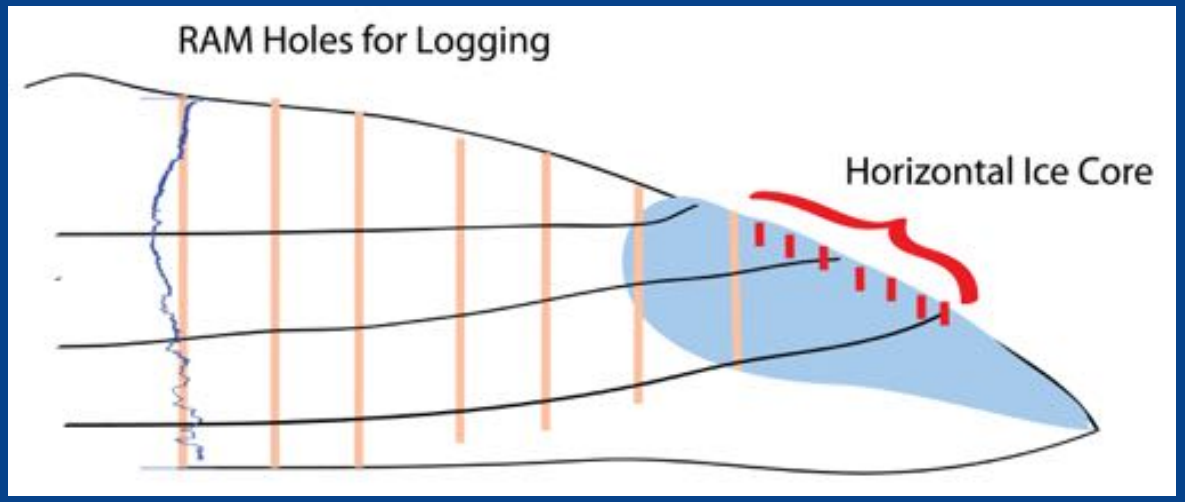
Extending observations of climate history and ice dynamics using borehole logging and a rapid access drill.



Erin Pettit
University of Alaska Fairbanks
IPDO Community Meeting

Key Points

1. Physical properties of ice are important for modeling ice sheet flow – especially temperature and fabric

2. Still many questions about ice dynamics – this feeds models and helps interpret climate and ice sheet history

3. Logging has potential to provide a broader regional context for ice cores, including providing

   - dating constraints for "horizontal ice cores", searching for new core sites
   - dynamic context for ice core interpretation such as at Siple Dome and WAIS

4. Future science? Cross borehole radar and seismics to understand 10cm-100m scale features. (may need bigger holes)

Rapid Access Drill - ~5cm holes

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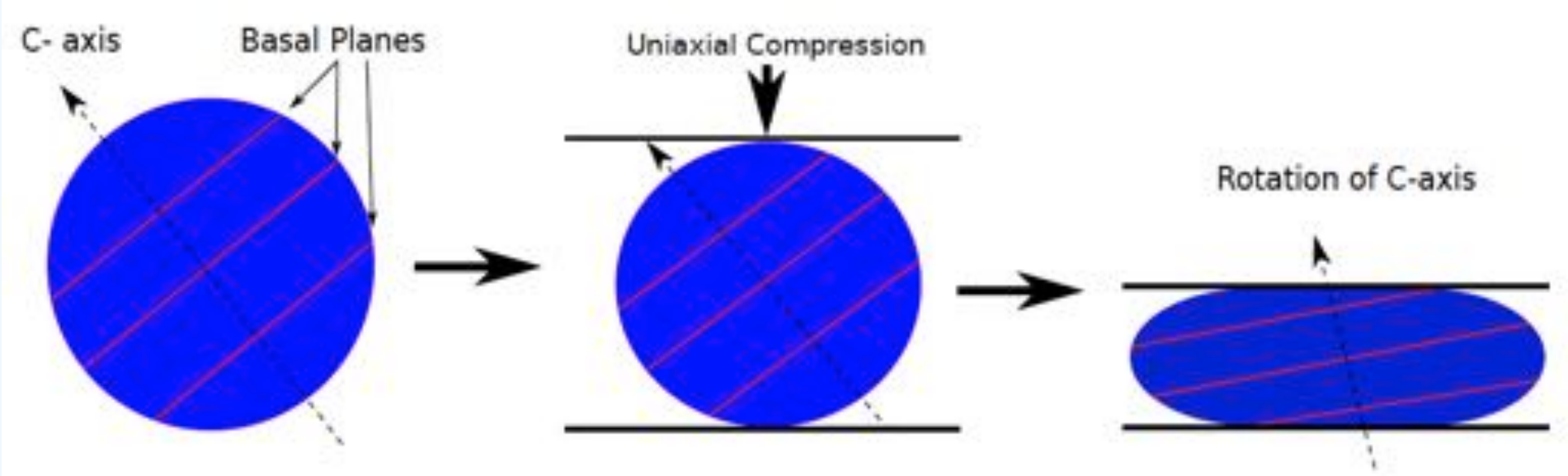
about Crystal Anisotropy

