EGU2020-128 Characterising the bed of Rutford Ice Stream, West Antarctica, using reflection seismics

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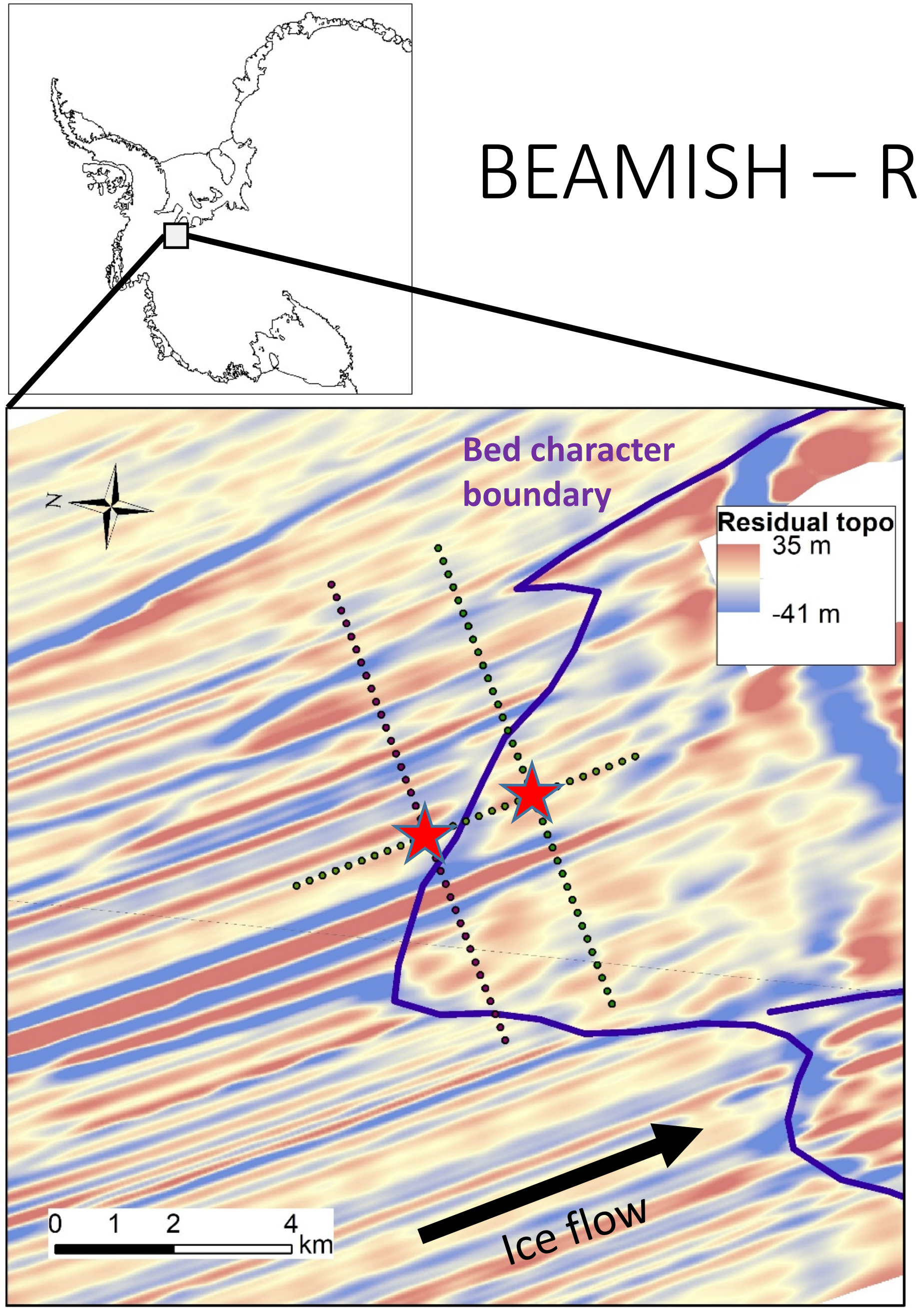
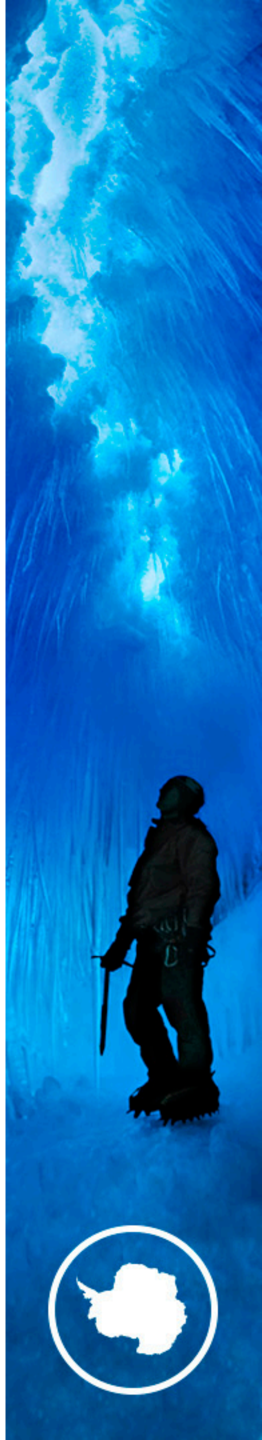
BEAMISH – Rutford Ice Stream

