A modern analogy to relict grounding lines on Kamb Ice Stream

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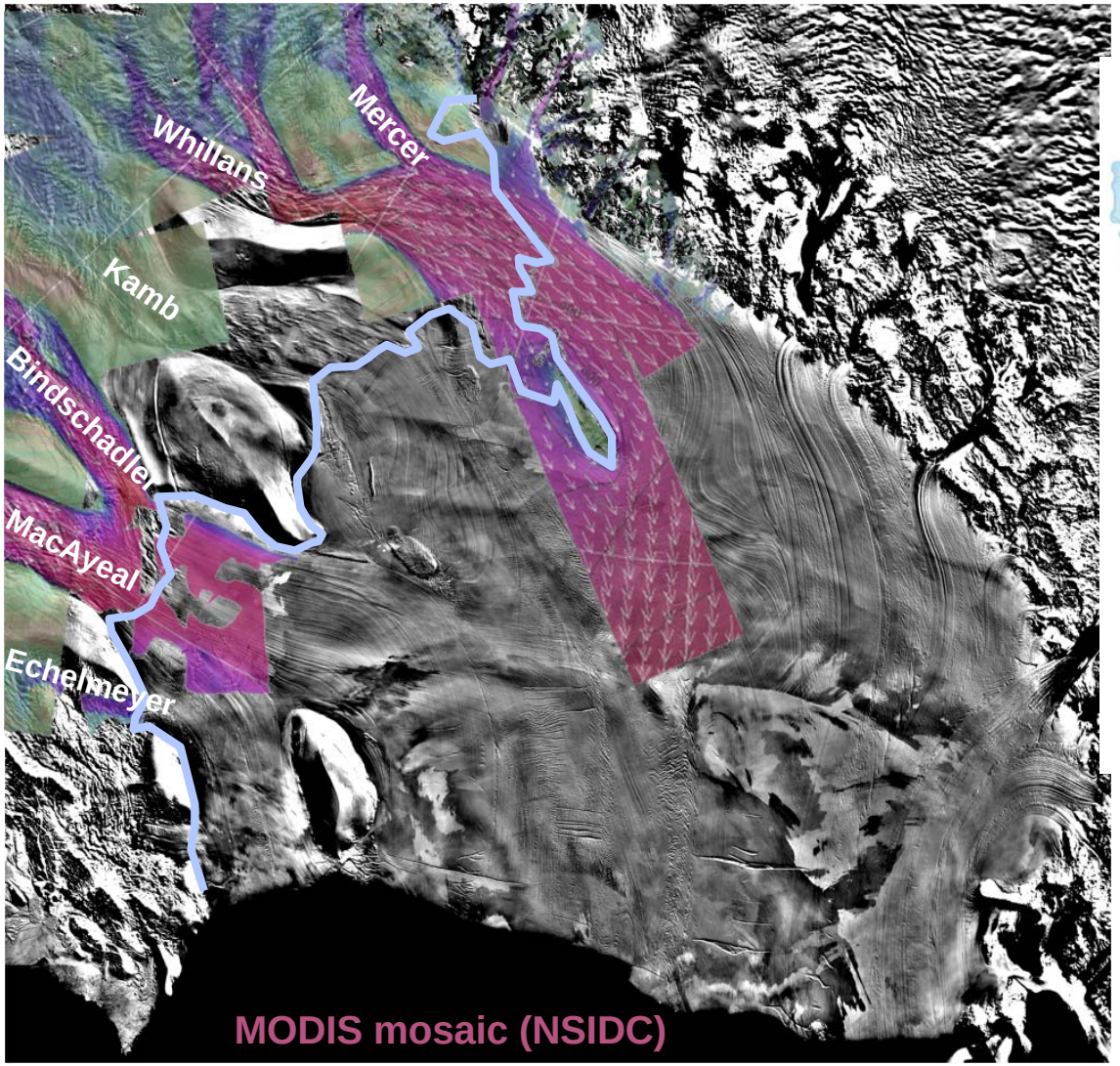
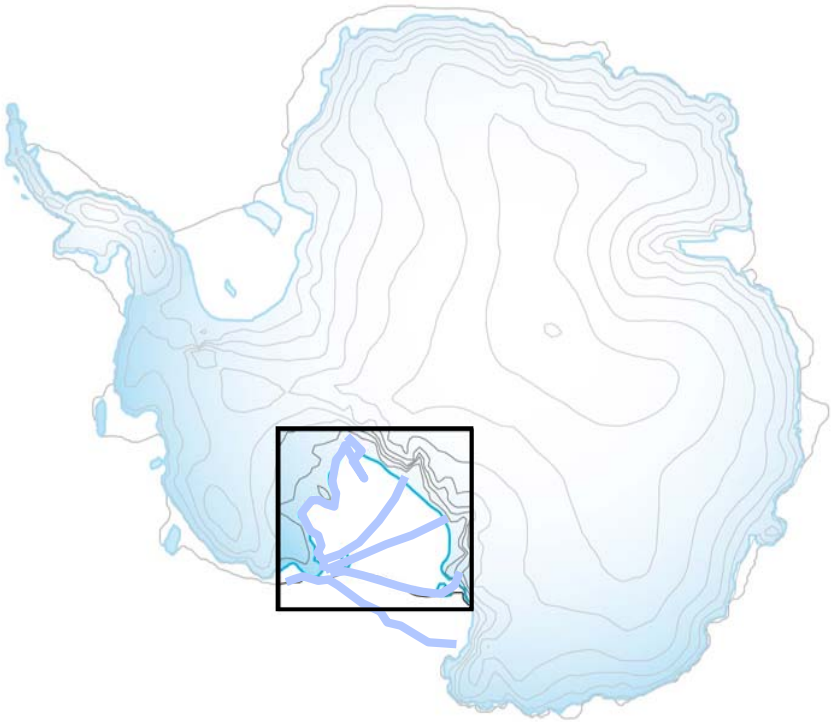
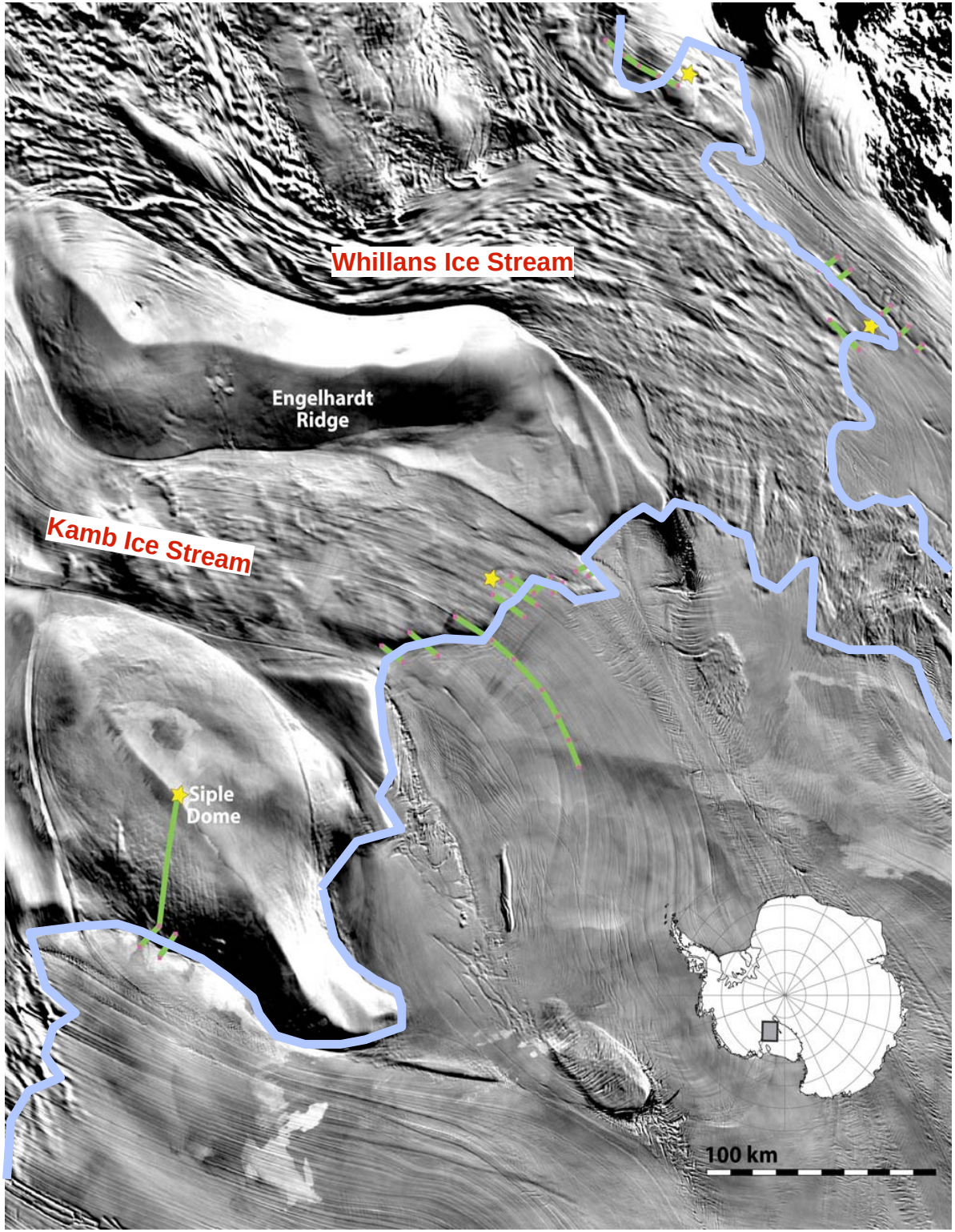