Ice crystals have a preferred deformation direction



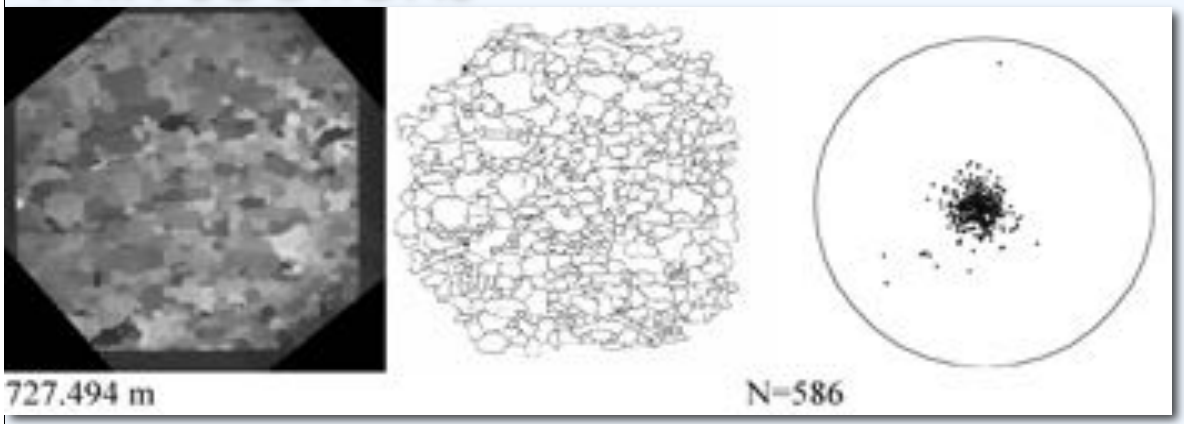
In the central regions of ice sheets,
crystals tend to rotate such that their c-axes are near vertical

Siple Dome Thin Section (Diprinzio and others, 2005)

This results in a
"single maximum fabric"

