What Can Radar Scattering Tell Us About the Relative Character of Past and Future Retreats in the Amundsen Sea Embayment

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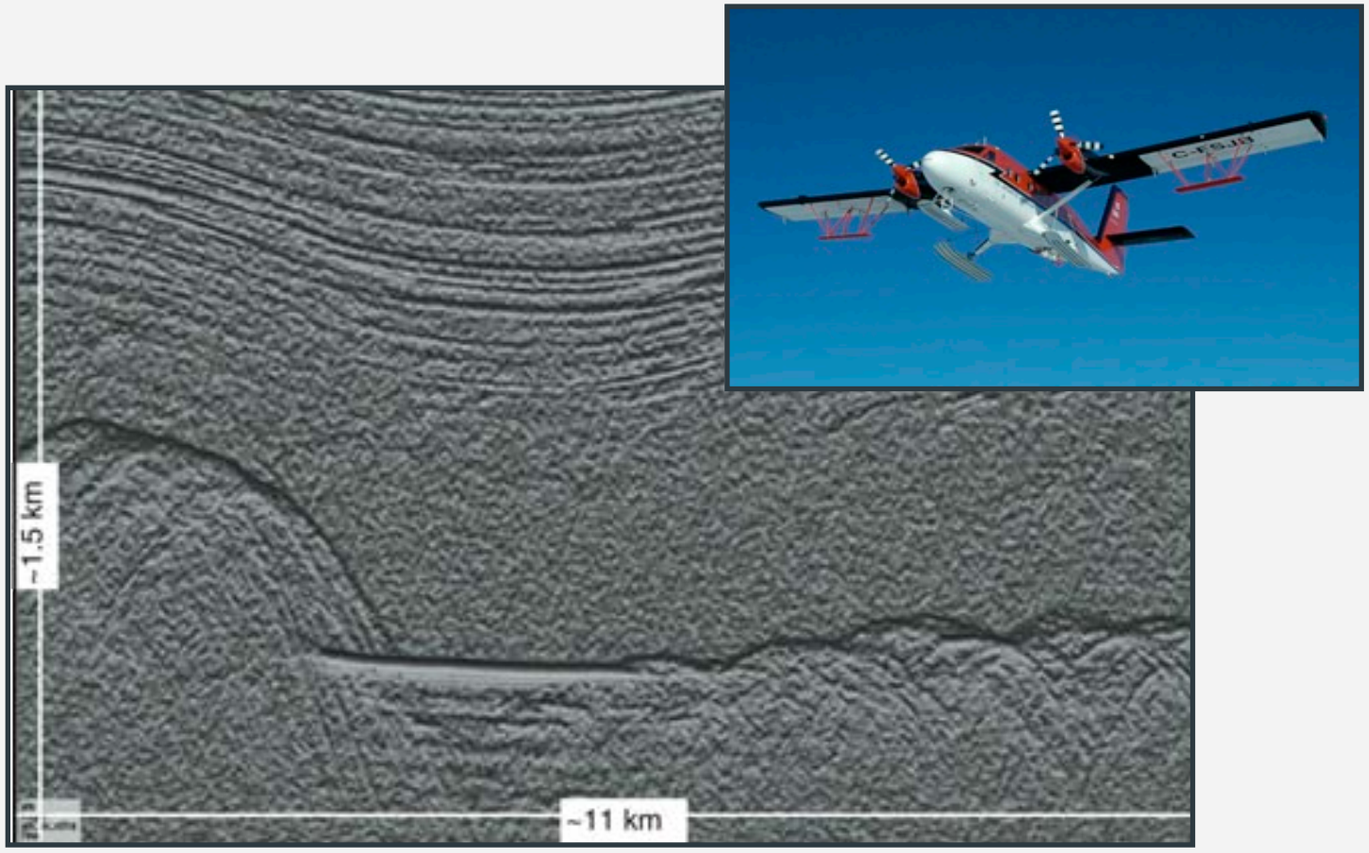
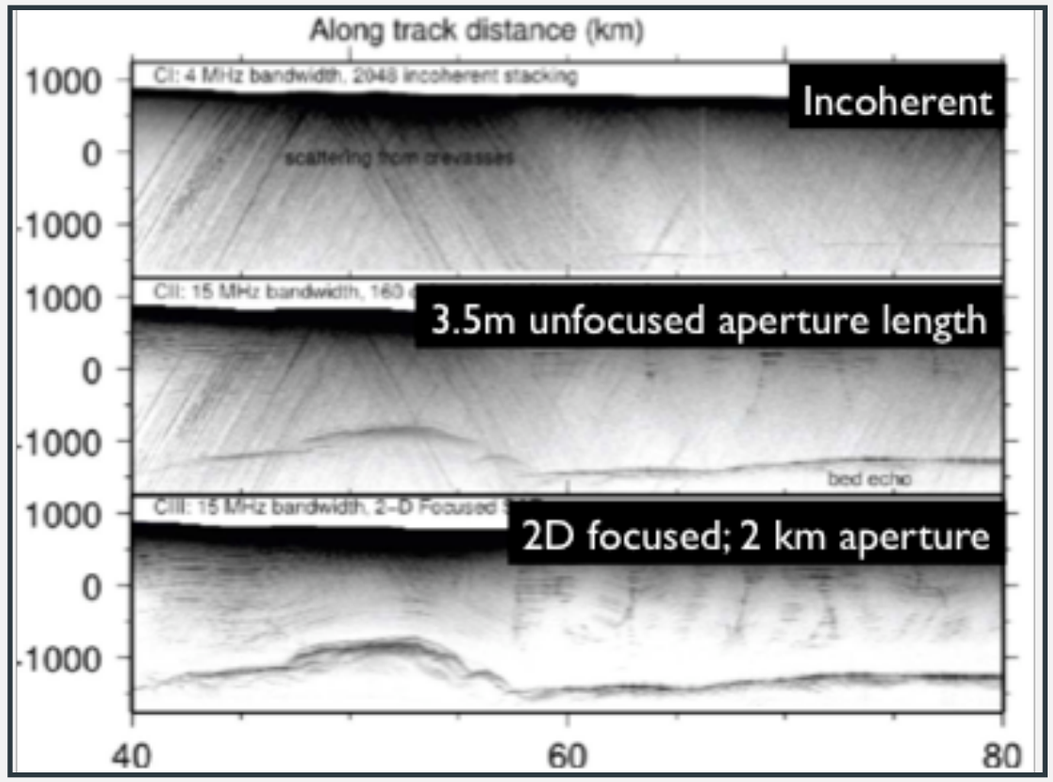
[Specularity and Water: A Review]

Information in the Scattering Function

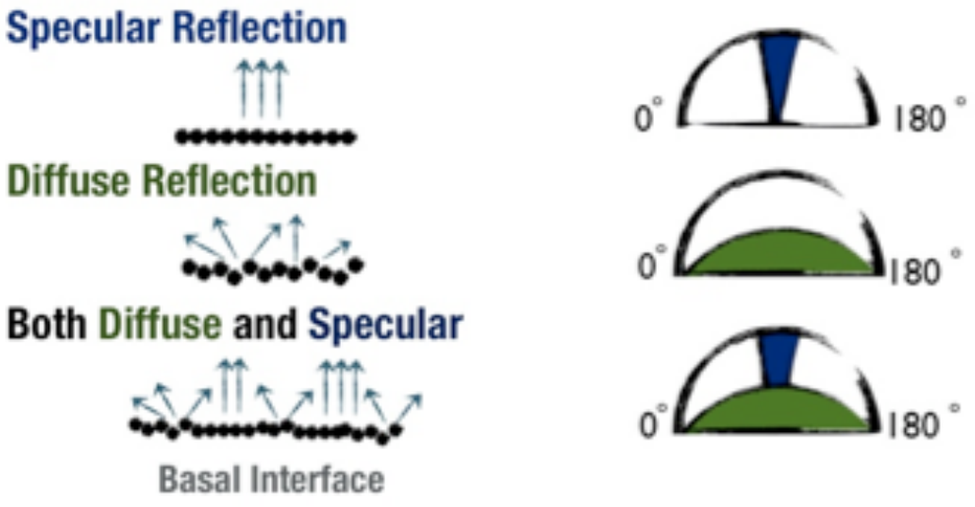
Using Specularity Content to Detect Subglacial Water