Conway et al., 1999



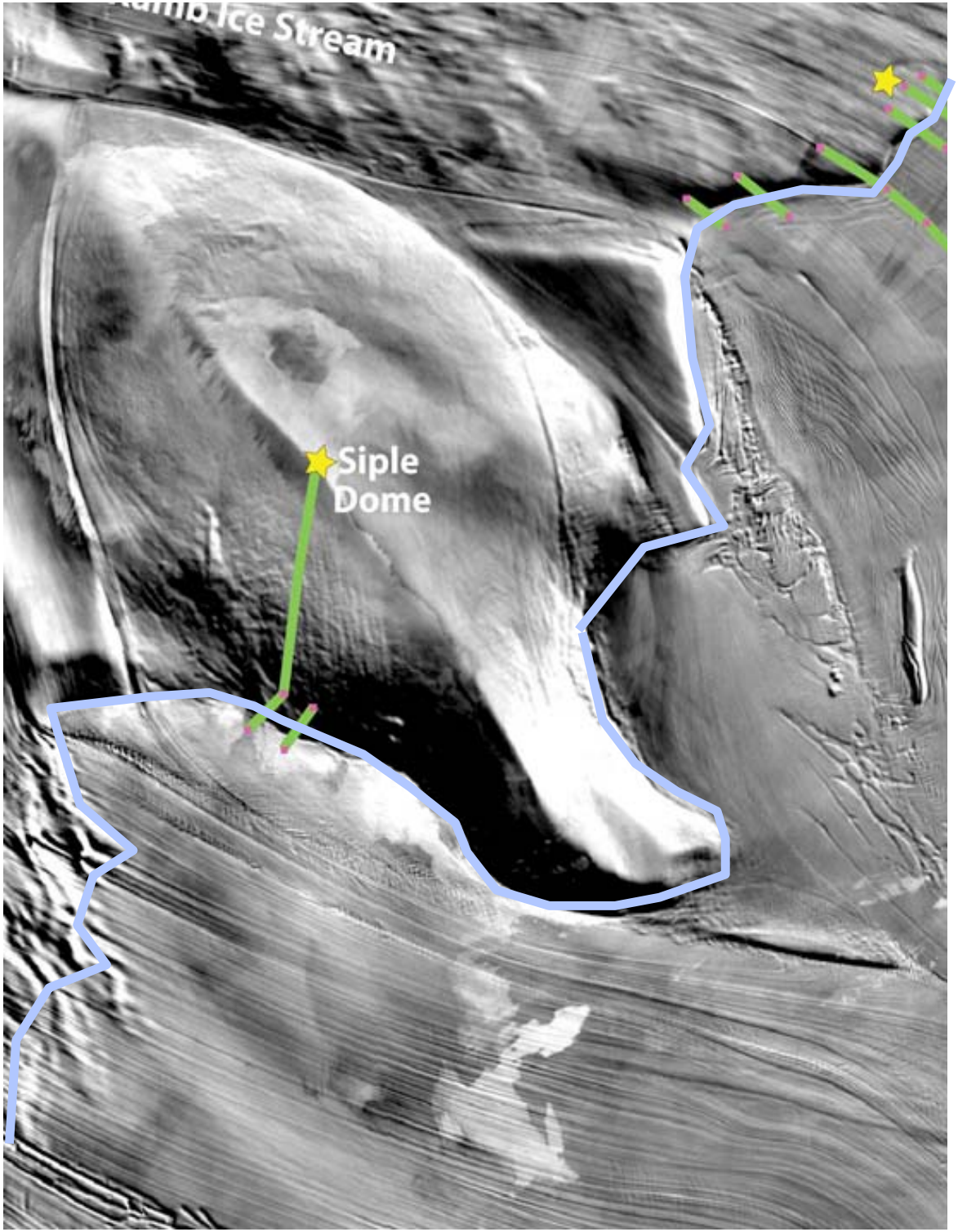
2006 season

Several profiles across different types of grounding lines:

- ridge-type
- stagnant ice stream (lg. basal drag gradient)
- active stream type (sm. basal drag gradient)
- embayment type