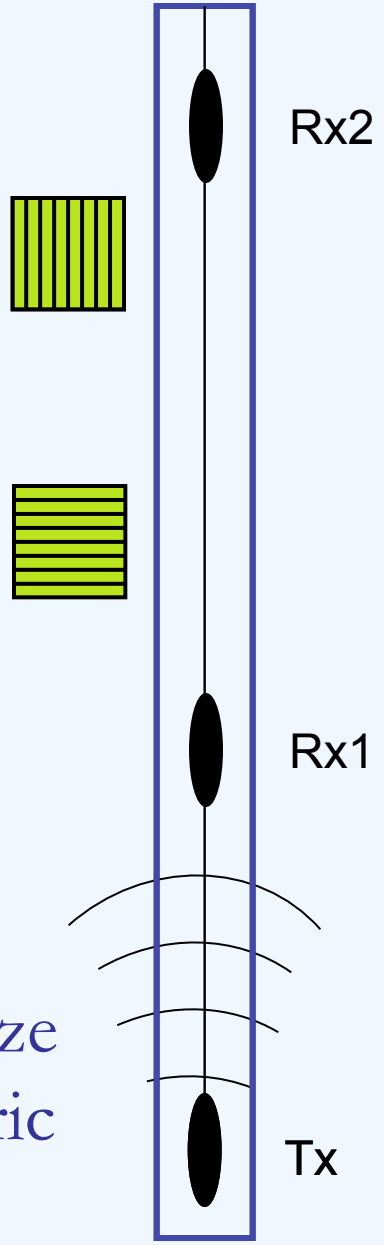
measuring Crystal Anisotropy

Thin sections



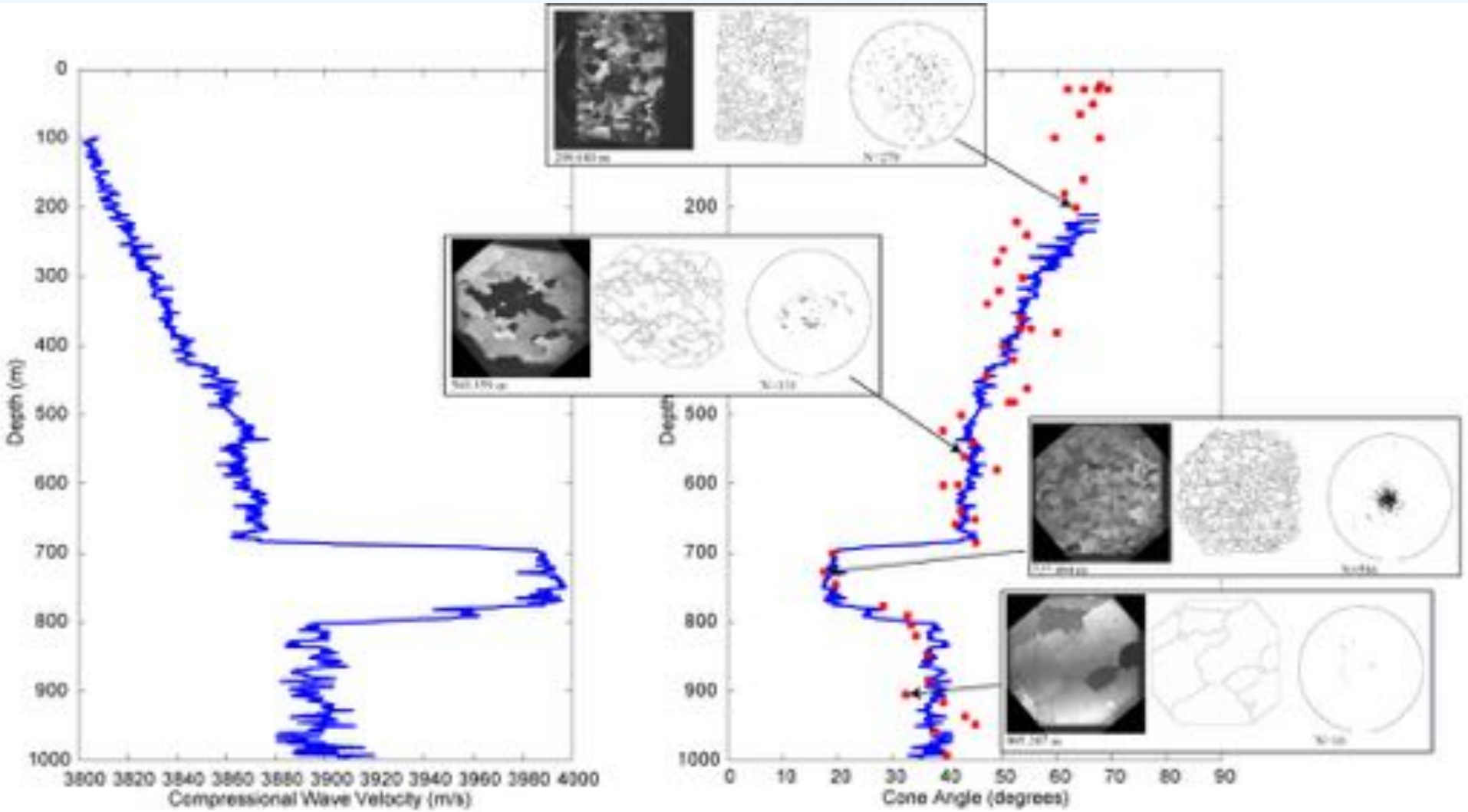
Siple Dome Thin Section (Diprinzio and others, 2005)

Small sample size
Time consuming
Captures all fabric patterns



Large sample size
Best for single maximum fabric

Siple Dome Sonic Log



1. borehole sonic velocity contains information about **ice fabric**, which can give us clues to ice sheet deformation

Summary: Physical Properties

1. Physical properties of ice are important for modeling ice sheet flow – especially temperature and fabric

Note: Recent results from Robin Bell (radar) and Huw Horgan (seismic) suggest large scale variability in ice properties and folding.

Logging tools

Temperature: Temp Logger (USGS, Gary Clow)
Fabric: Sonic Logger (UW and UAF)
Dust: Optical Dust Logger (Berkeley, Ryan Bay)
Additional Structure Detail: Optical Televiewer (Dartmouth) and Acoustic Televiewer (Berkeley and UAF?)

