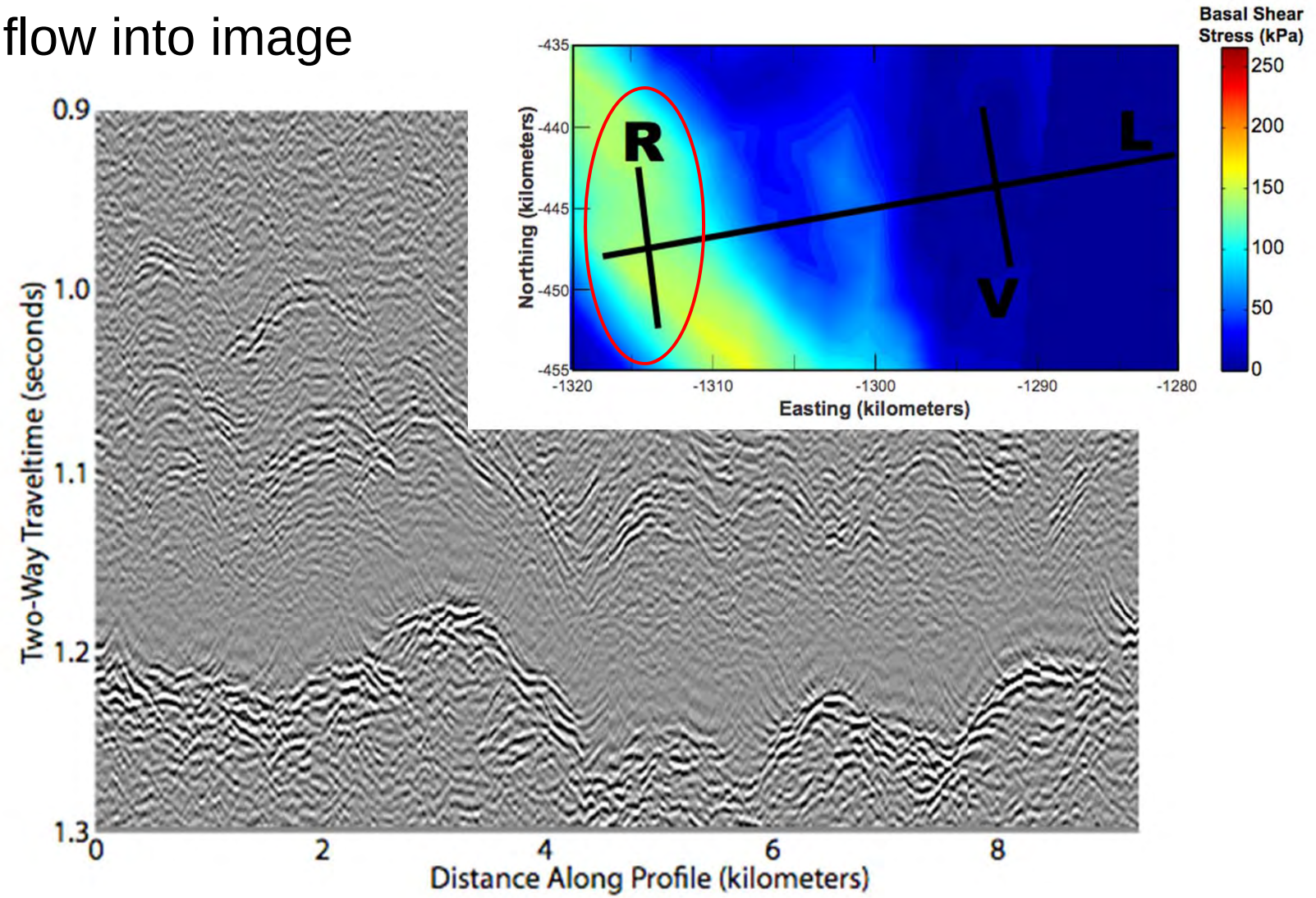
V Line - Seismic Data

Ice flow into image



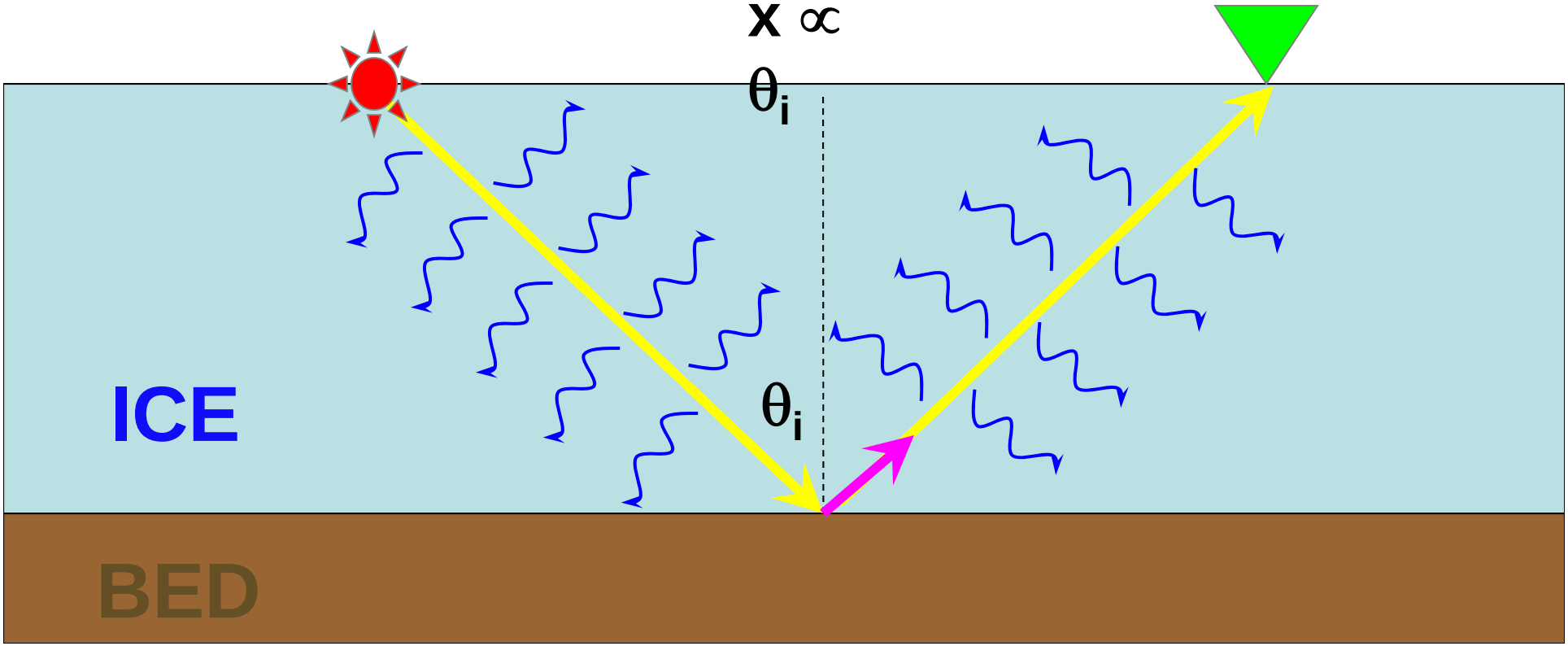
R Line - Seismic Data

Ice flow into image