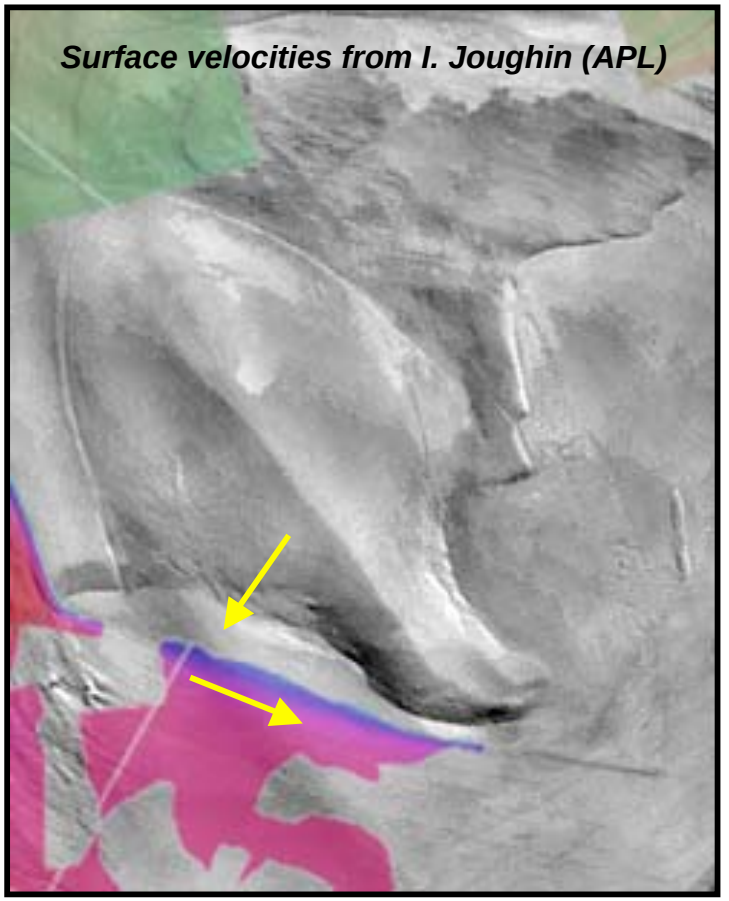
Also installed GPS strain networks across two different grounding line types

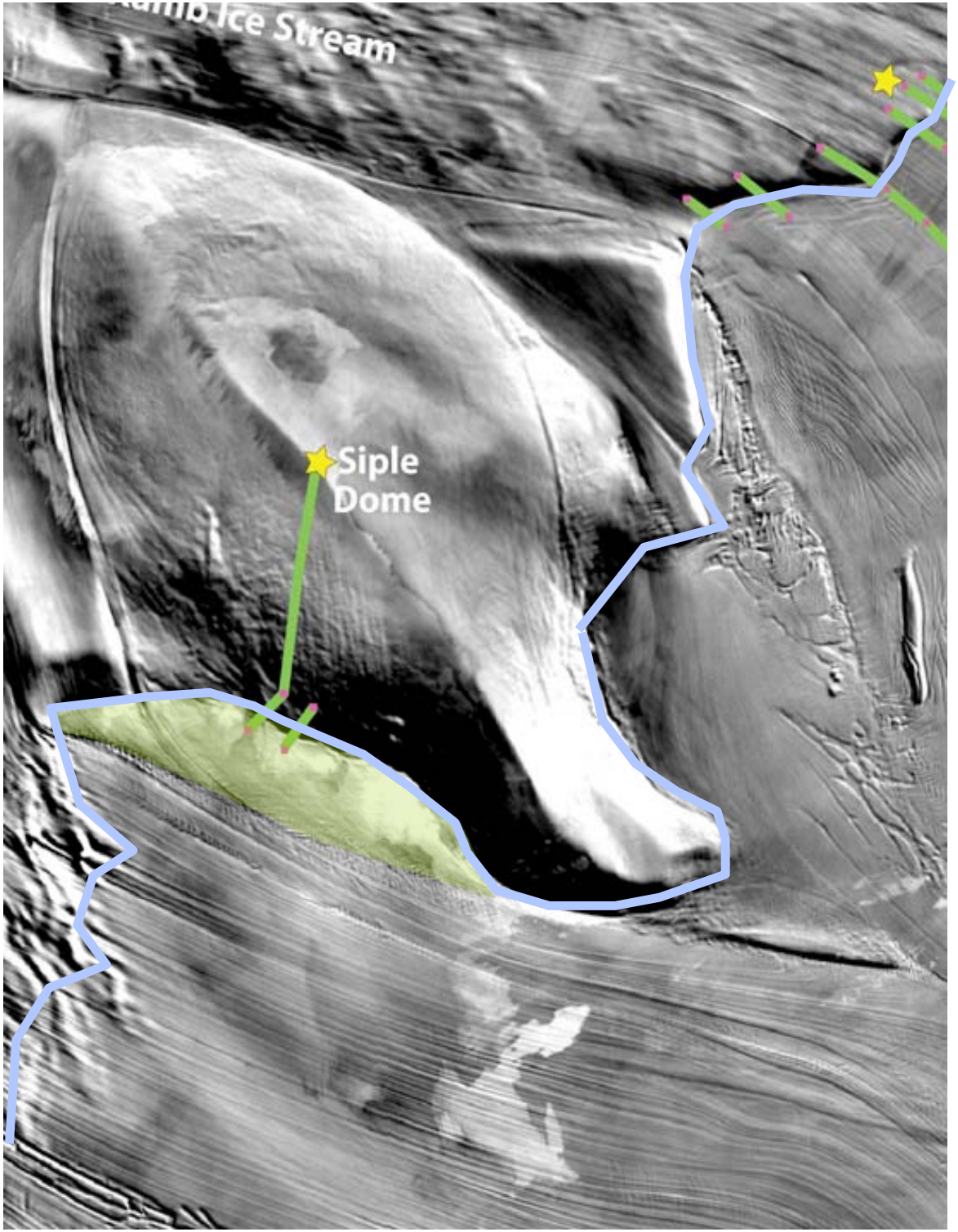
Primarily we are imaging modern grounding lines in order to build a context in which relict features may be interpreted, in particular the history of grounding line migration and processes controlling migration.