Where to drill? – any data help provide constraints for models, targeted site would depends on specific research questions, such as development of large scale folding

Key Points

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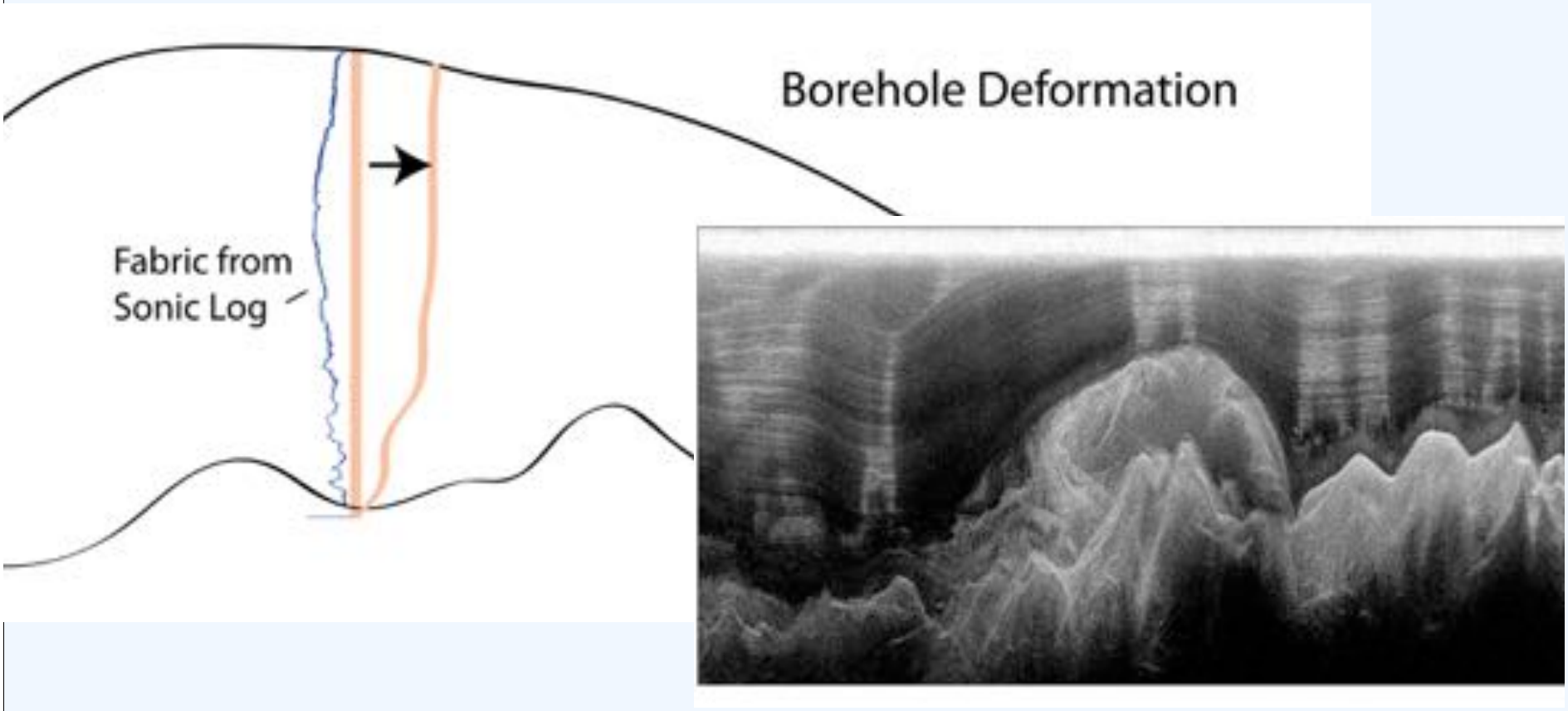
Ice Dynamics

Strong fabric development downstream of divides?

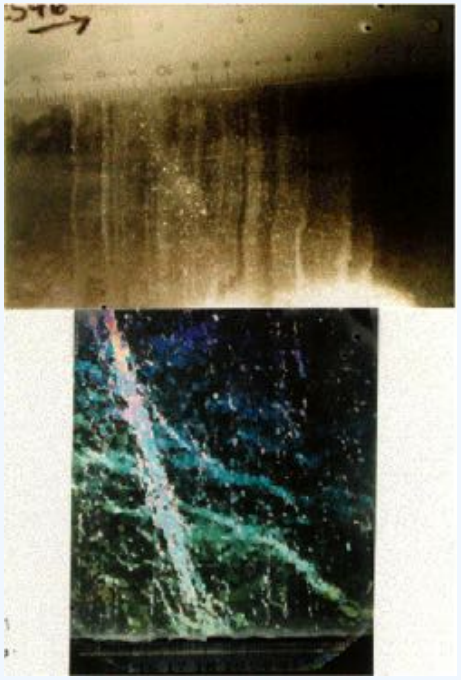
Large-scale folding and shear band development?