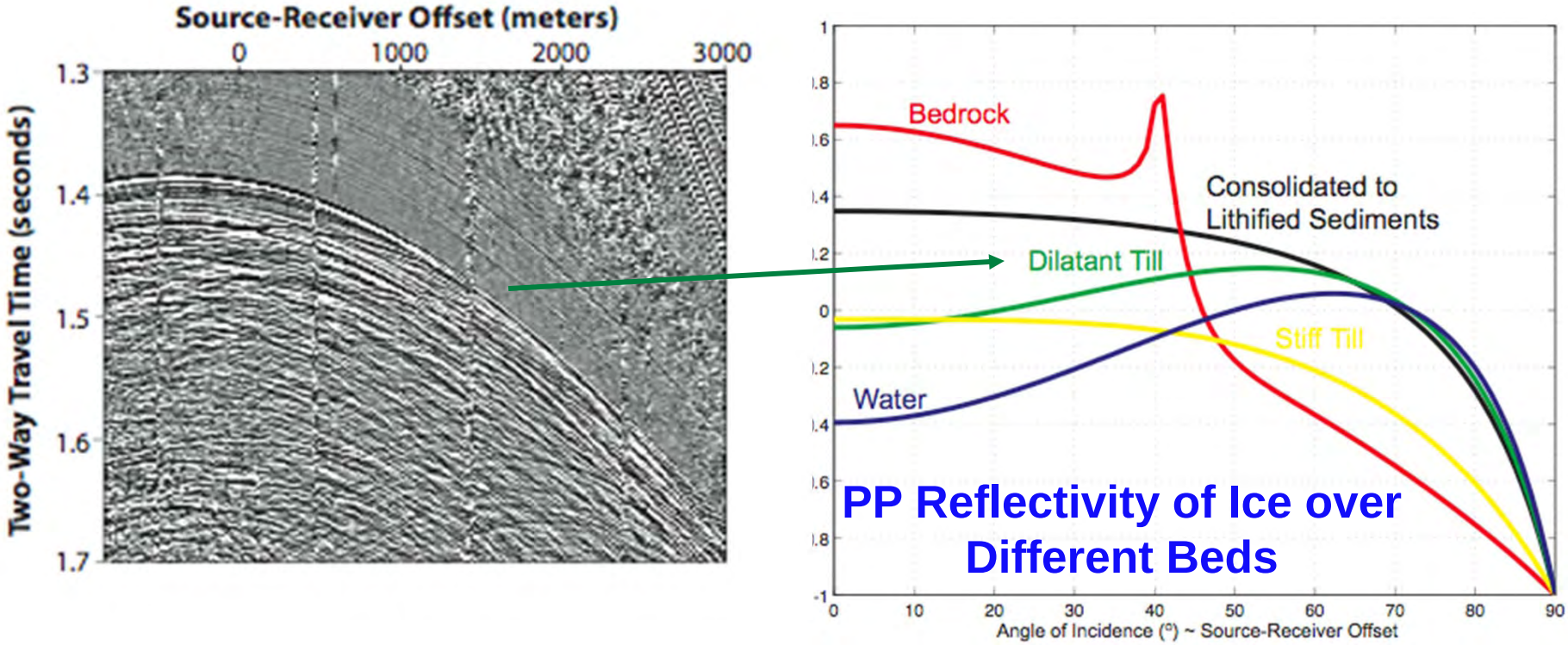


Amplitude Analysis of the Ice Bottom Reflection - I

$$A_{observed}(\theta_i) = A_0 R(\theta_i) \gamma(\theta_i) e^{-a\, r(\theta_i)}$$