North Side of Siple Dome

- grounding line embayment
- area where slow ice goes afloat
- two radar profiles across g.l. here





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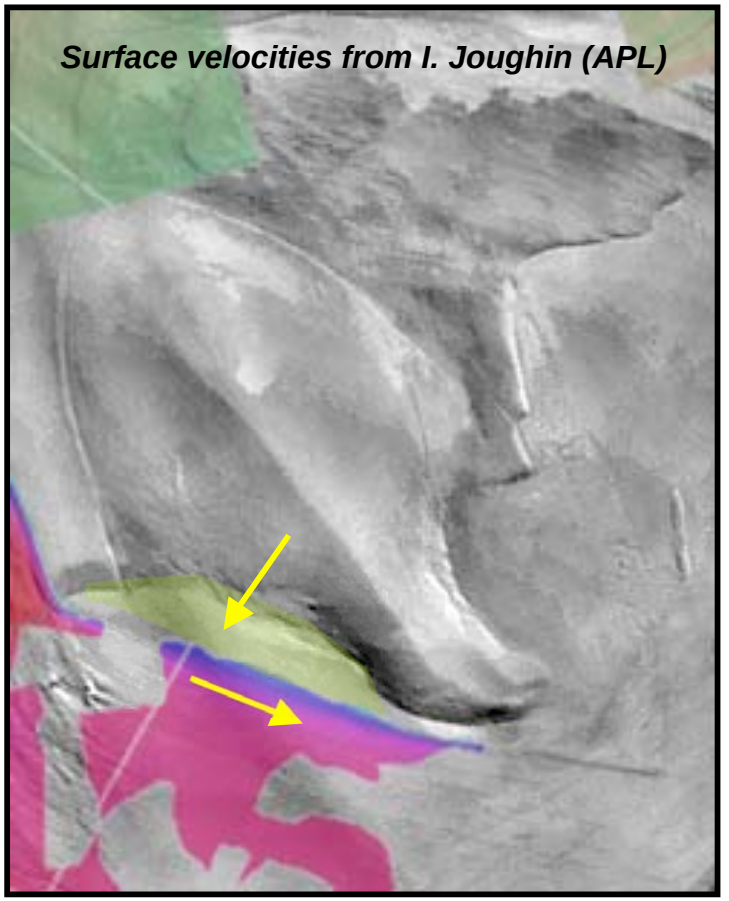