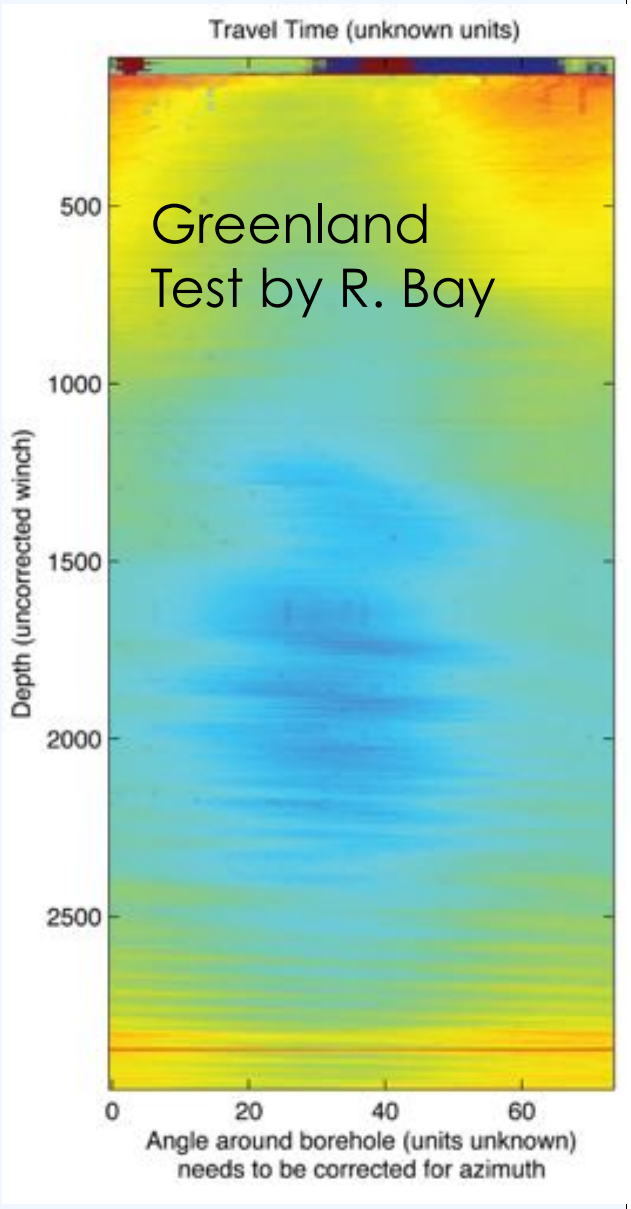
Requires Repeat Logging in hole over period of years

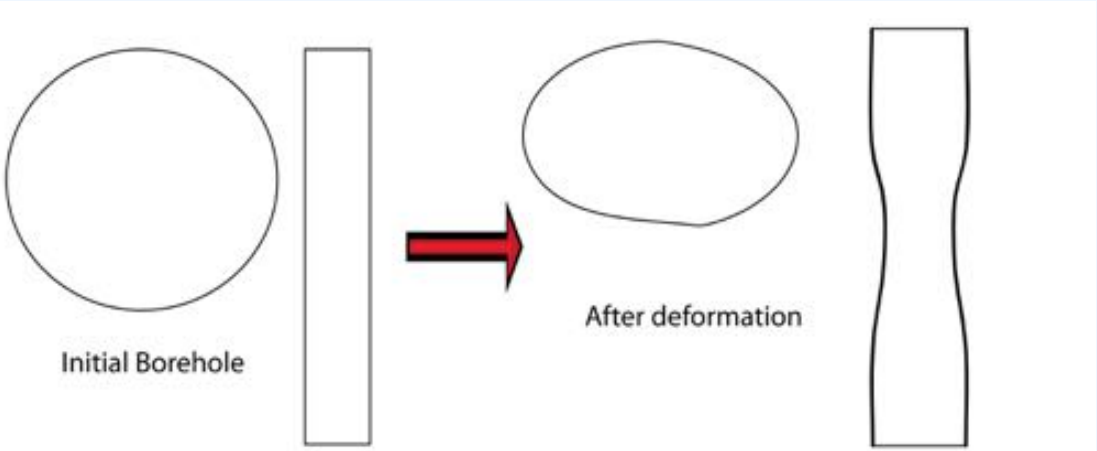
Ice Dynamics

Greenland Ice Core



Small Scale deformation to study effects of fabric on deformation and folding observed in ice cores.





Summary: Ice Dynamics

1. Still many questions about ice dynamics – this feeds models and helps interpret climate and ice sheet history

Logging tools

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Dust: Optical Dust Logger (Berkeley, Ryan Bay)
Tilt, Inclinometry, and Structure Detail:
Optical Televiewer (Dartmouth)
Acoustic Televiewer (Berkeley and UAF?)
Borehole radar??