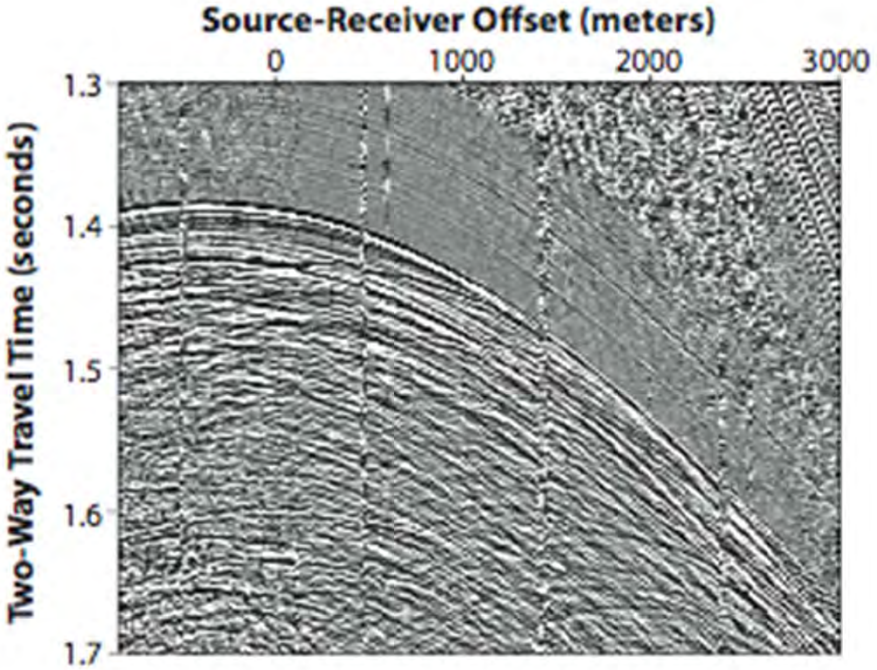


Amplitude Analysis of the Ice Bottom Reflection

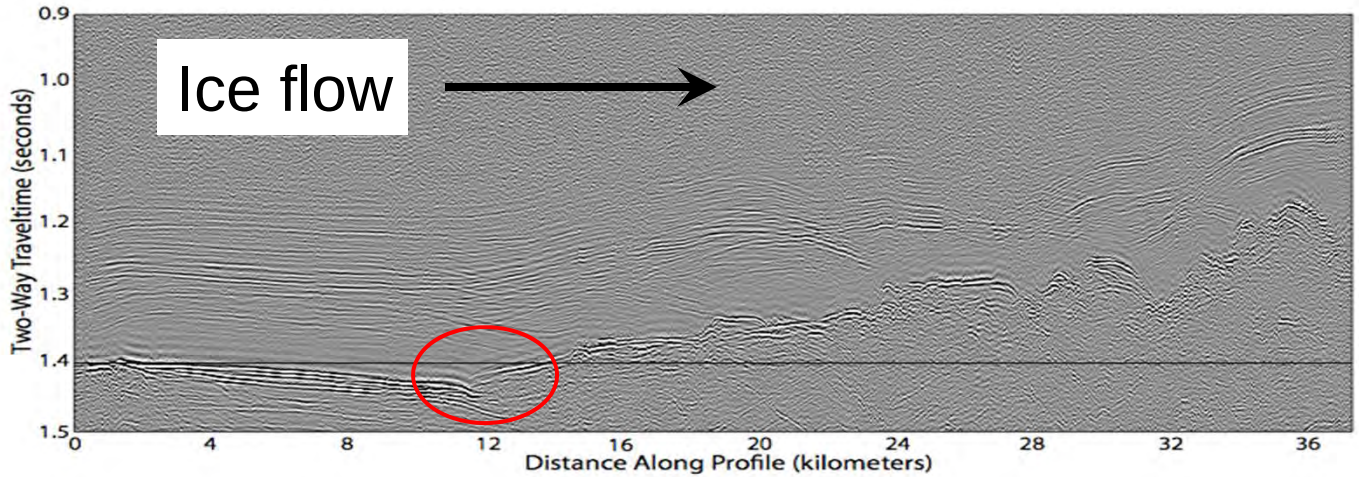


Phase and magnitude of the ice bottom reflection over a range of o
yields basal lithology and water content