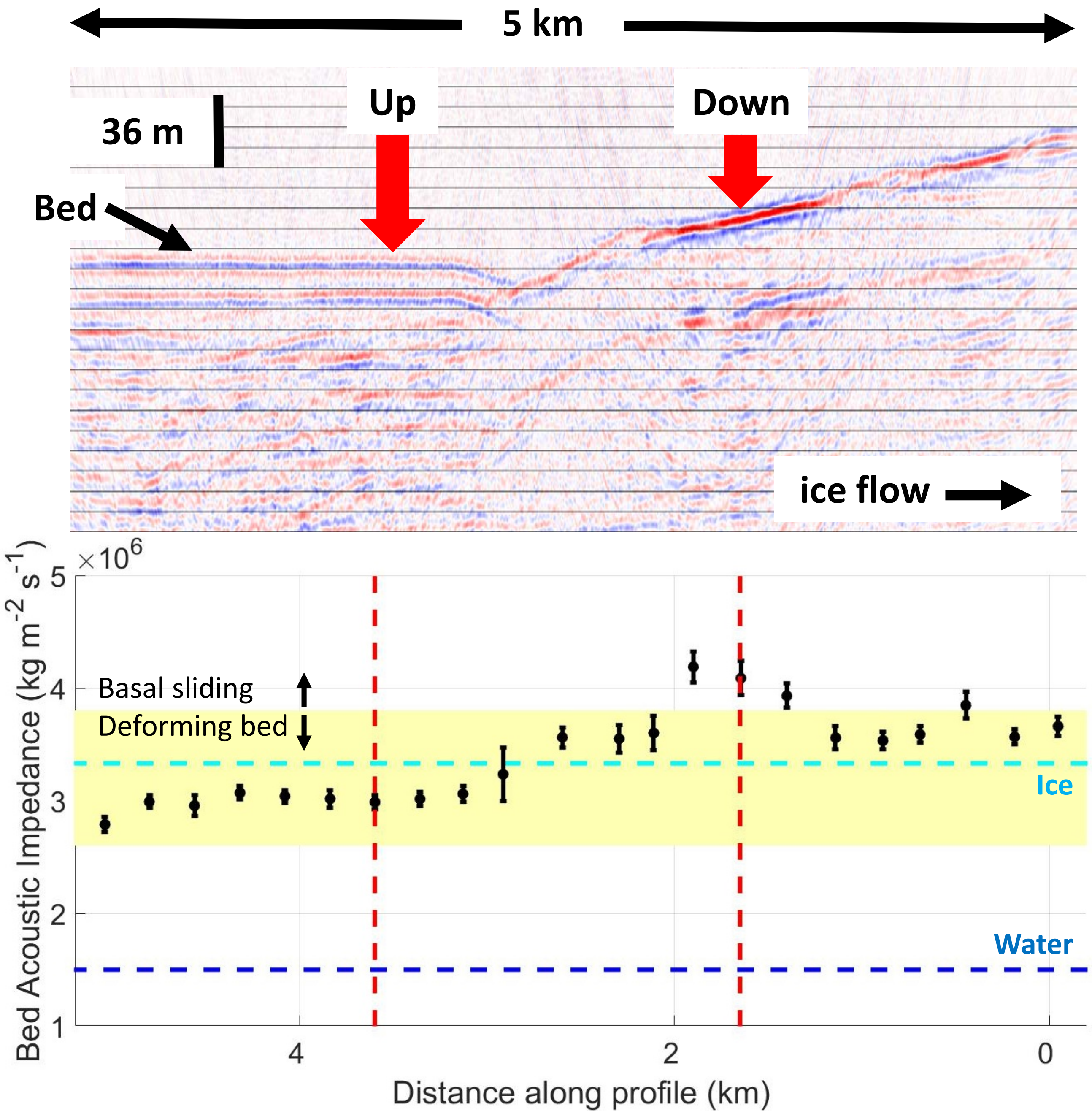
BEAMISH ANTARCTICA



- Rutford Ice Stream flows at ~1 m/day into the Ronne Ice Shelf, West Antarctica
- Ice is over 2 km thick at this location
- The bed topography has been mapped in detail using Delores radar (King, 2016, ESSD) and shows a distinctive and rapid change in bed character along flow (**purple line**)
  - Residual topography (background colour) highlights the transition from a linear to hummocky bed
- Seismic reflection profiles indicate a reversal in the bed reflection polarity across this boundary, consistent with a transition from dilated to more consolidated sediment
- In 2018/19 the BEAMISH team drilled to the bed at two sites (**red stars**) to instrument the ice column/bed and also sample the bed
- Concurrent seismic reflection (three lines) and AVA data (**red stars**) were acquired



Flow-parallel normal incidence seismic reflection profile

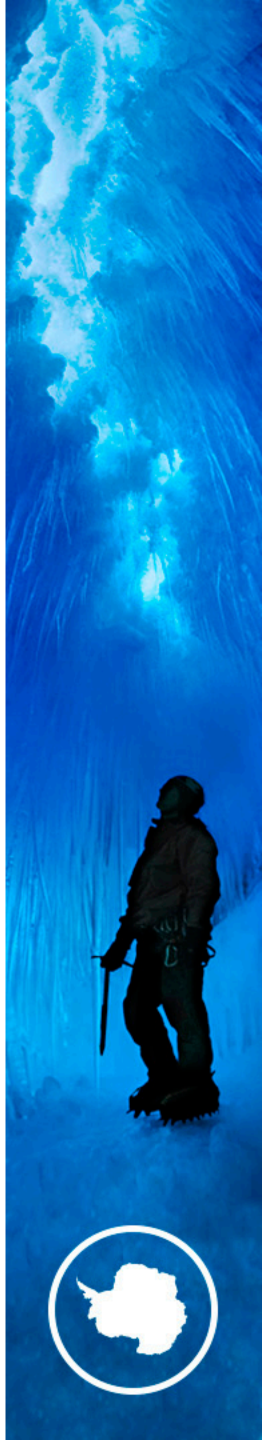


Migrated normal incidence seismic reflection profile along-flow through the two drill sites (**red arrows**)