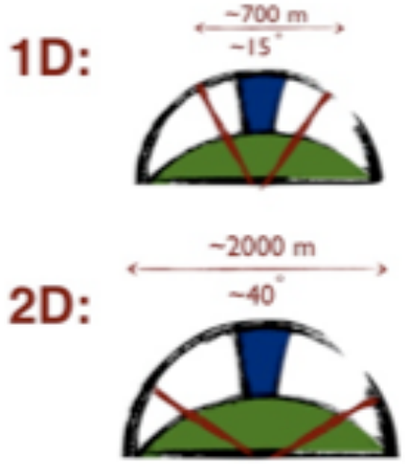


Blankenship 2009

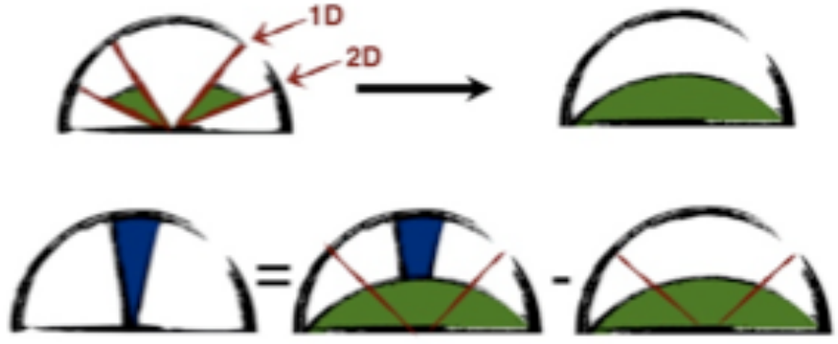
Reflecting Interfaces



Focusing Windows



Specularity Calculation

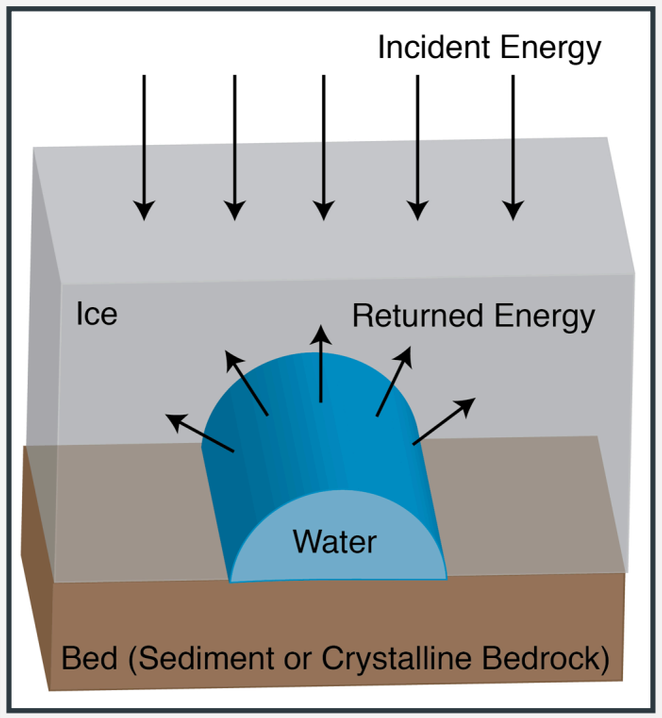


Signatures of a Distributed to Concentrated Transition

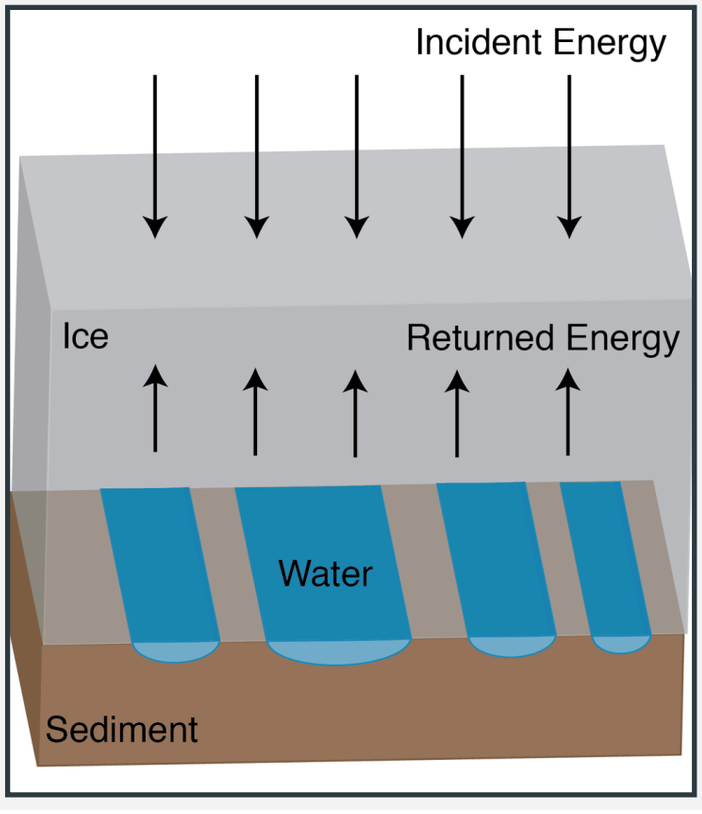
Specularity, Amplitude, Water Flux, and Surface Slope