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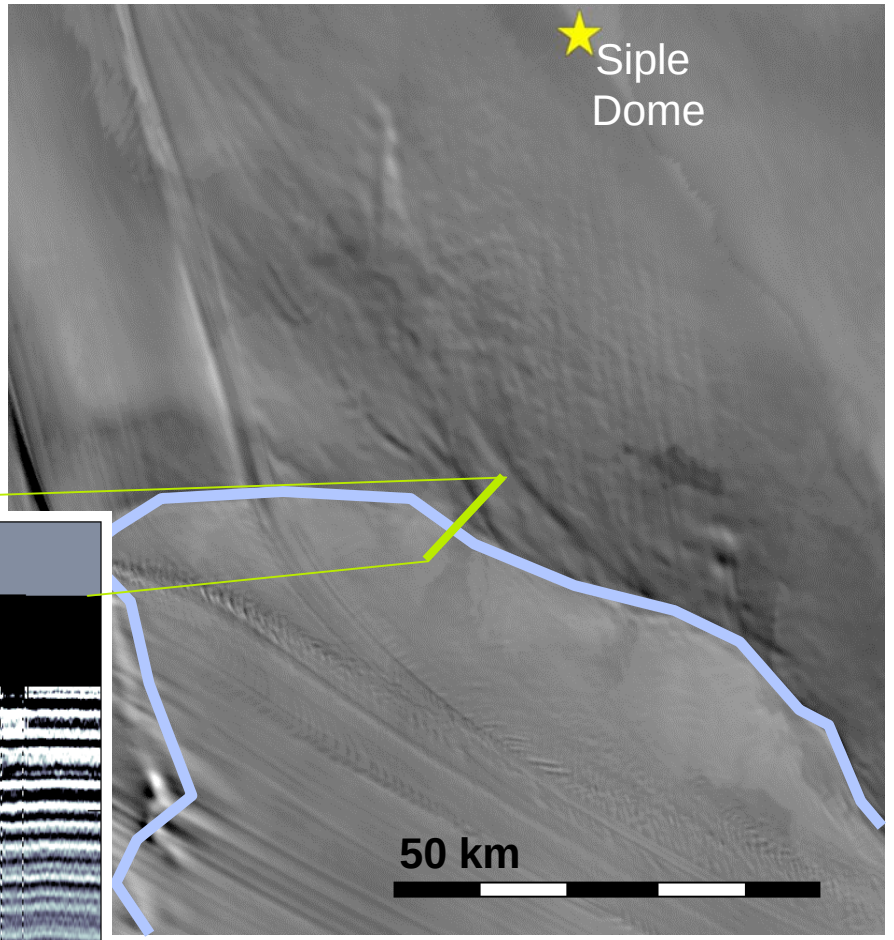
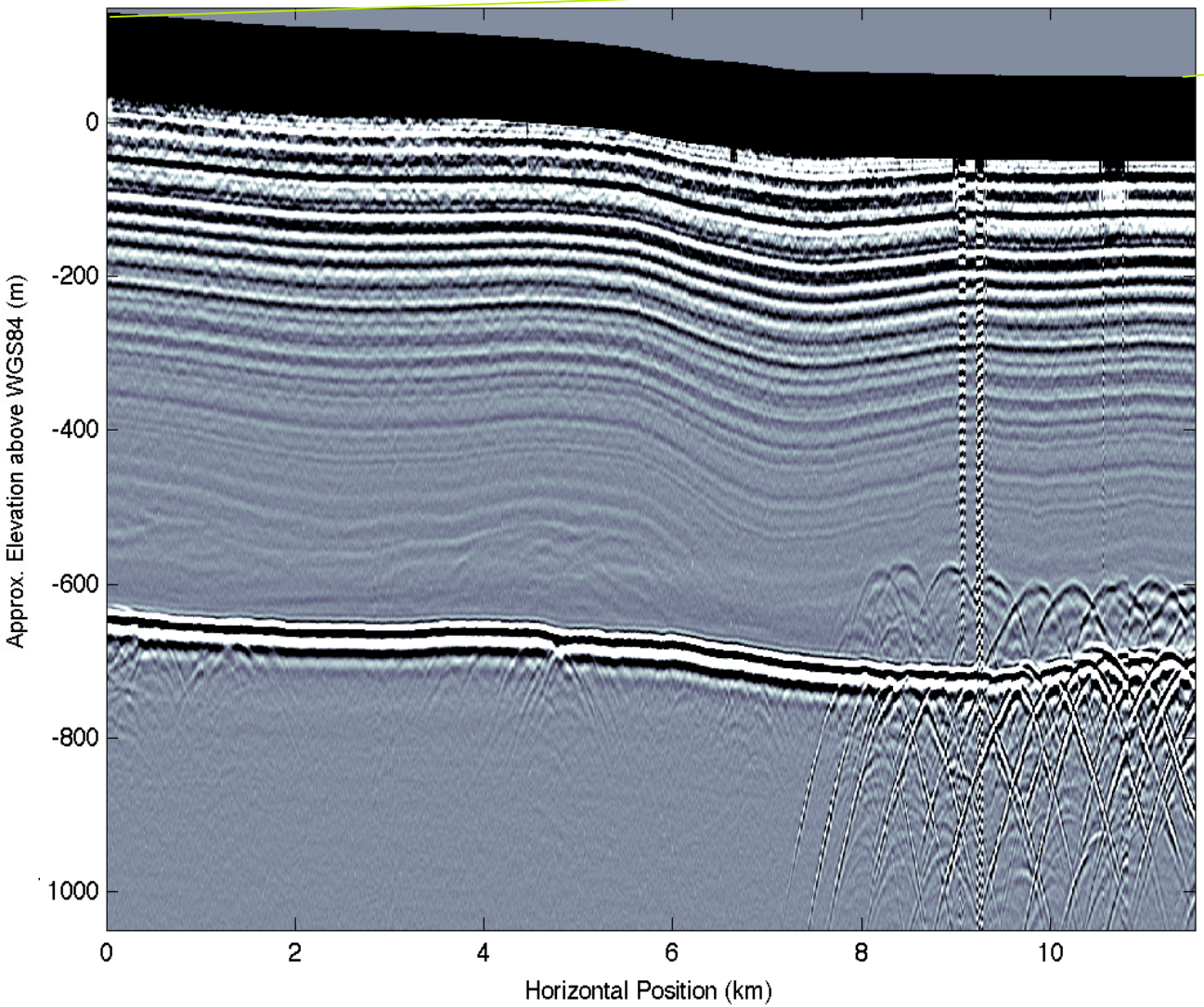
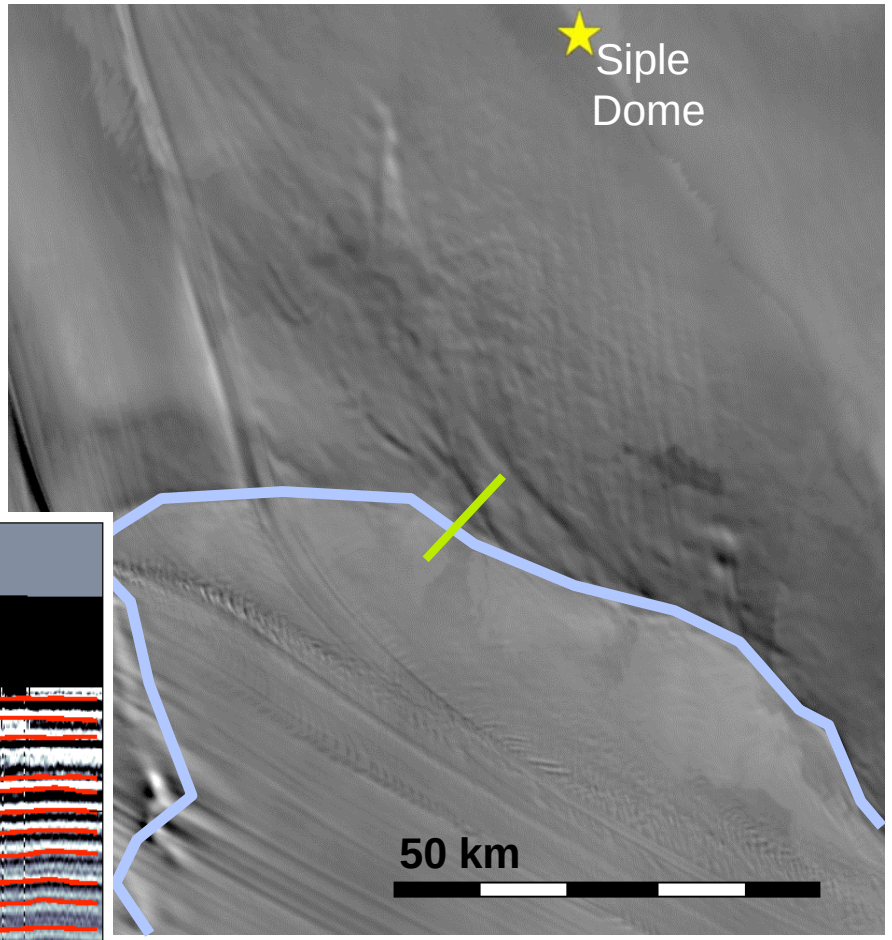
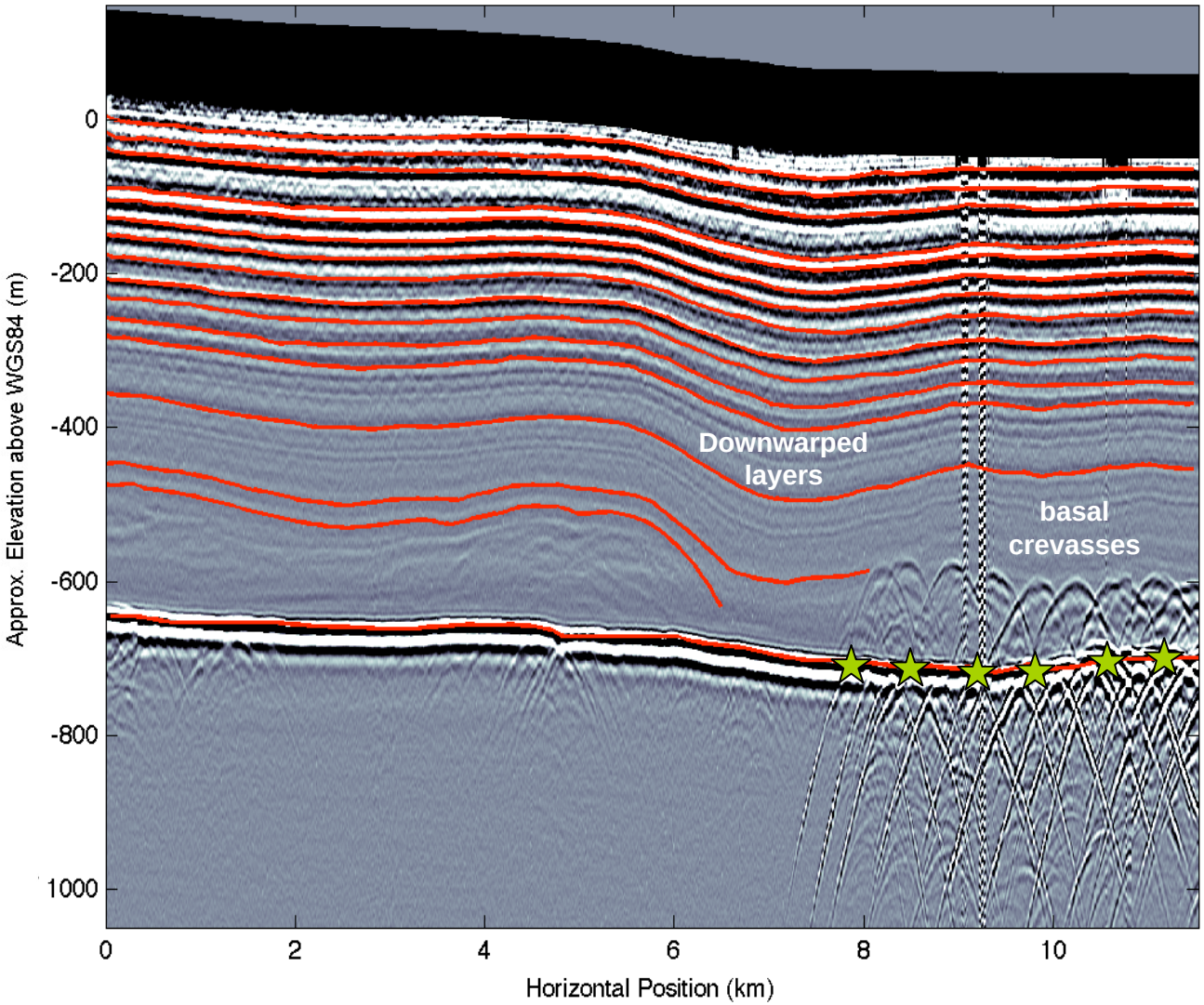