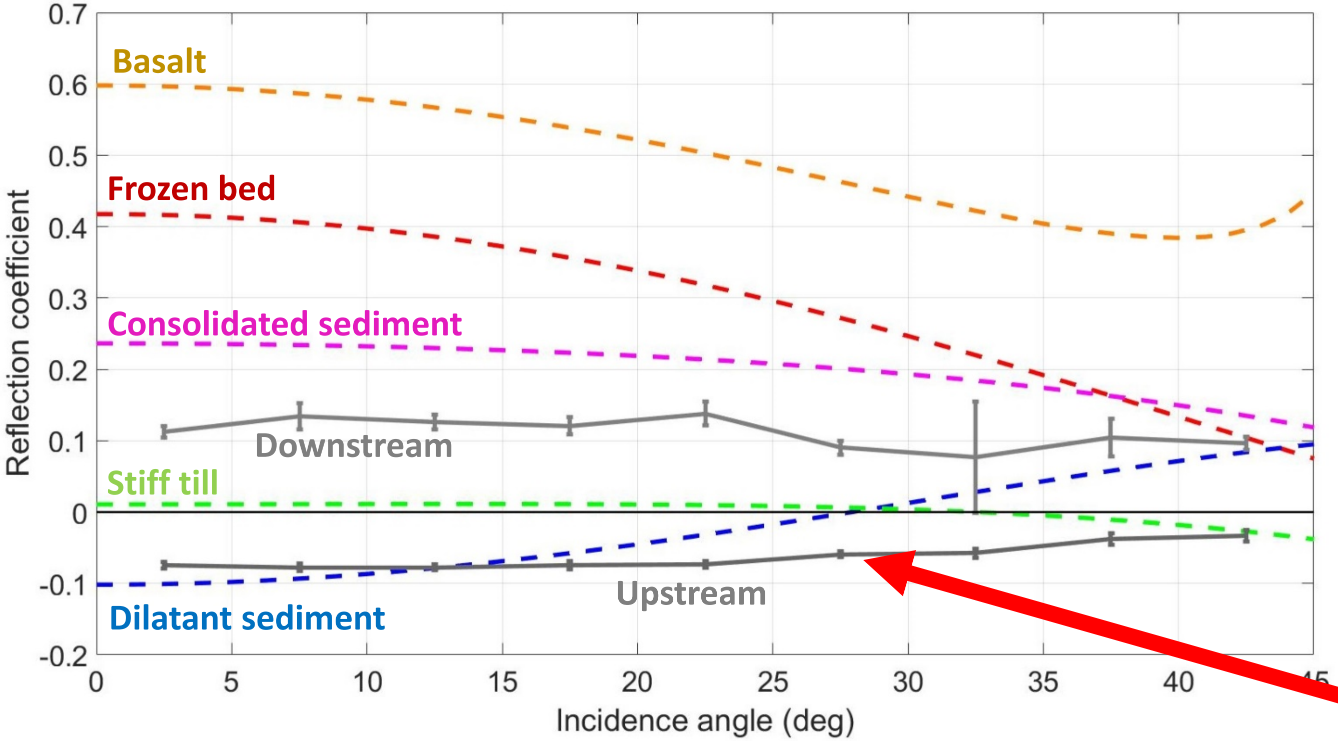
- **Upstream** - reverse polarity bed reflection
- **Downstream** - normal polarity bed reflection

Calculation of shot size and estimated seismic properties of ice allows calculation of basal acoustic impedance from reflection strength (Holland & Anandakrishnan, 2009)

- Acoustic impedance change indicates a transition to a more consolidated sediment downstream
- Yellow band is the approximate range associated with dilated, deforming sediments, including porosities in the range 0.35–0.45 (Atre and Bentley, 1993; Smith, 1997).