Radar Scattering

Concentrated Channels

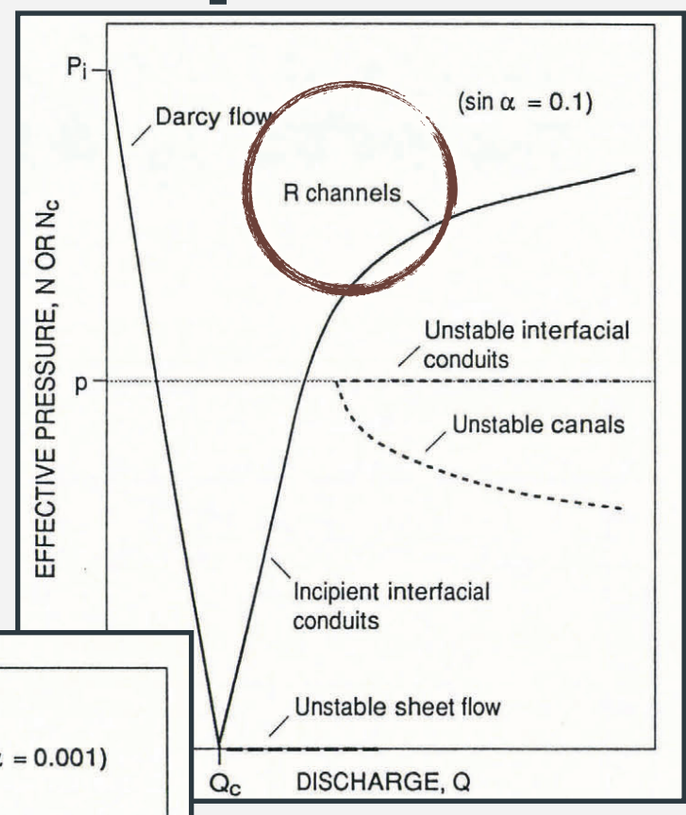


Distributed Canals

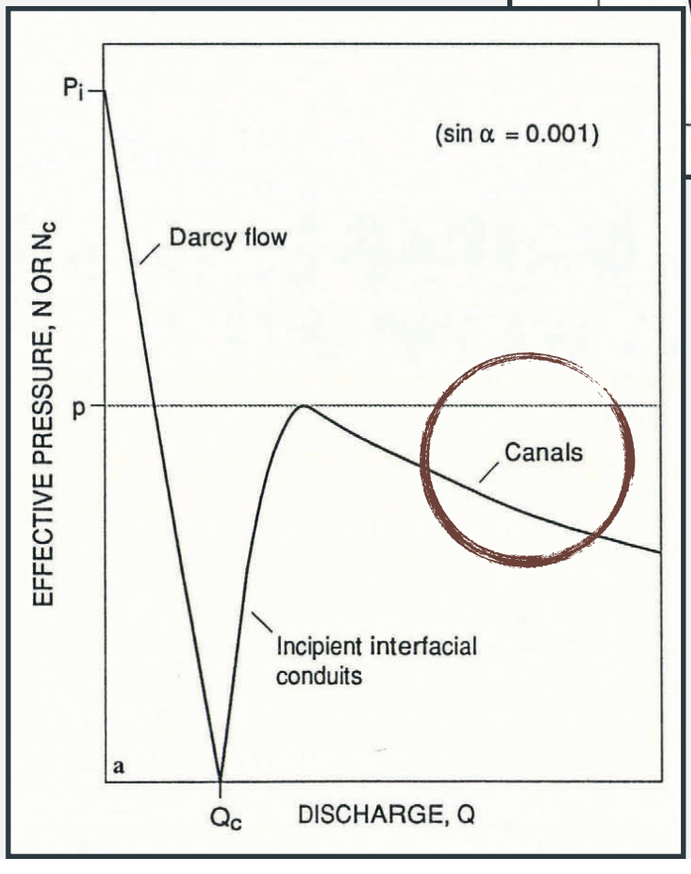


Glaciological Setting

Steep Ice Surface



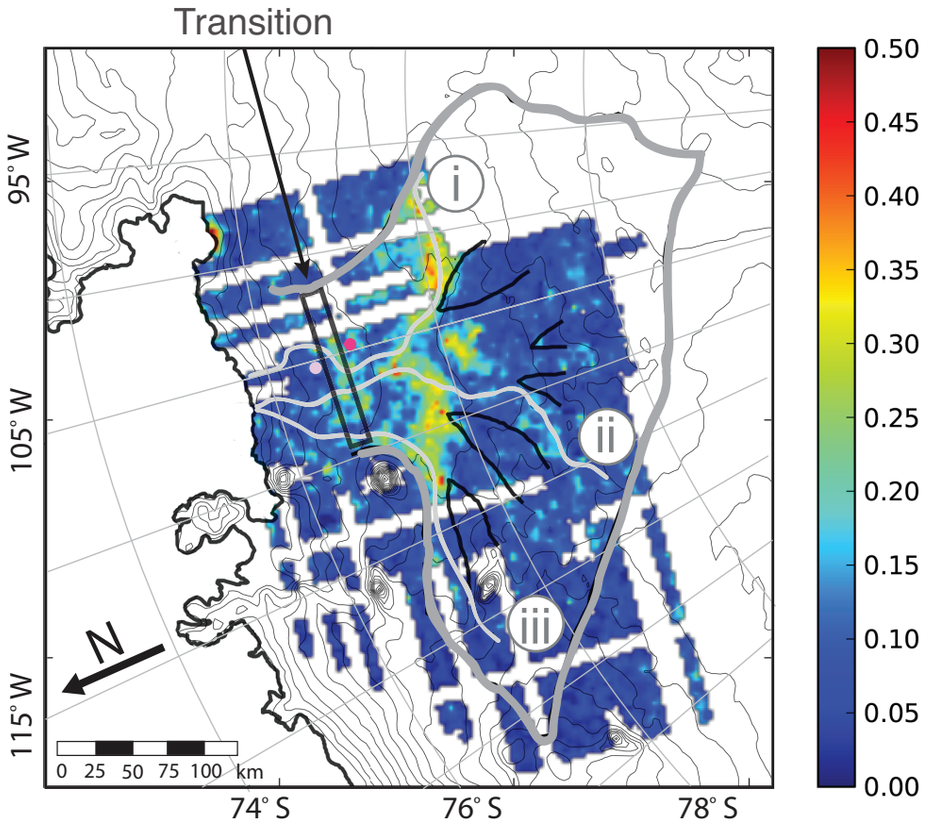
Flat Ice Surface

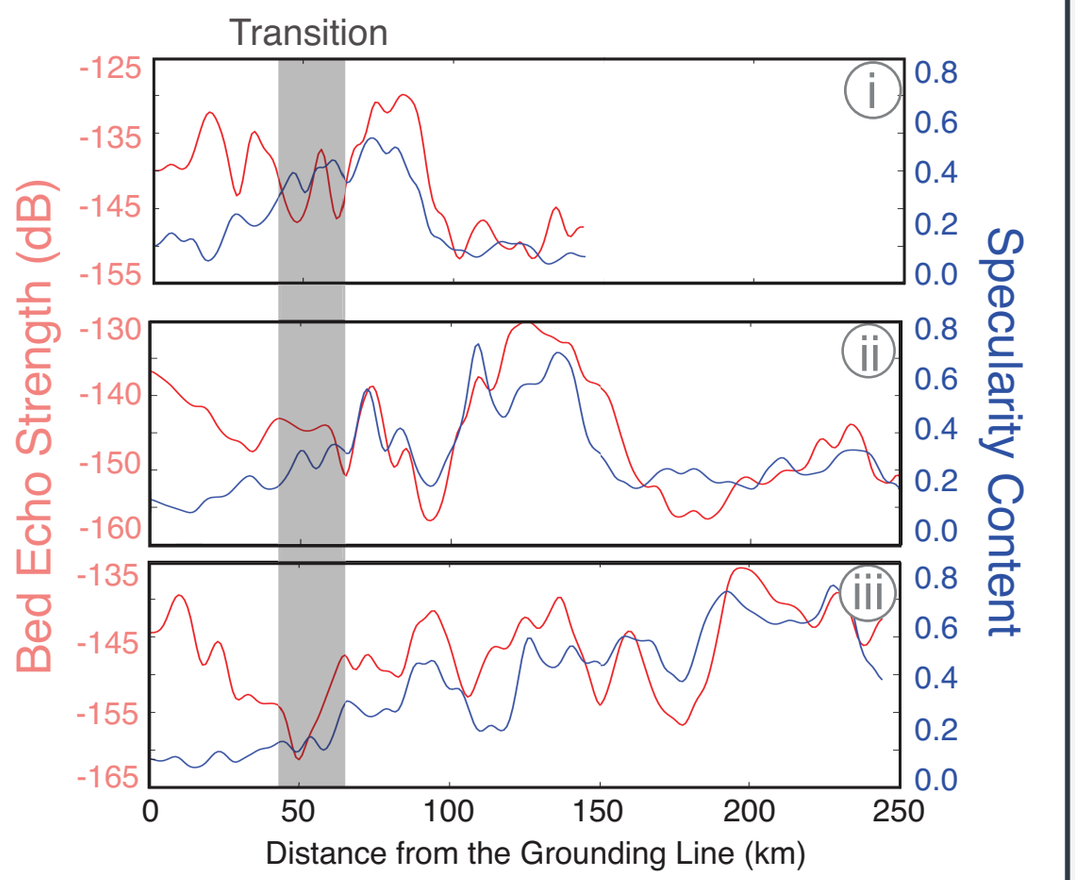


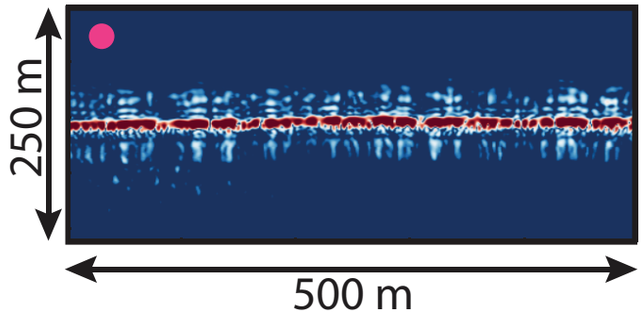
Walder and Folwer 1994

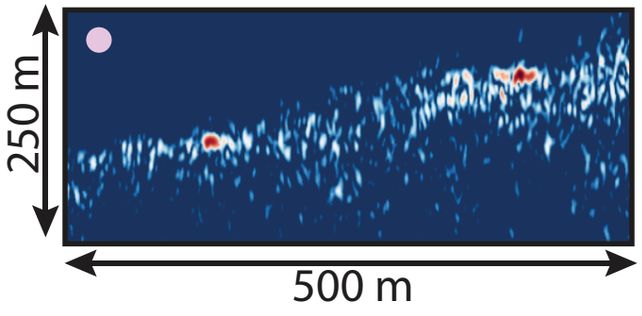
Coupling Between Subglacial Water and Ice Flow

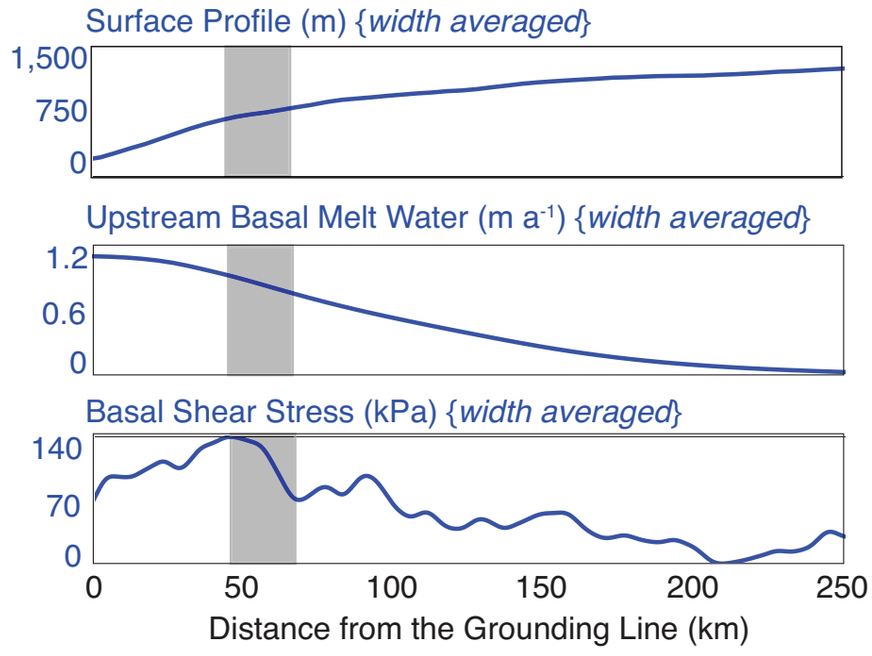
Transition with Increased Surface Slope, Water Flux, and Basal Shear Stress











[Specularity and Bedforms]

Thwaites Glacier vs. Paleo Pine Island Glacier

Bedform Geometries and Sedimentary Records

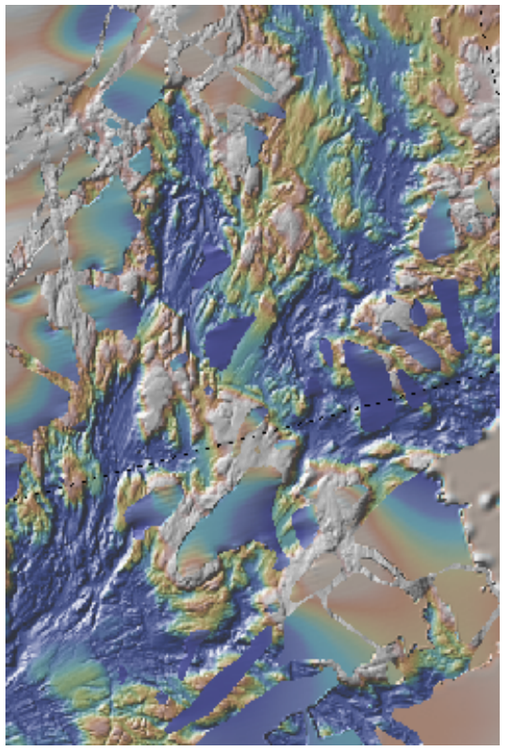
Is Thwaites Glacier configured to experience a retreat similar to the Paleo-Pine Island Glacier?