North side of Siple Dome

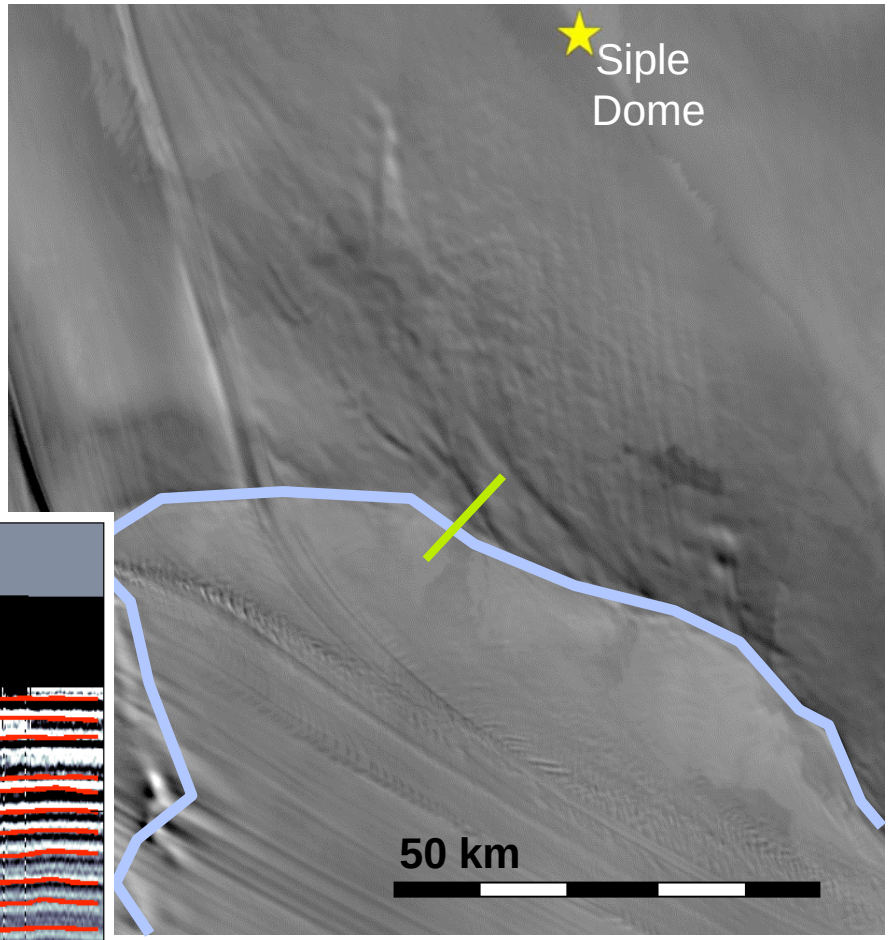
- downwarp amplitude grows with depth
- deep layers are truncated by the bed