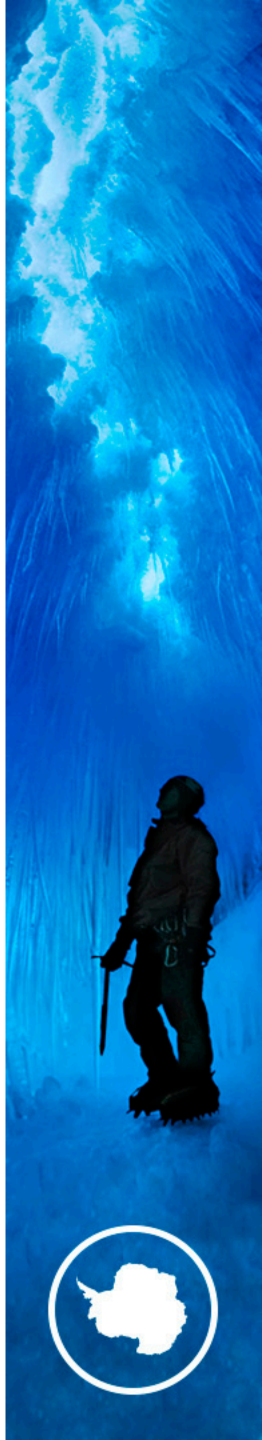


Amplitude variation with bed incidence angle (AVA) - observed and synthetic curves