What is the distribution of deformable sediment and bedrock across the Thwaites catchment?

Can the water system beneath Thwaites explain the Paleo Pine Island sediment record?

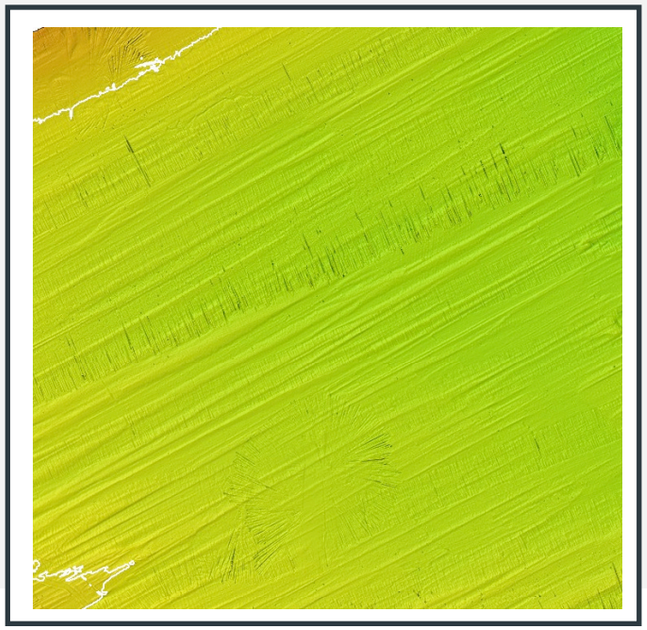
Using PIG Bathymetry to Understand the Thwaites Bed
and Thwaites Hydrology to Understand Paleo Pine Island Sediments