Key for these studies

Where to drill? – Sites where radar and seismic suggest large scale folding. For smaller scale deformation, near ice cores sites is most useful right now.

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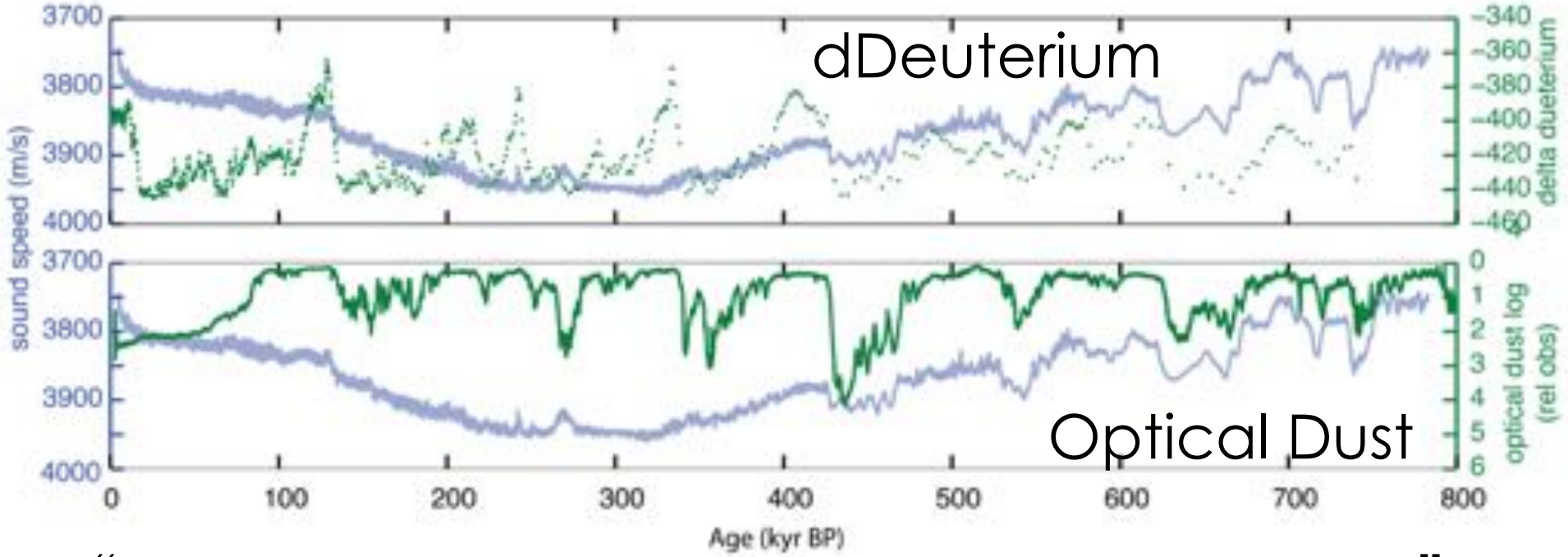
   Rapid Access Drill - ~5cm holes

Climate

These logs contain climate information,
we should take more advantage of this!