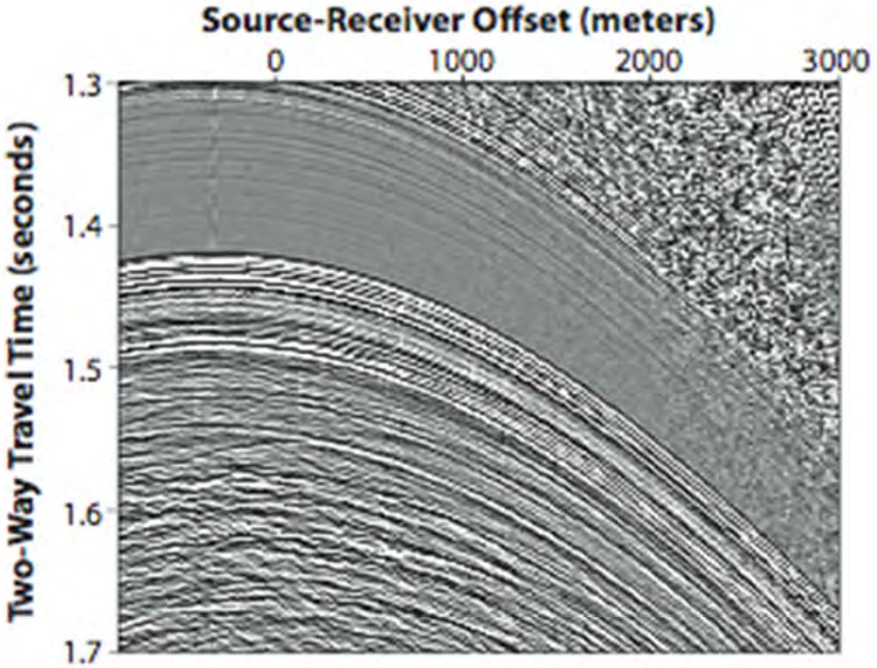
Dilatant Till at the Bed



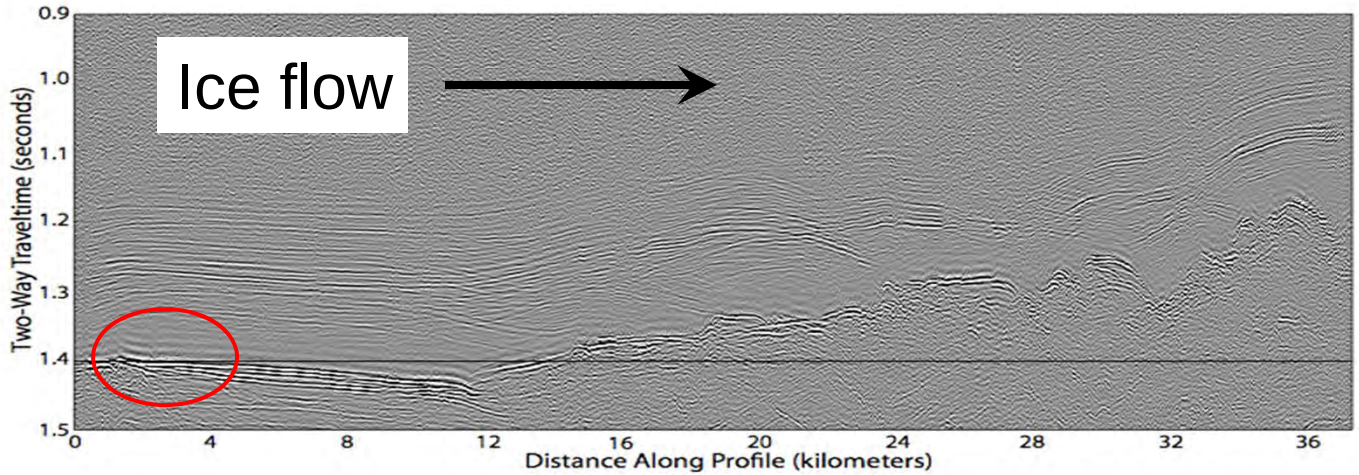
- Reflection w/ negative phase at near offsets & positive phase at far offsets
- Largely observed in topographic lows and upglacier sides of basal highs