Bedrock with Channels

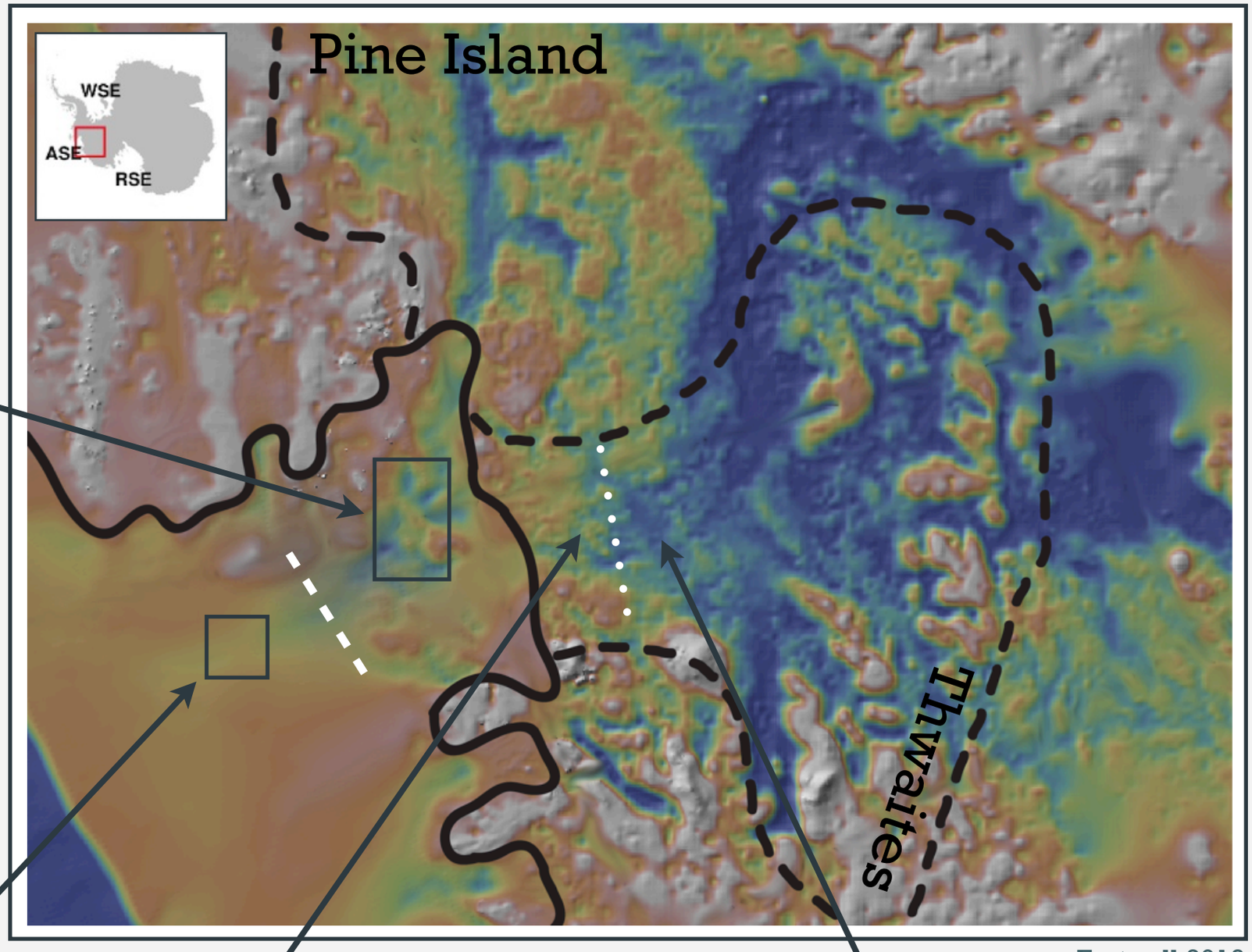


Nitsche 2012

Sediments with Lineations

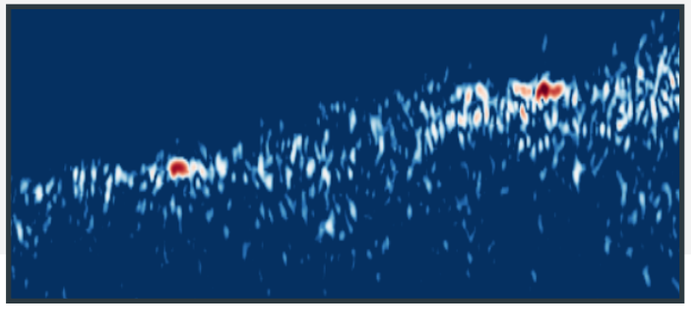


Jakobsson 2012

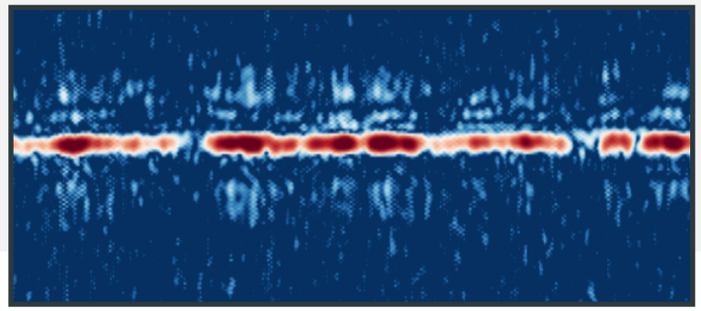


Fretwell 2013

Concentrated Water



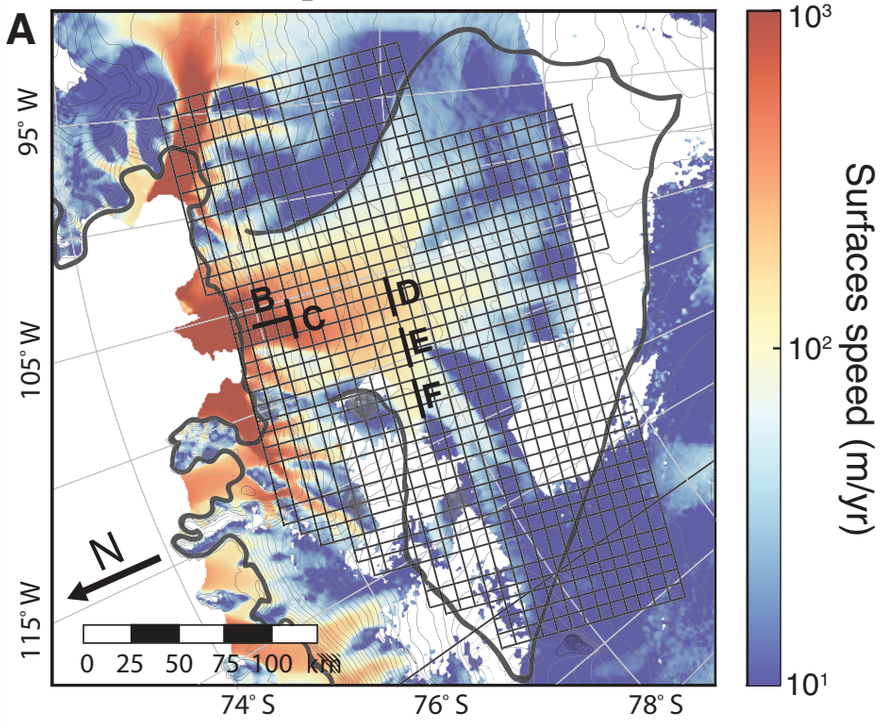
Distributed Water



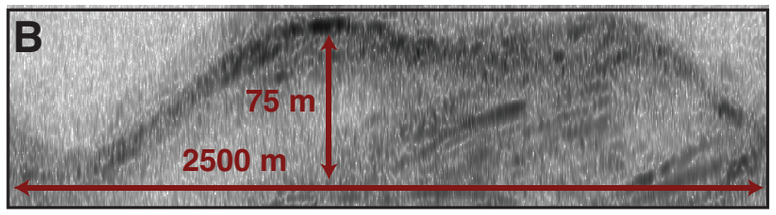
Radar Imagery of Bedforms

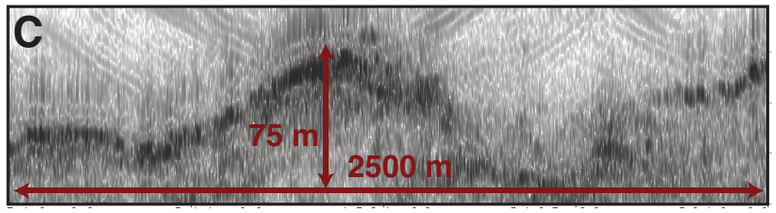
Flow-Aligned Features Consistent with Off-Shore Lineations