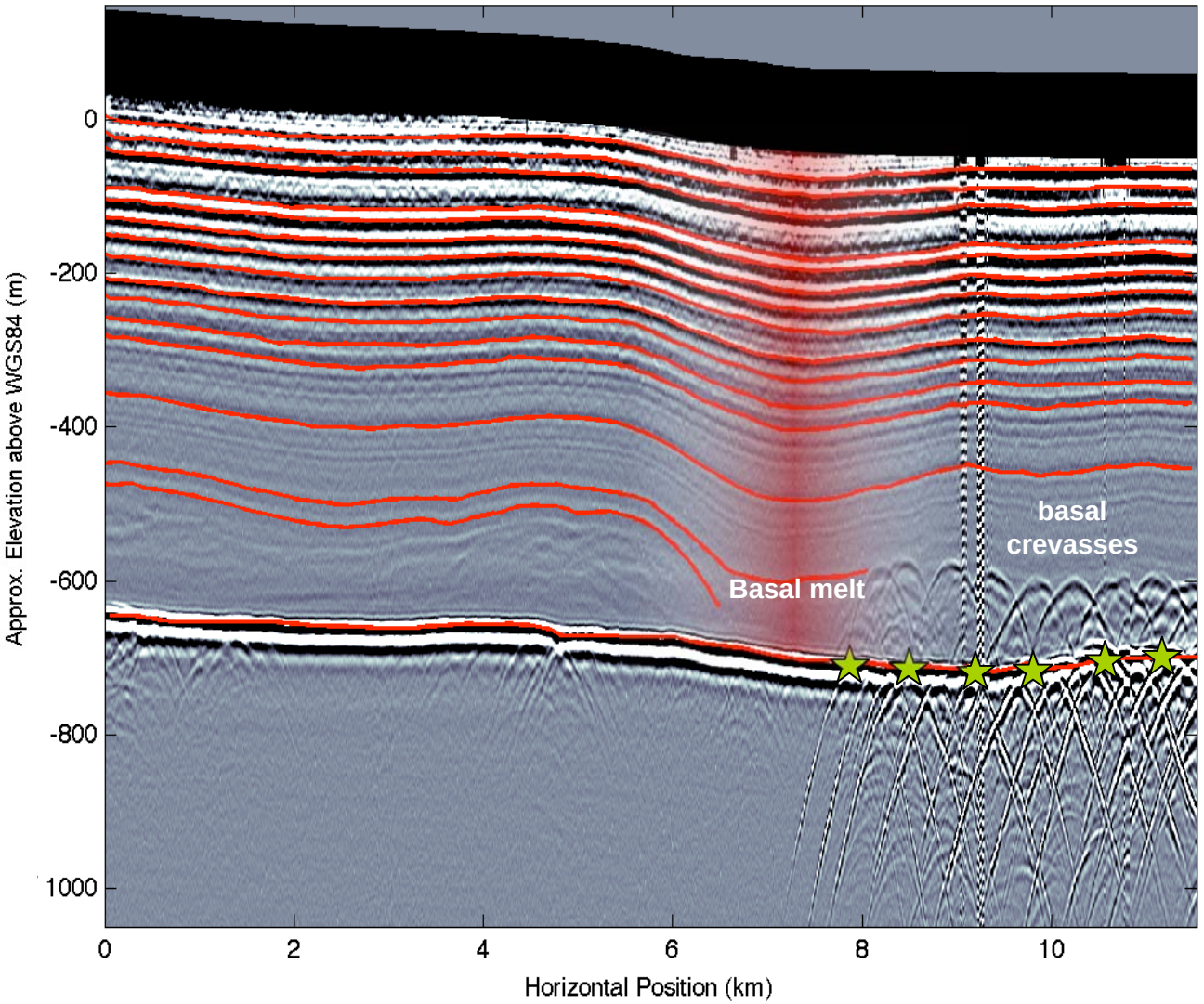




characteristics match basal melt

- downwarp amplitude grows with depth
- deep layers are truncated by the bed
- melt region is very focused (~2 km)
- melt occurs upstream of basal crevasses



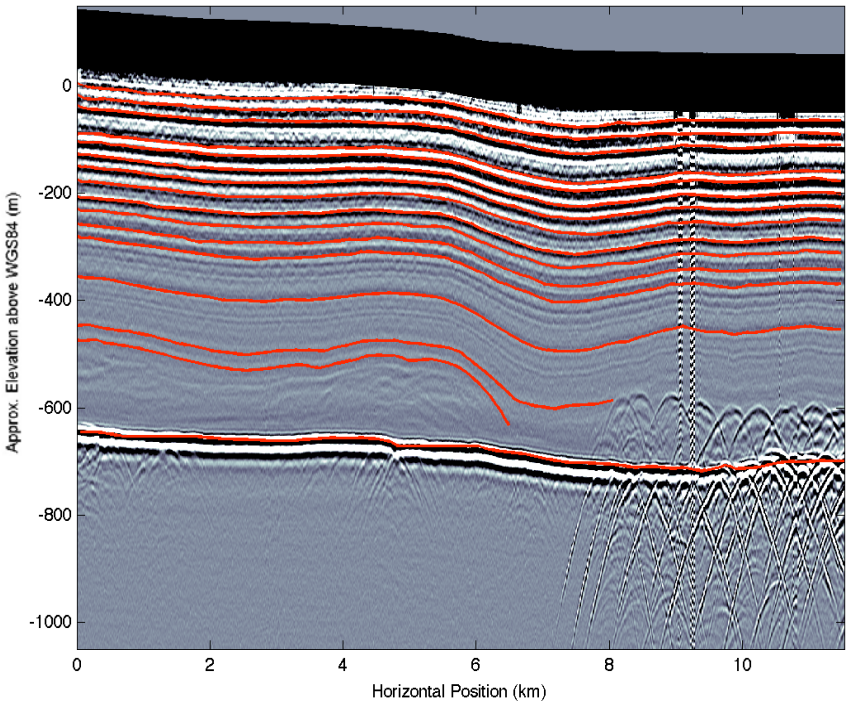


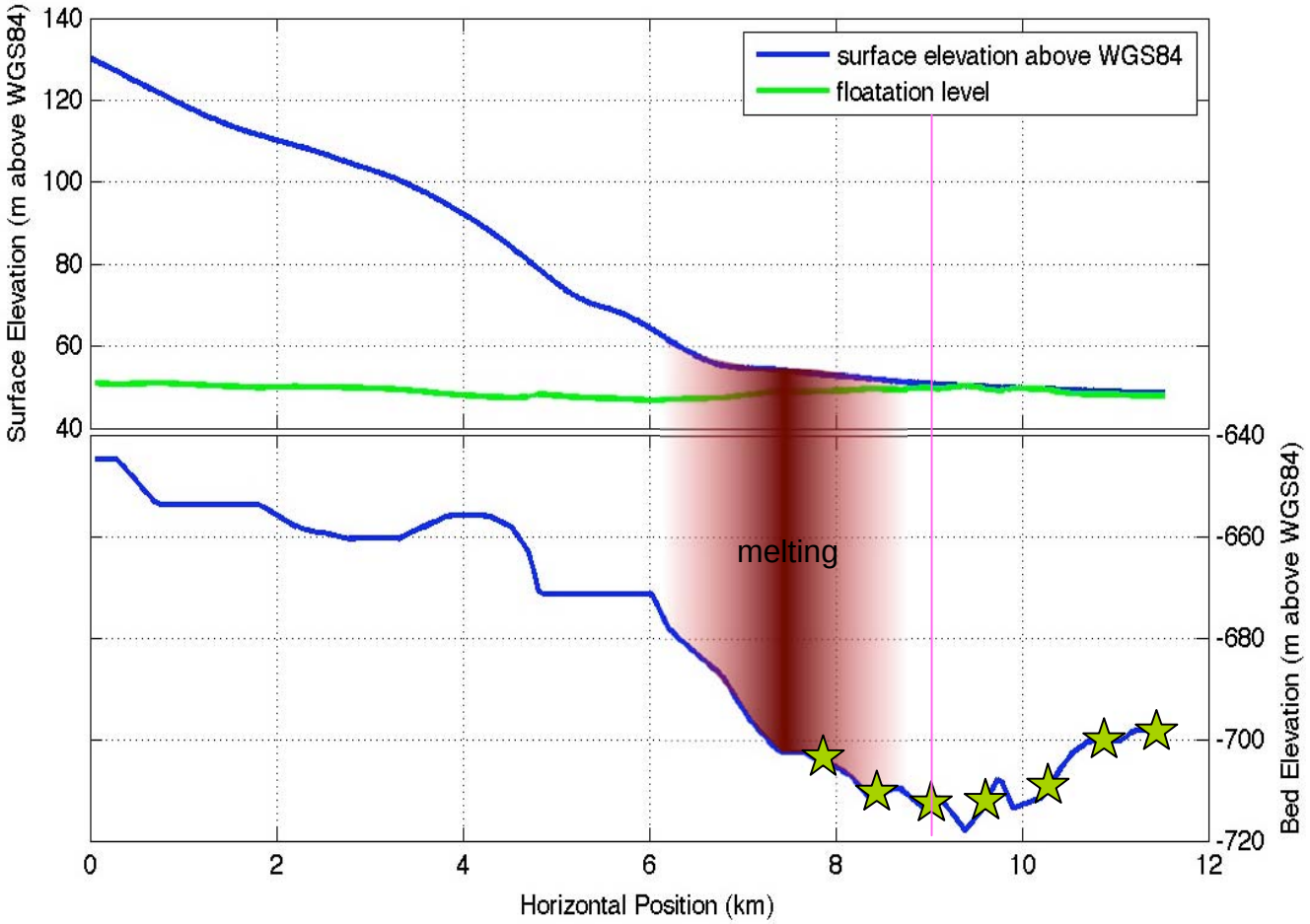
Ice shelf melt from HSSW(?)