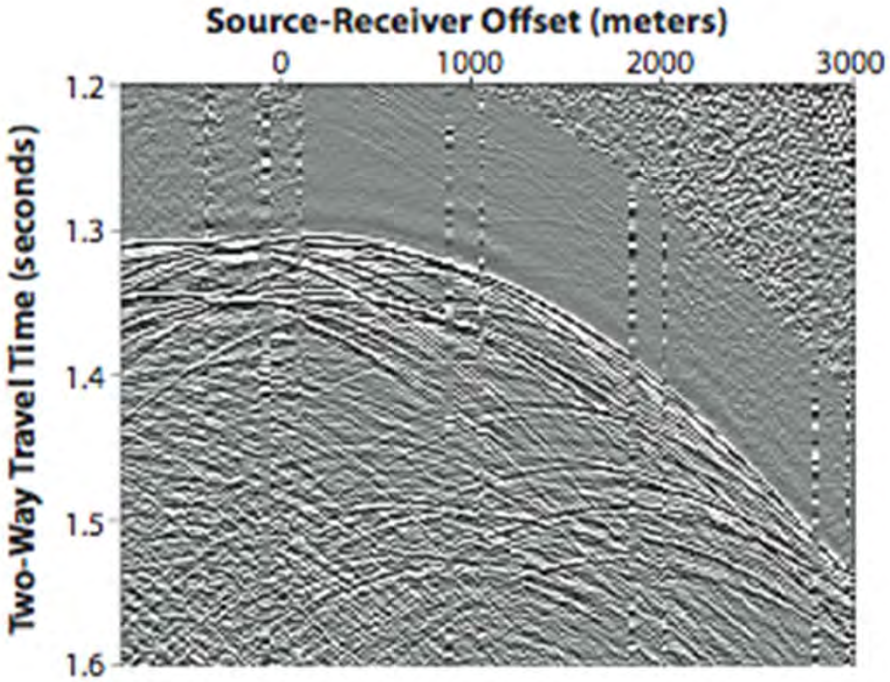
Stiff Till at the Bed



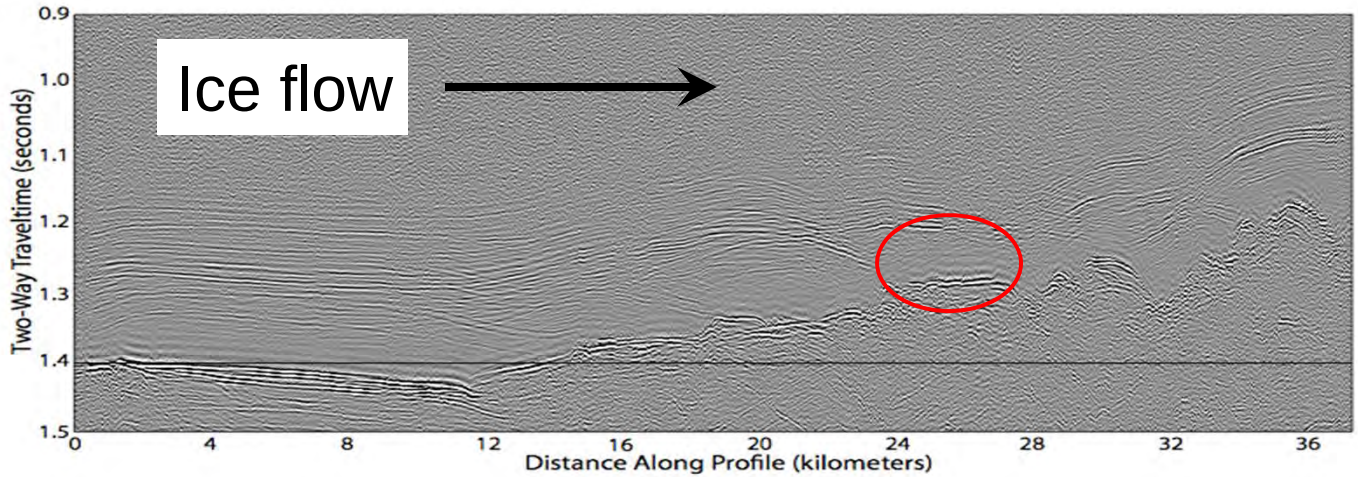
- Reflection w/ negative phase at near offsets that becomes increasingly negative at far offsets
- Largely observed in flat basal region of L profile



A Hard Sediment Bed

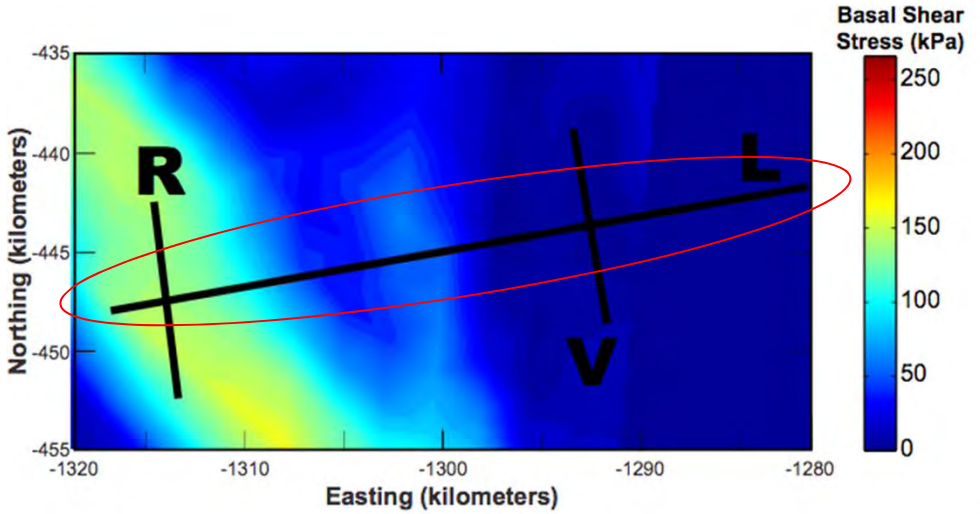


- Reflection w/ positive phase at near offsets that remains positive at far offsets
- Largely observed on the basal highs