Survey Orientation

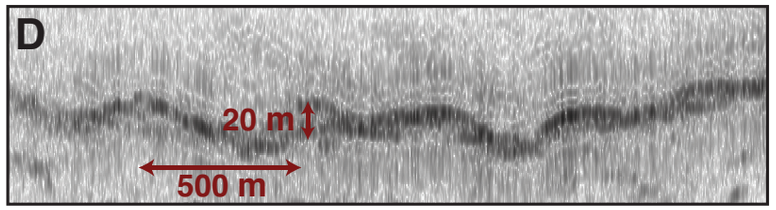


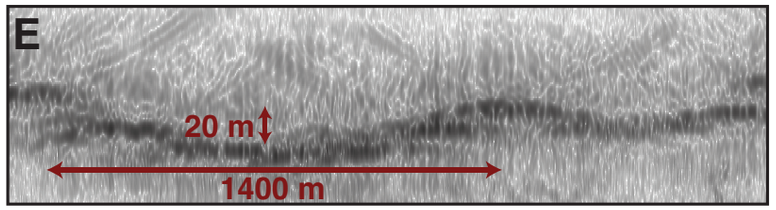
Downstream of Transition

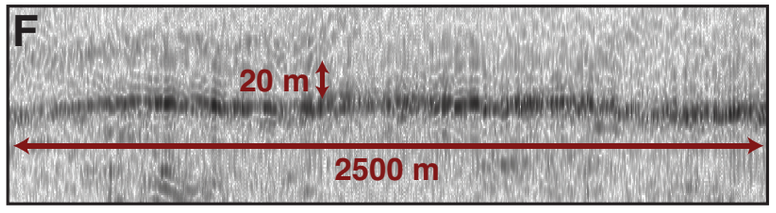




Upstream of Transition



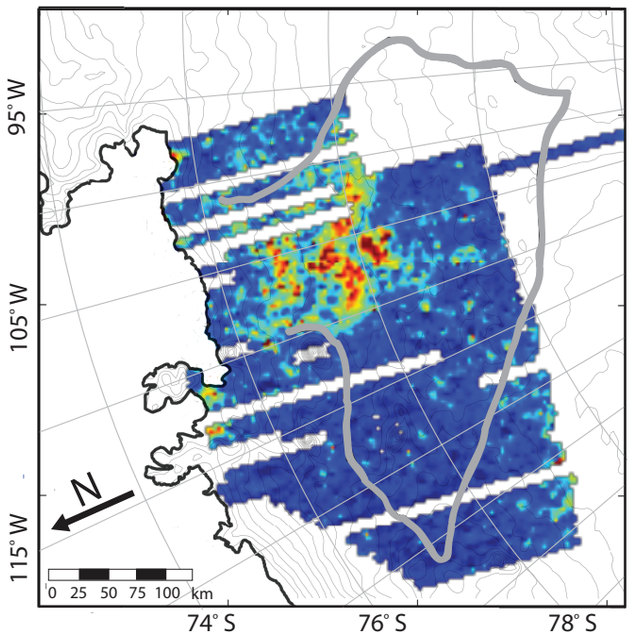




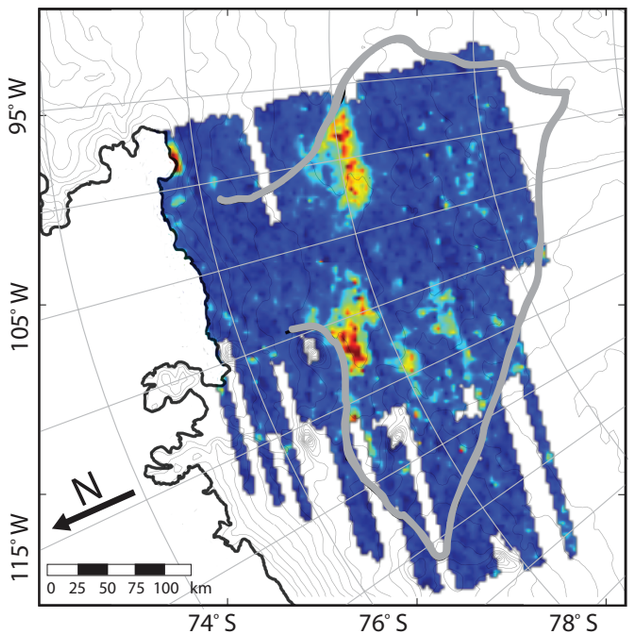
Anisotropy of Low Specularity Values

Alignment with the Direction of Ice Flow

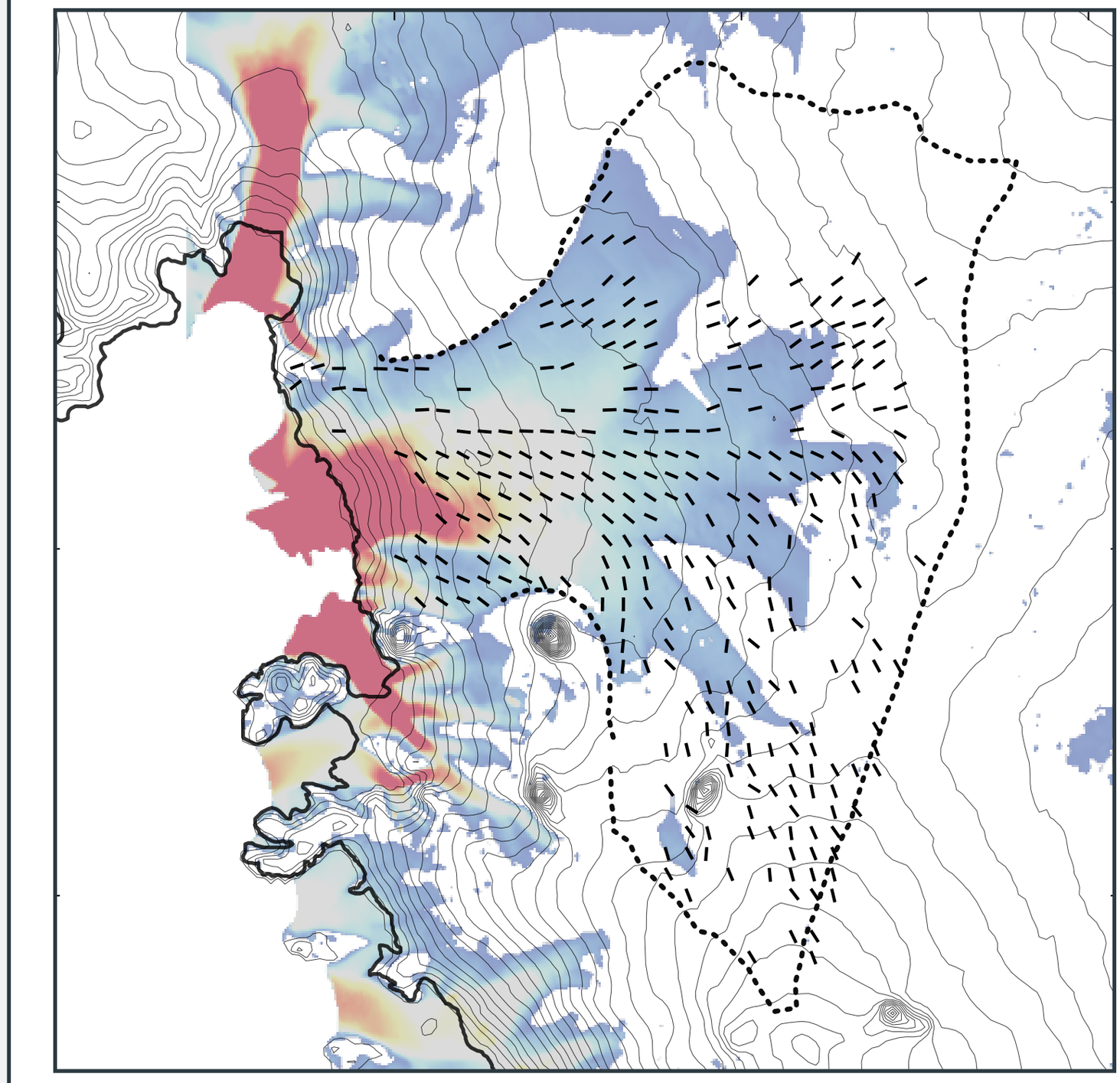
North-South



East-West



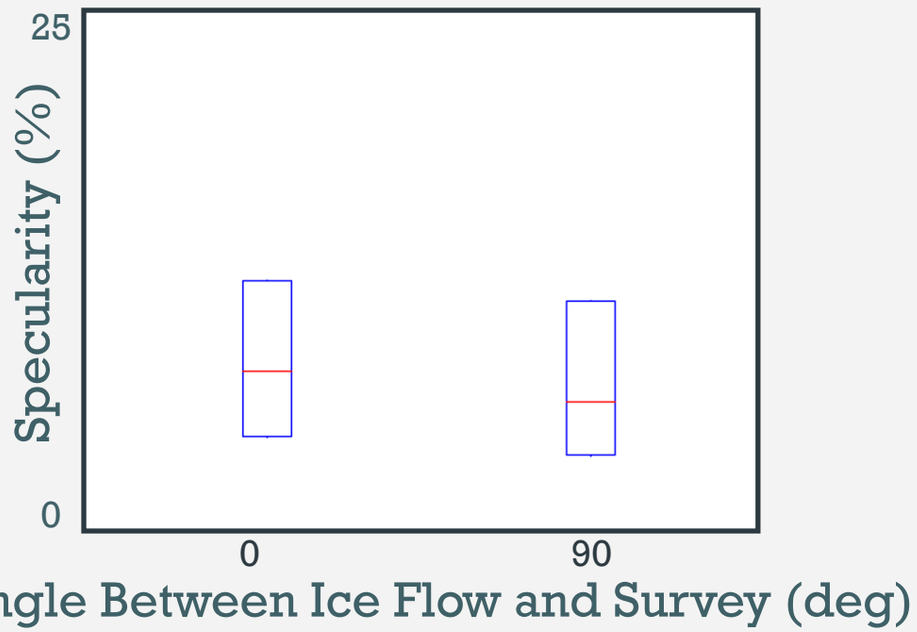
Low Specularity Anisotropy

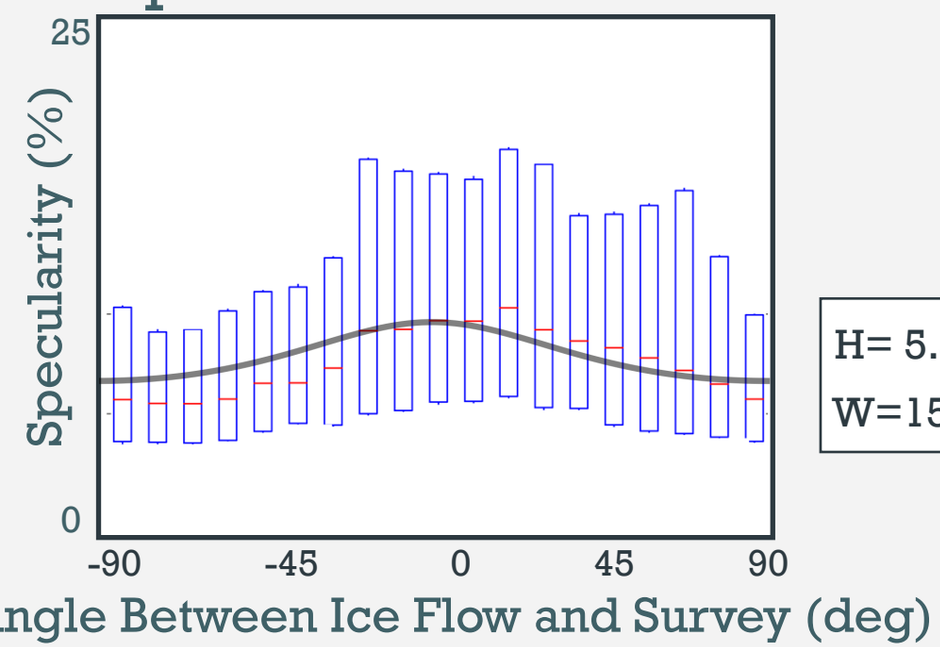


Angularly Dependent Specularity of Bedforms

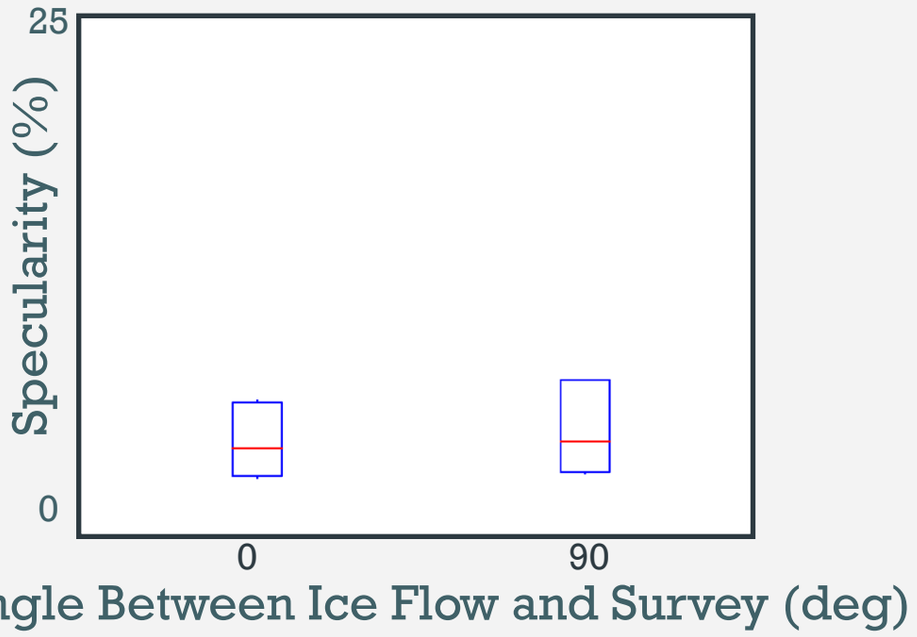
Isotropic Downstream and Anisotropic Upstream of Water Transition