Sonic Log

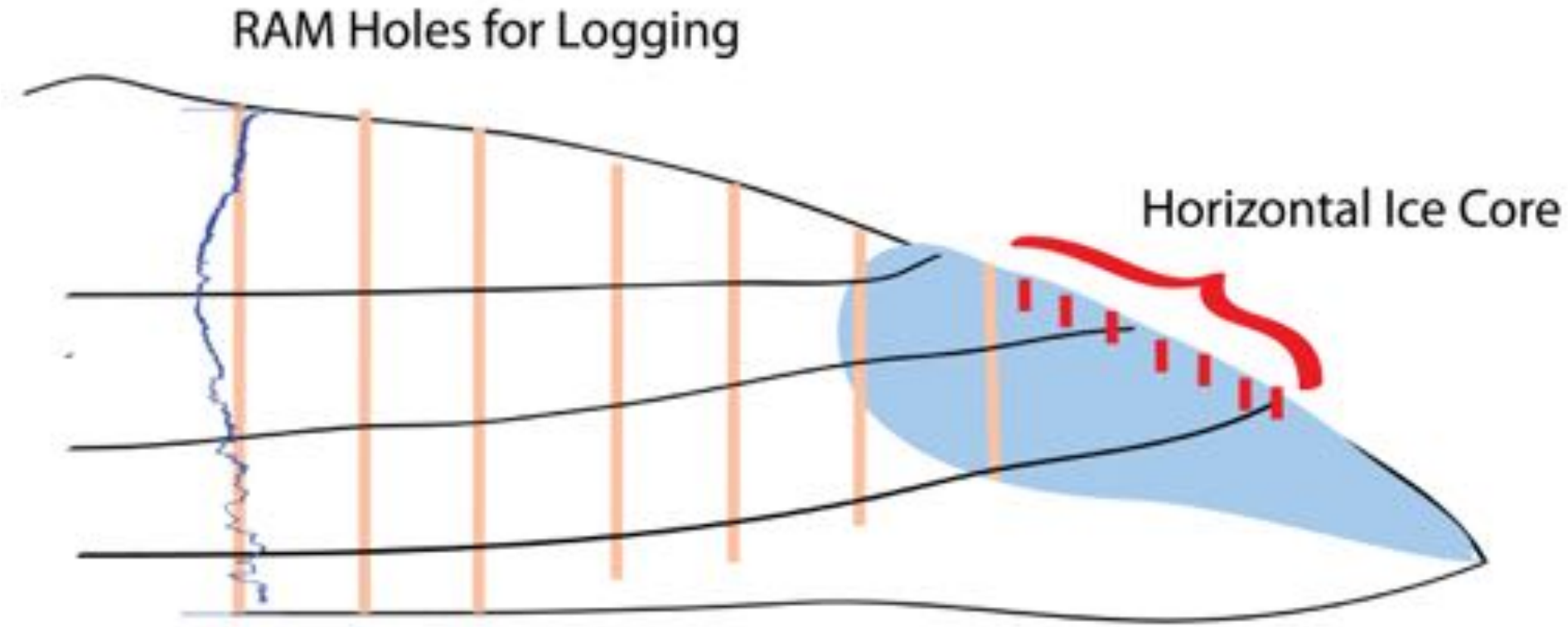


"Climate Variability comes in Spatial Patterns"