L Line - Basal Interpretations

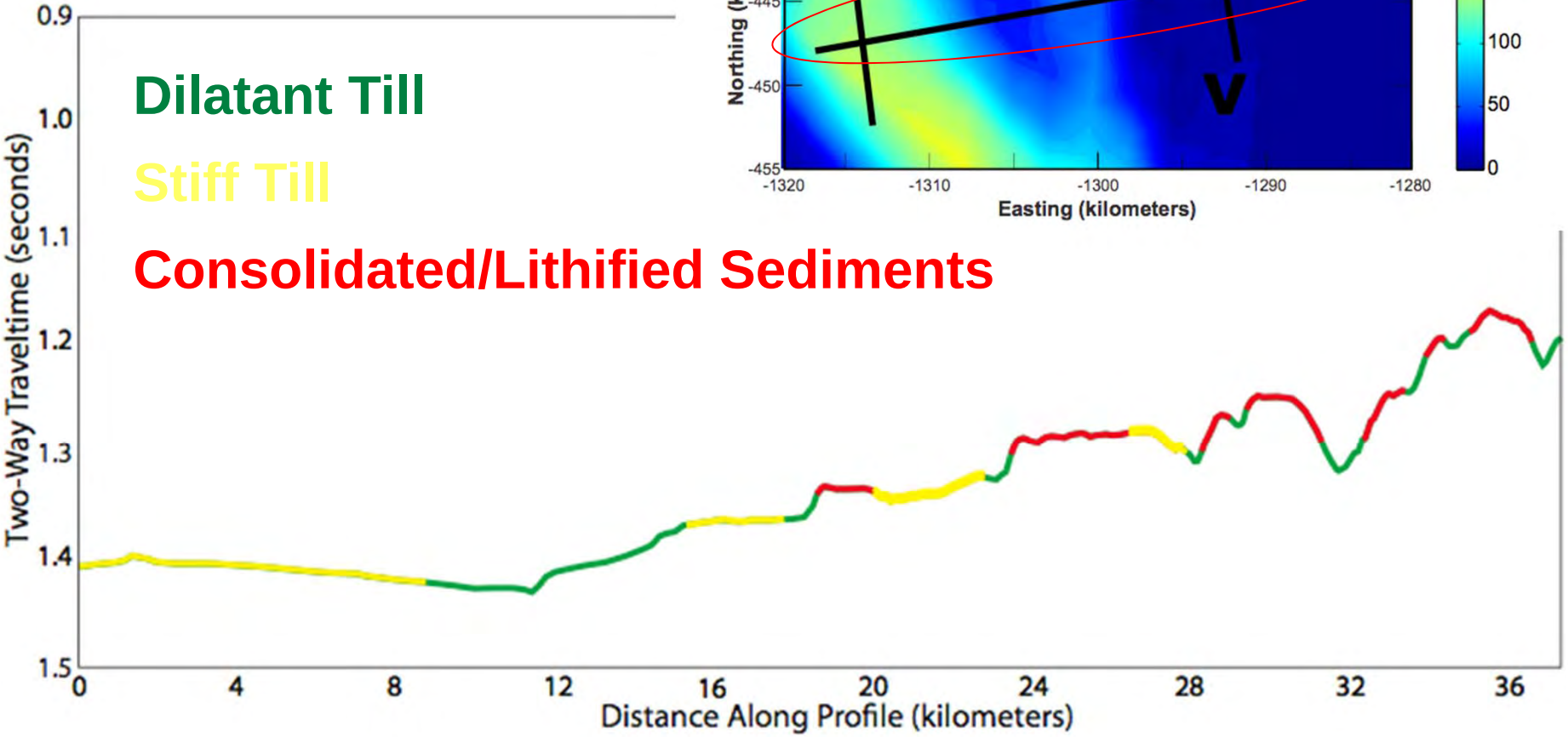
Ice flow



Dilatant Till

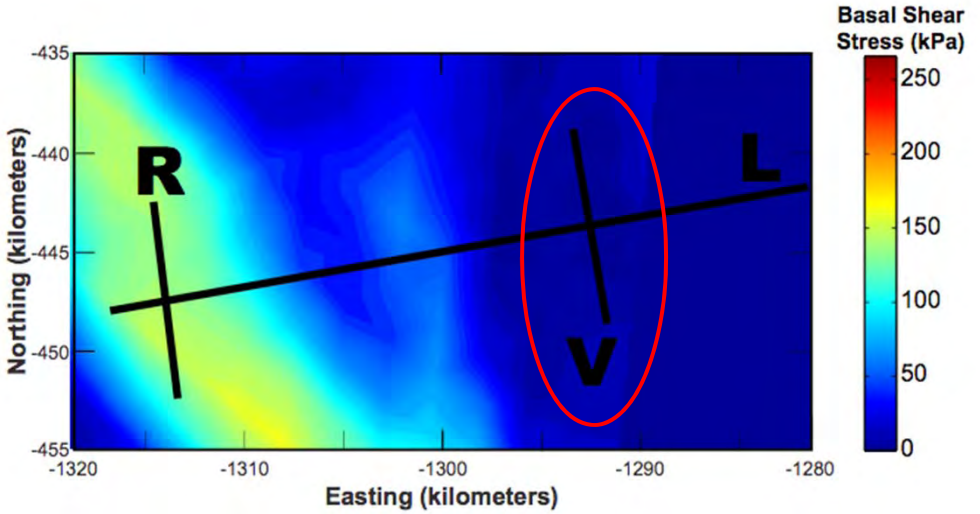
Stiff Till

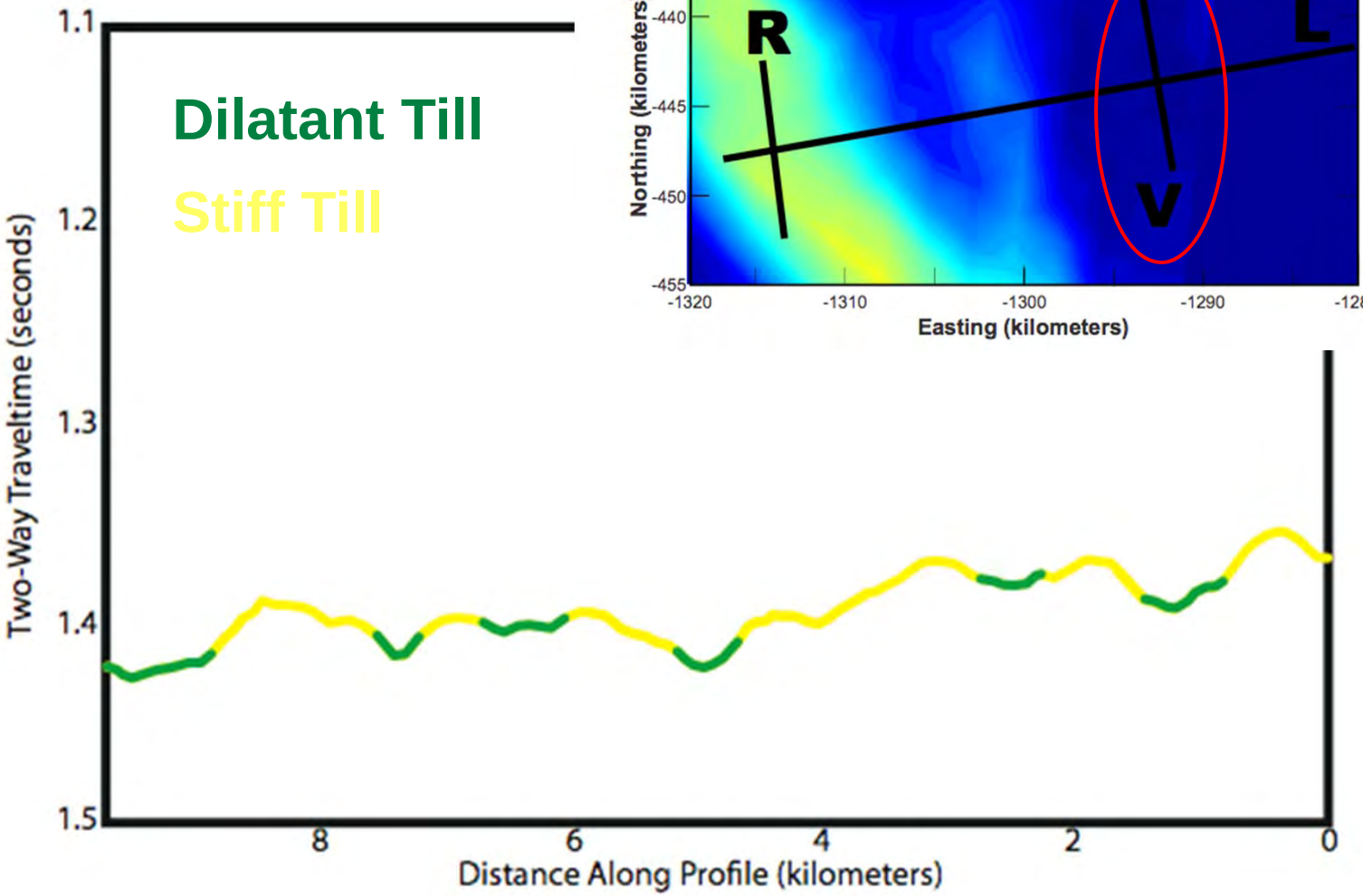
Consolidated/Lithified Sediments



V Line - Basal Interpretations

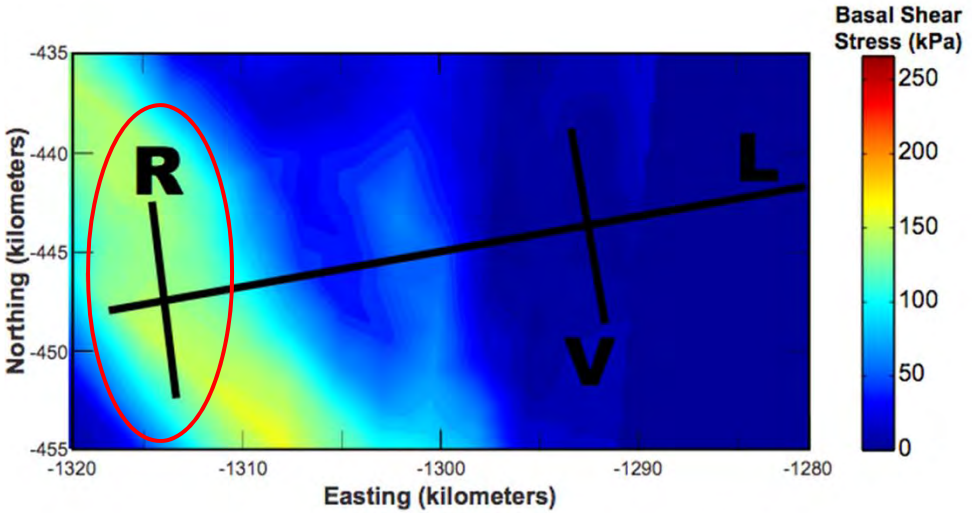
Ice flow into image

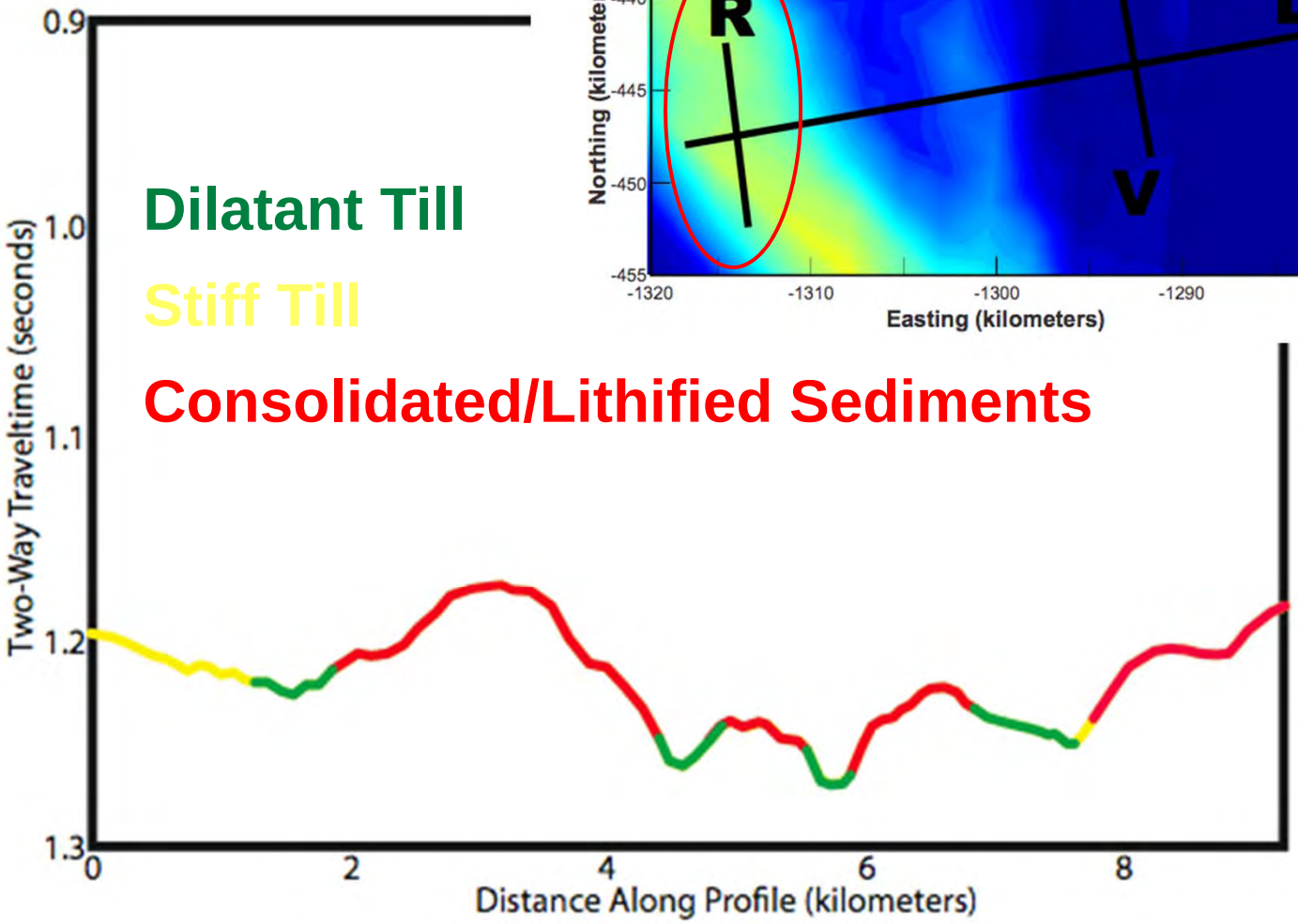




R Line - Basal Interpretations

Ice flow into image





Future Work

- Finalize seismic processing of the three profiles to delineate the thickness of the basal environment and any shallow structures that may dictate basal morphology

- Correlate these observations with coincident ground-based and airborne radar data to fully characterize the subglacial environment of Thwaites Glacier - more on this at AGU

Summary

- Variable basal conditions along Thwaites Glacier on the kilometer-scale
  - Dilatant till to lithified sediments/bedrock
  - Basal lithology does not always correspond to basal shear stress calculations
  - Wet basal conditions present throughout

- Work to be done …
  - Thorough analysis of the subglacial environment, its thickness, and spatial (dis)continuity
  - Correlation to radar reflectivity for glacier-scale analysis of the subglacial environment of Thwaites Glacier