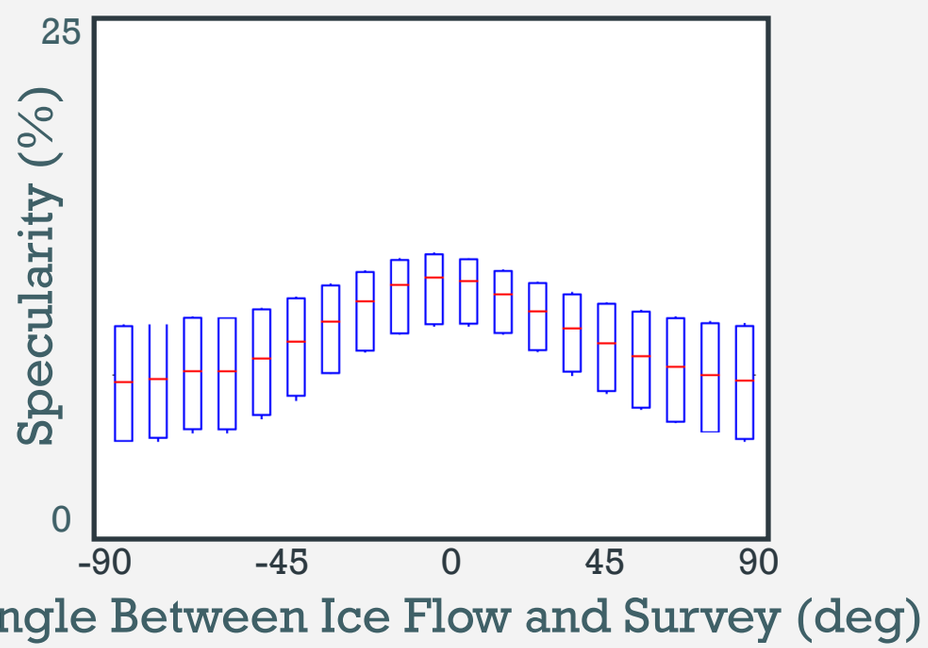
Thwaites Glacier (Contemporary)





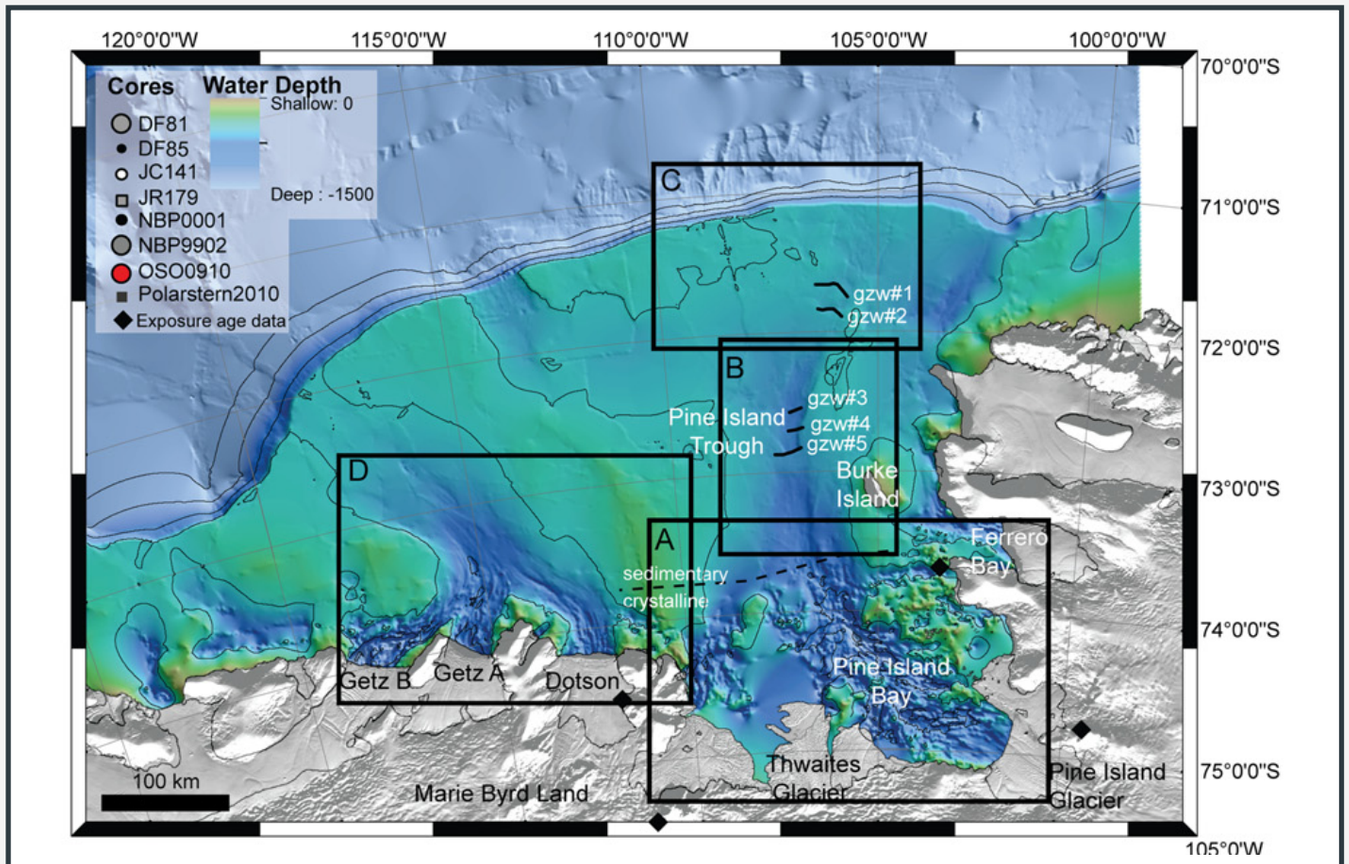
Pine Island Glacier (Paleo)

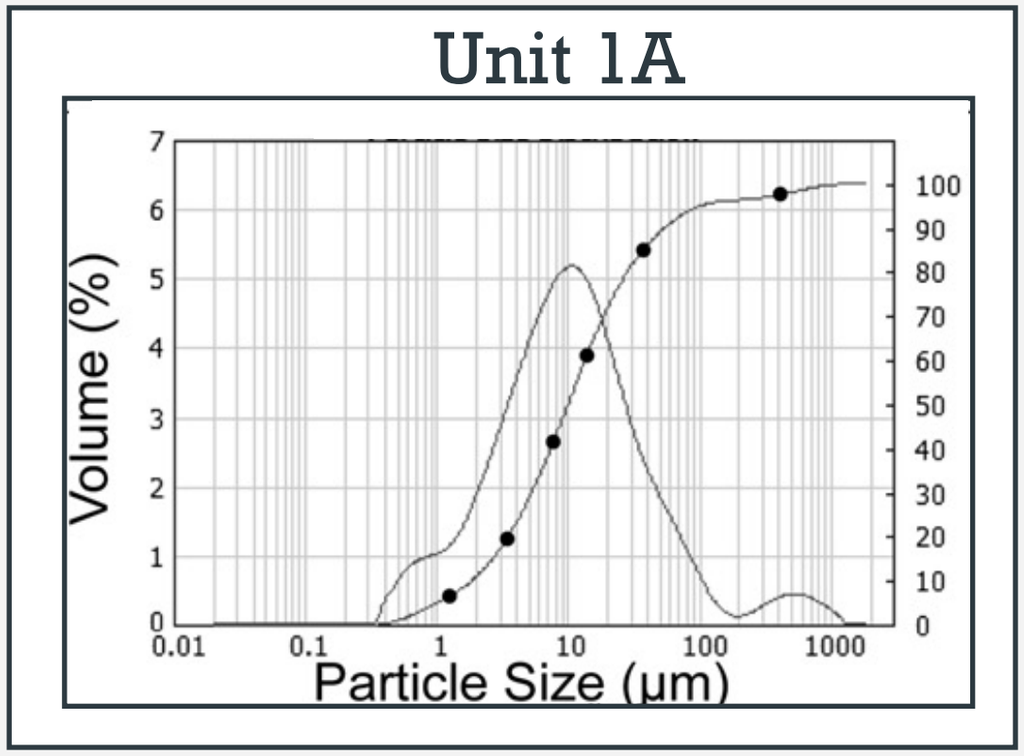


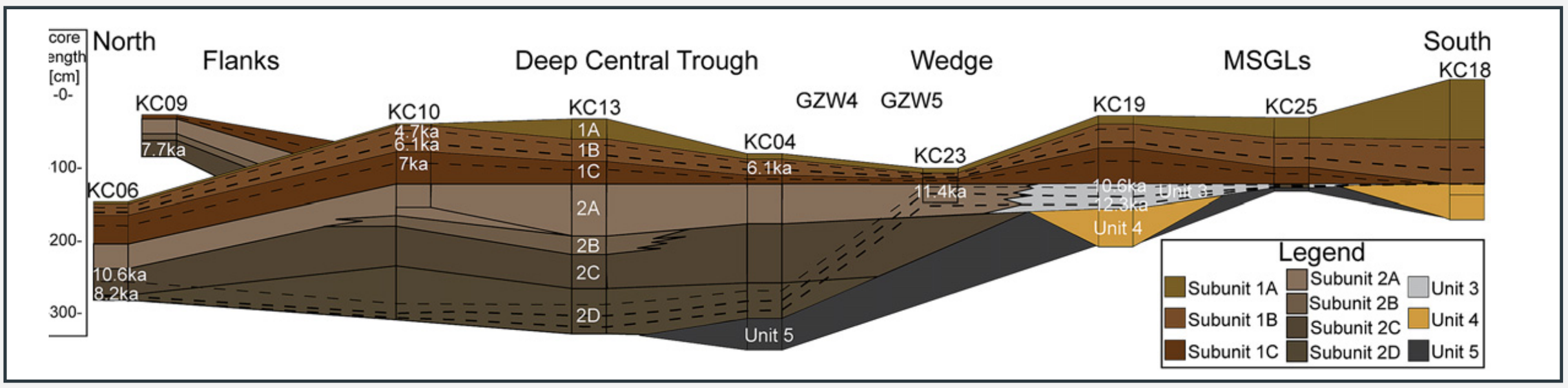


Reconciliation with Sediment Record

Is Silt Unit in ASE Evidence of Concentrated Water ?