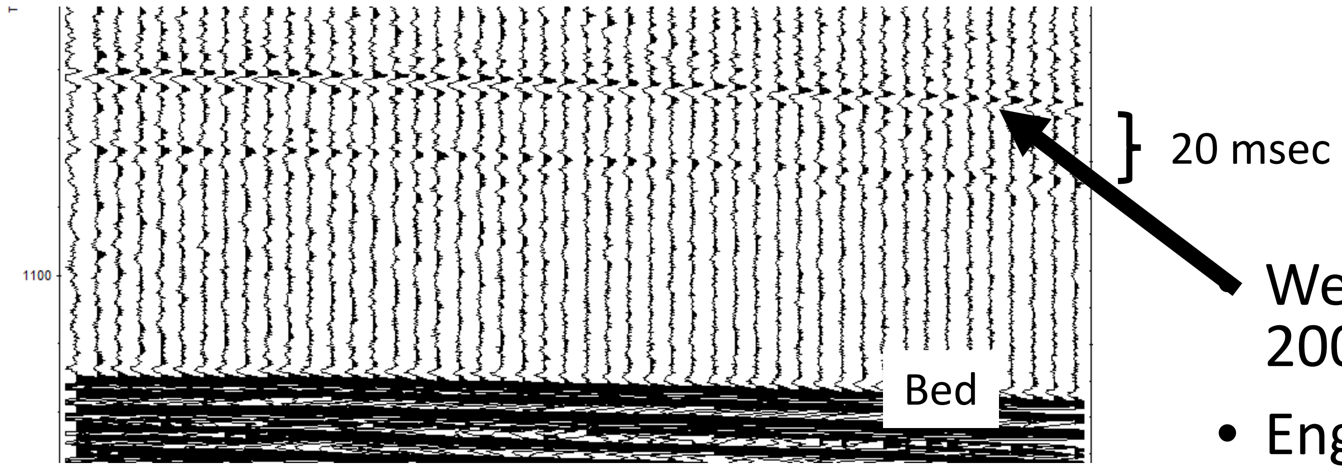


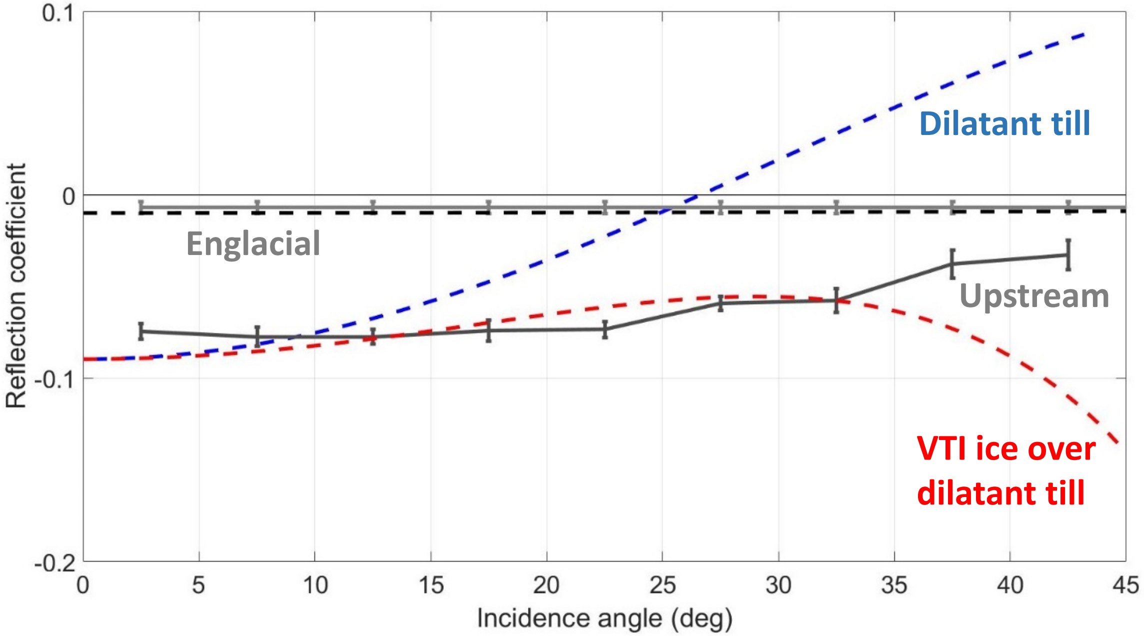
- **Downstream** – positive reflection with little angle dependence
  - General fit to consolidated sediment at the bed
- **Upstream** – negative reflection and no phase reversal with increasing offset
  - AVO signal does not fit standard deforming sediment AVO signature as not phase reversal with offset
- No indication of thin-bed effects which result in significant amplitude variation with incidence angle

But why no phase reversal in the bed AVA signal at the upstream site if it is dilatant till (as the normal incidence reflection coefficient indicates)?



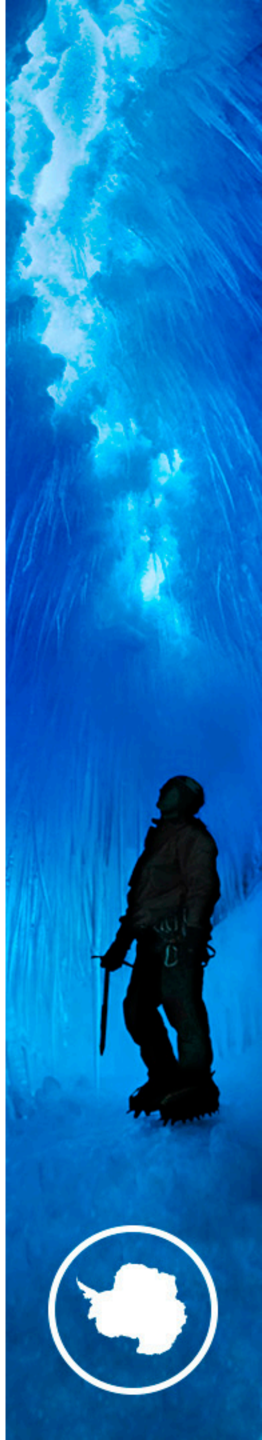
Englacial fabric





Weak englacial reflections within 200 m of the bed

- Englacial reflection AVA signature consistent with weak ice fabric contrast (**black dash** - modelled following Zillmer, 1998)
- Upstream bed AVA signal does not show phase reversal expected for dilatant till (**blue dash**)
- Upstream bed AVA signal fits better with VTI ice overlying dilatant till at the bed (**red dash**) (modelled following Ruger, 2002)



Conclusions

- Preliminary seismic normal incidence and AVA results indicate a dilated basal sediment transitioning to a more consolidated sediment downstream
- AVA analysis of englacial reflections indicates weak fabric contrasts close to the bed
- Fabric in the basal ice can modify the basal AVA signature to better match observations

Further work

- Determine likely fabric transitions in basal ice
- Match AVA signature of bed to likely basal ice fabric to improve fit at far offsets
- Compare seismic observations to ongoing bed-sample analysis results

References

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