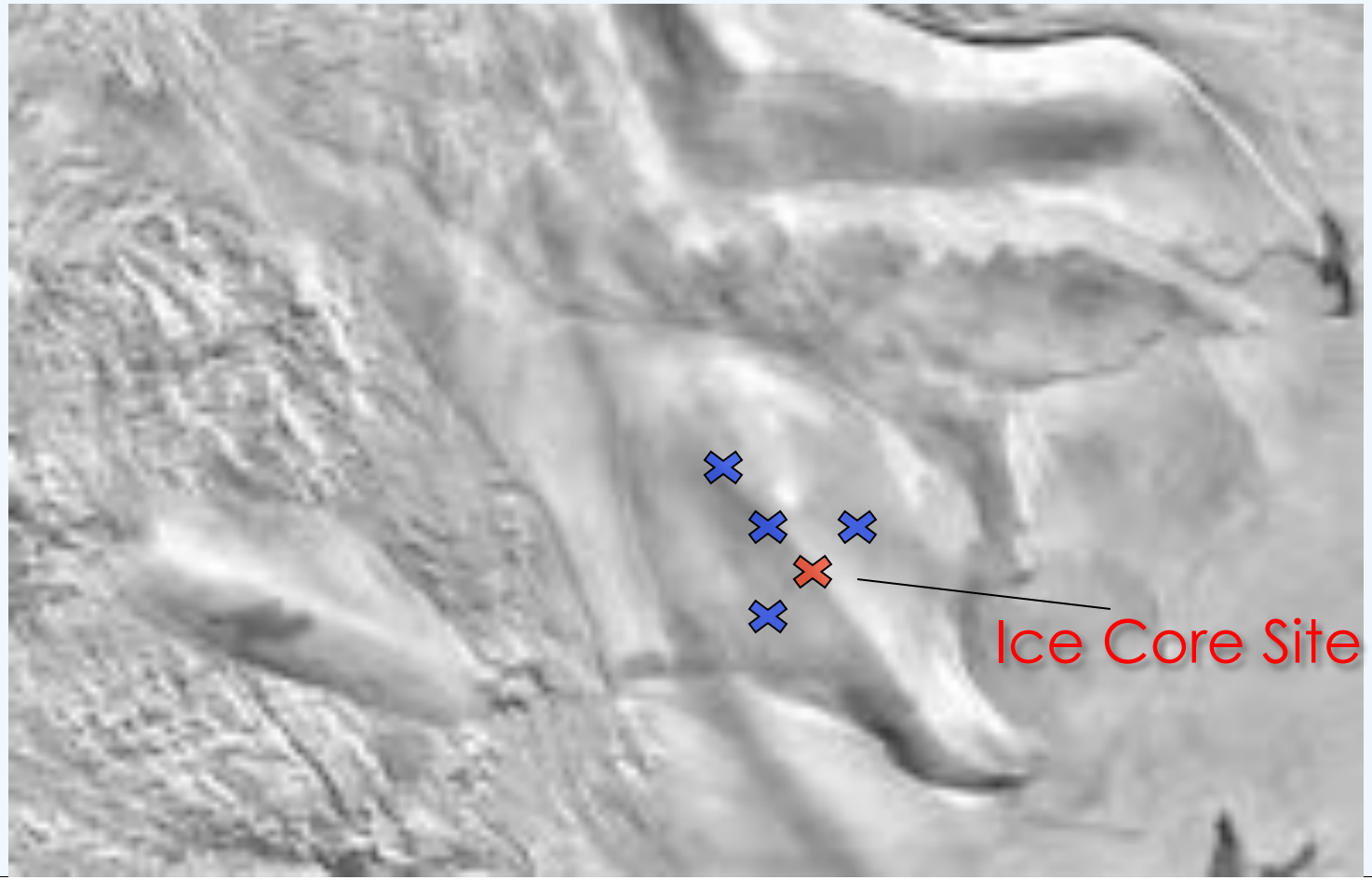
Eric Steig

Climate

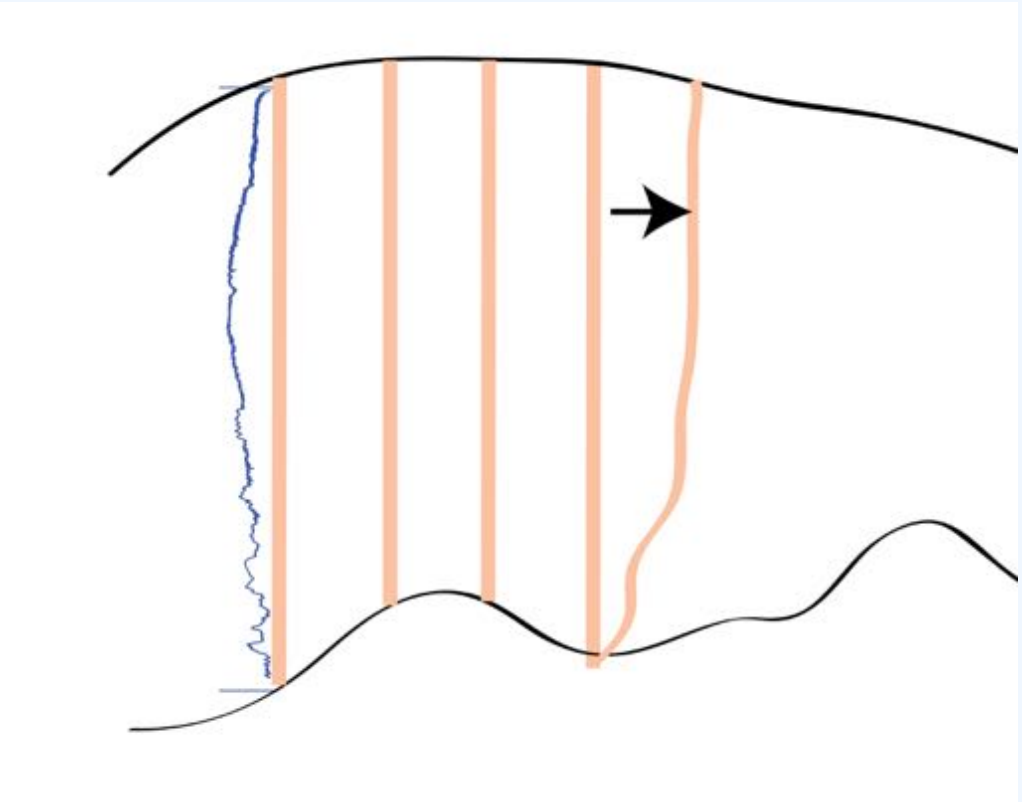
Example 1: Provide dating and context for horizontal ice core



Example 2: Providing Regional Context for Siple Dome Ice Core. Are dynamics affecting the ice core record?



Example 3: Providing Regional Context for WAIS Divide Ice Core.



- Drill and log boreholes up and over the divide
- Borehole deformation studies

Summary: Climate

1. Logging has potential to provide a broader regional context for ice cores, including providing

   - dating constraints for "horizontal ice cores"
   - dynamic context for ice core interpretation such as at Siple Dome and WAIS Divide
   - Site location for "Oldest Ice" or Eemian Ice

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} Which tools depend on specific question

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