Kirshner 2012

Reconciliation with Sediment Record

Differential Erosion: Distributed Canals vs. Concentrated Channels

Channels

Radius: 0.1 to 2.5 m

Velocity: 500 to 3000 cm/s

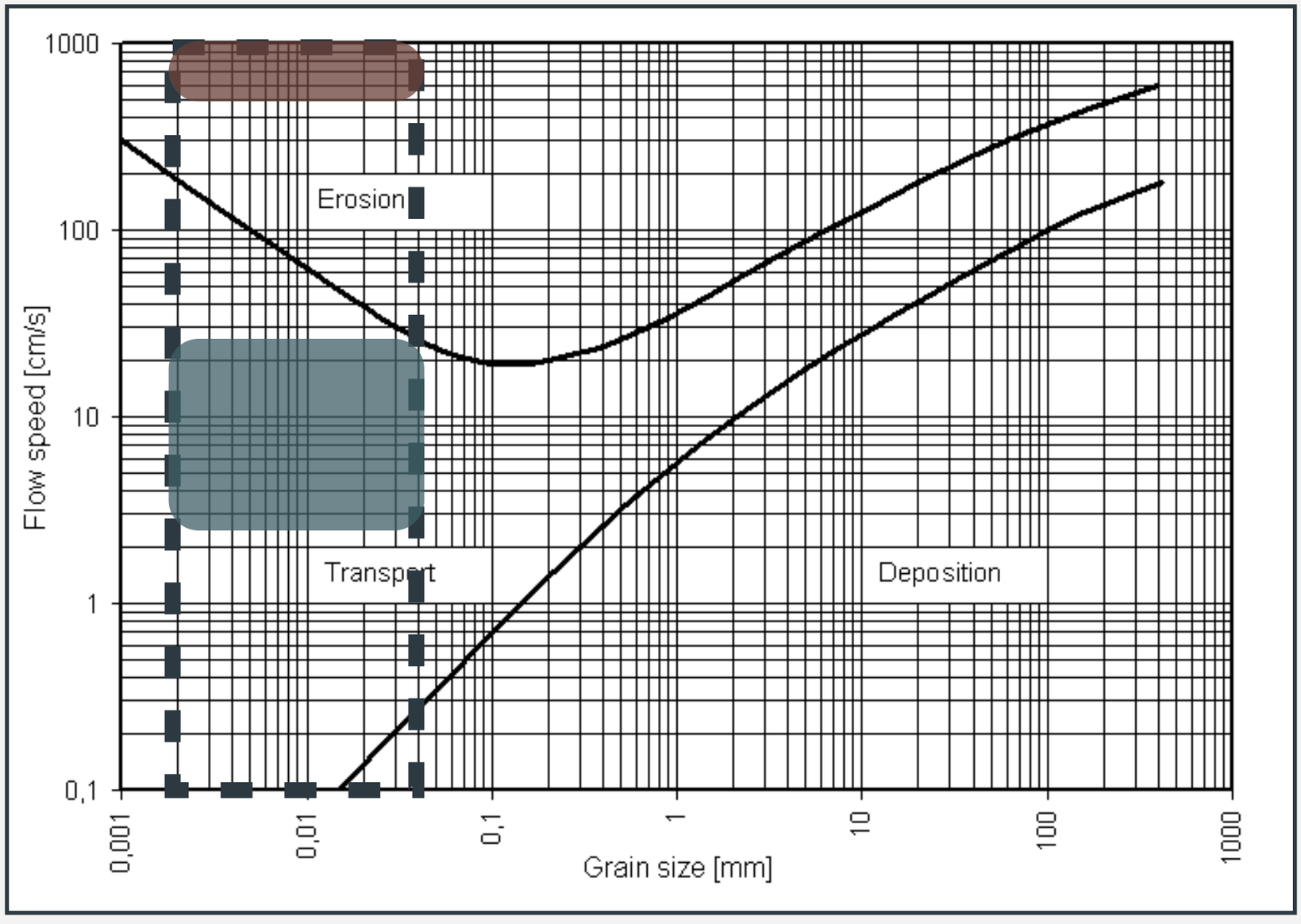
Canals

Depth: 0.1 to 10 cm

Velocity: 2.6 to 26 cm/s

Walder and Folwer 1994

Flow Speed of Erosion for Grain Size

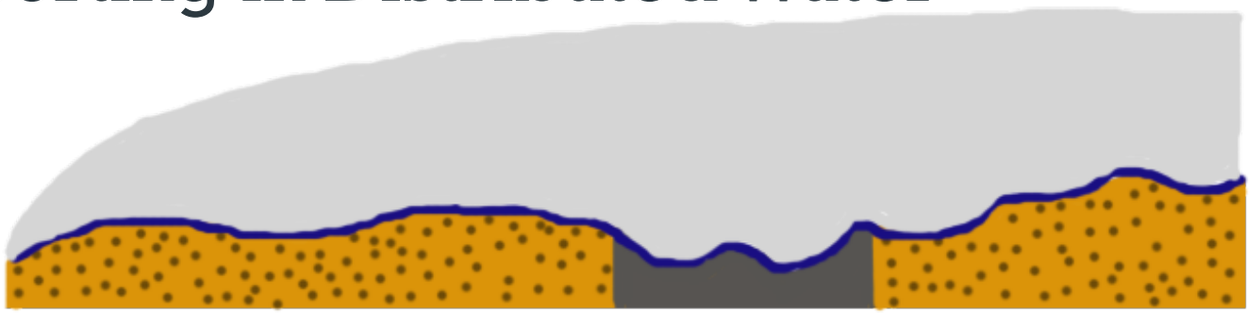


Reconciliation with Sediment Record

Variable Water Quantity vs. Variable Water Configuration

Mechanism for Silt Unit Production by Paleo Concentrated Water

Sorting in Distributed Water



Erosion by Concentrated Water

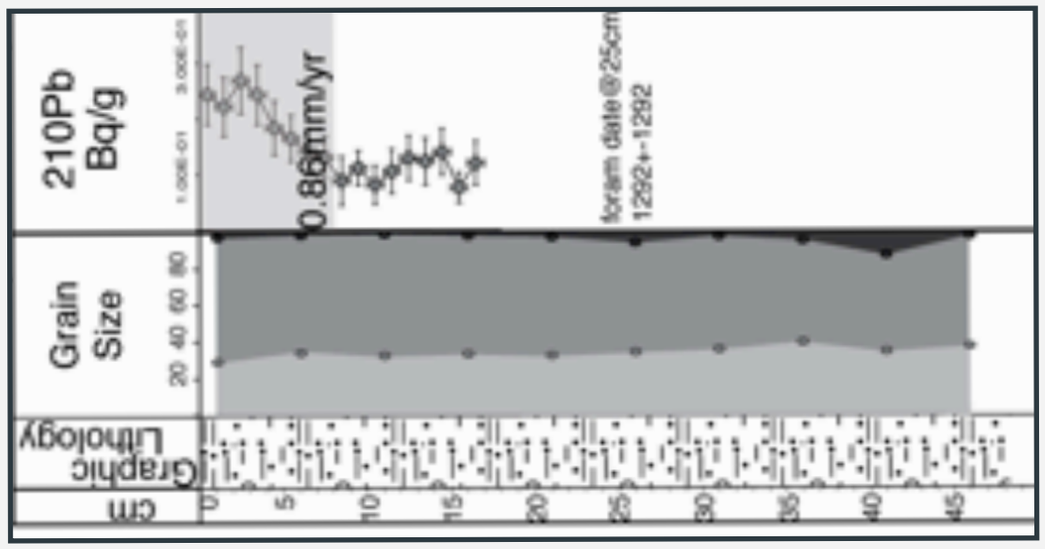
Limitation by Basin Storage

Silt Unit 1

Thickness ~ 1m
Area ~ 120,000 km^2
Rate 1A (Pb^{210}) ~ 0.8 mm/yr
Rate 1 (foram) ~ 0.1 mm/yr

P.I.B. Bedrock Basins

Volume ~ 120 km^3
Retreat ~ 7 kyr



Kirshner (in review)

Bed Configuration Conclusions

Learning about Thwaites from Paleo Pine Island and Vice-Versa

Thwaites Glacier is is underlain by flow-aligned bedforms of deformable sediment beneath its tributaries and upper trunk and is grounded in a region of exposed bedrock.

The uppermost unit of silt in the Amundsen Sea is consistent with a transition from distributed to concentrated water beneath the Paleo Pine Island Glacier.

[Thank You]

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