proximity to grounding line

- melt occurs just upstream of grounding line
- crevasses appear upstream of grounding line

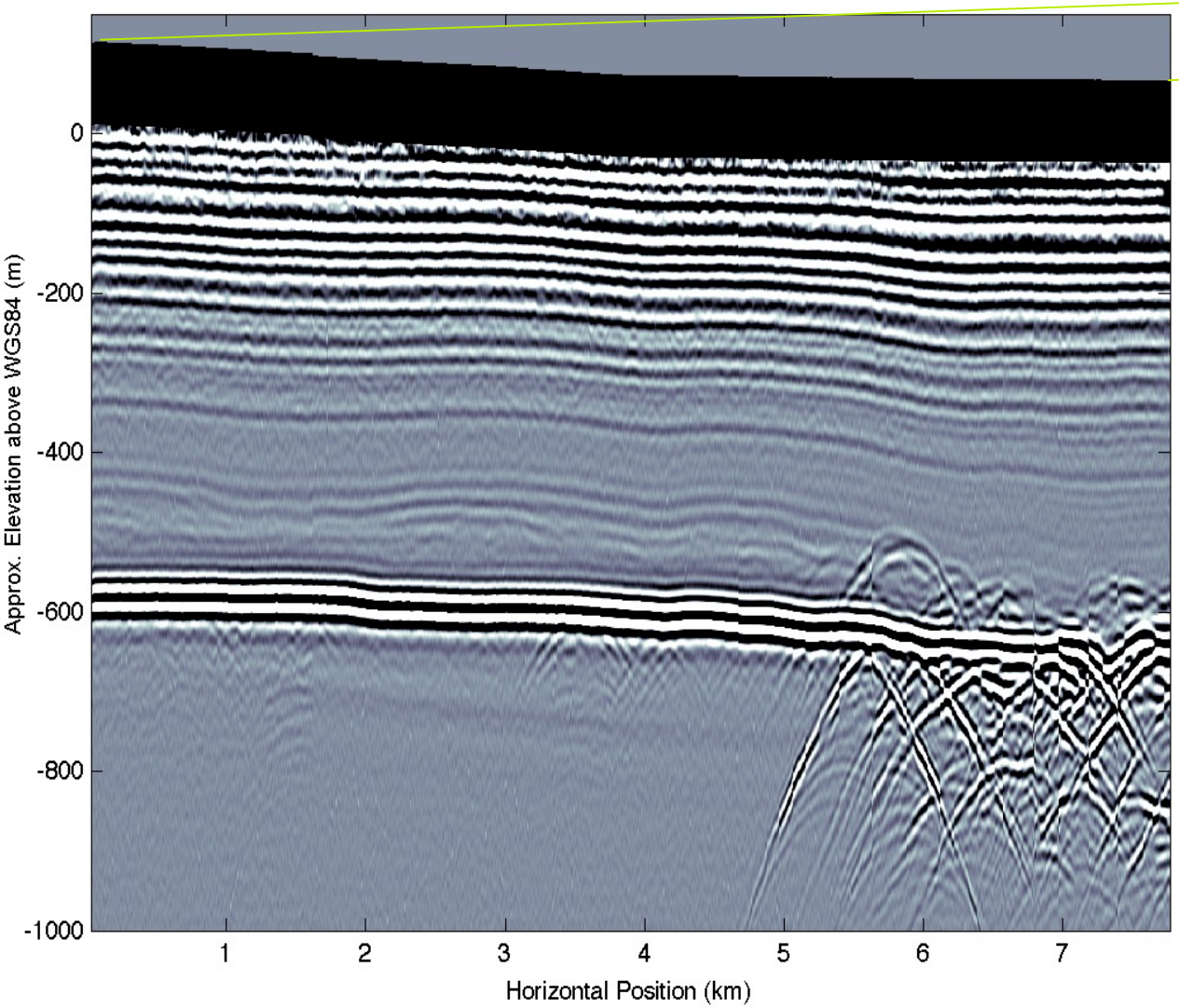
possibly indicates grounding line movement?

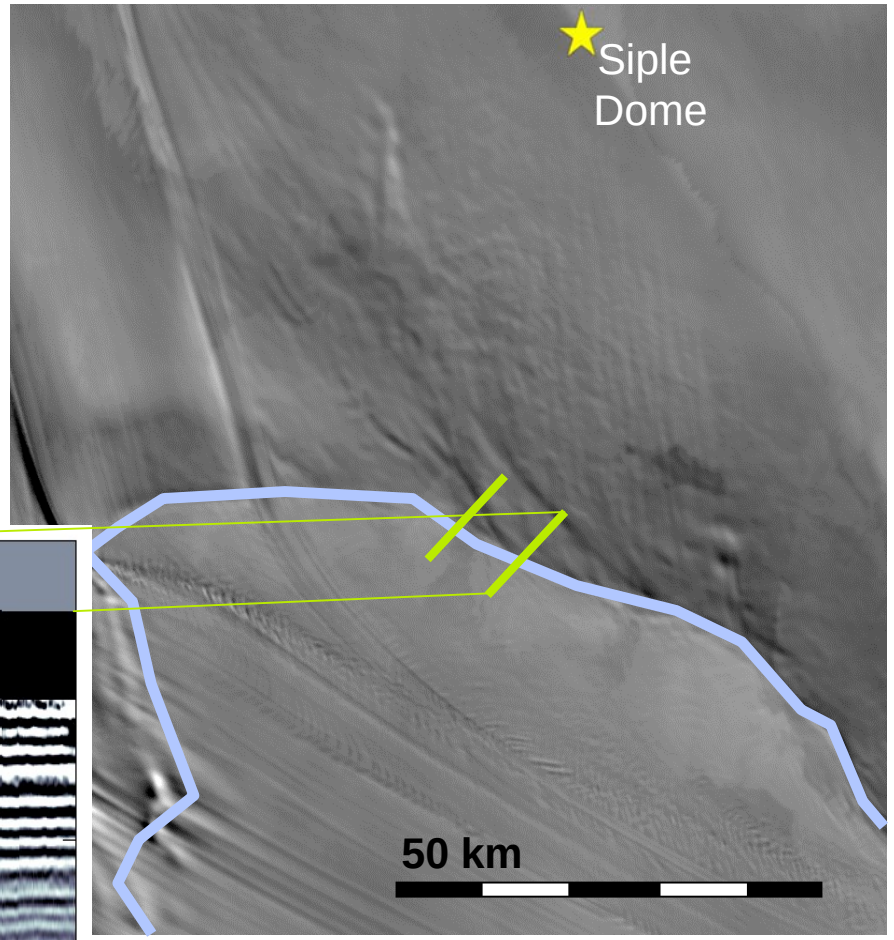




North side of Siple Dome

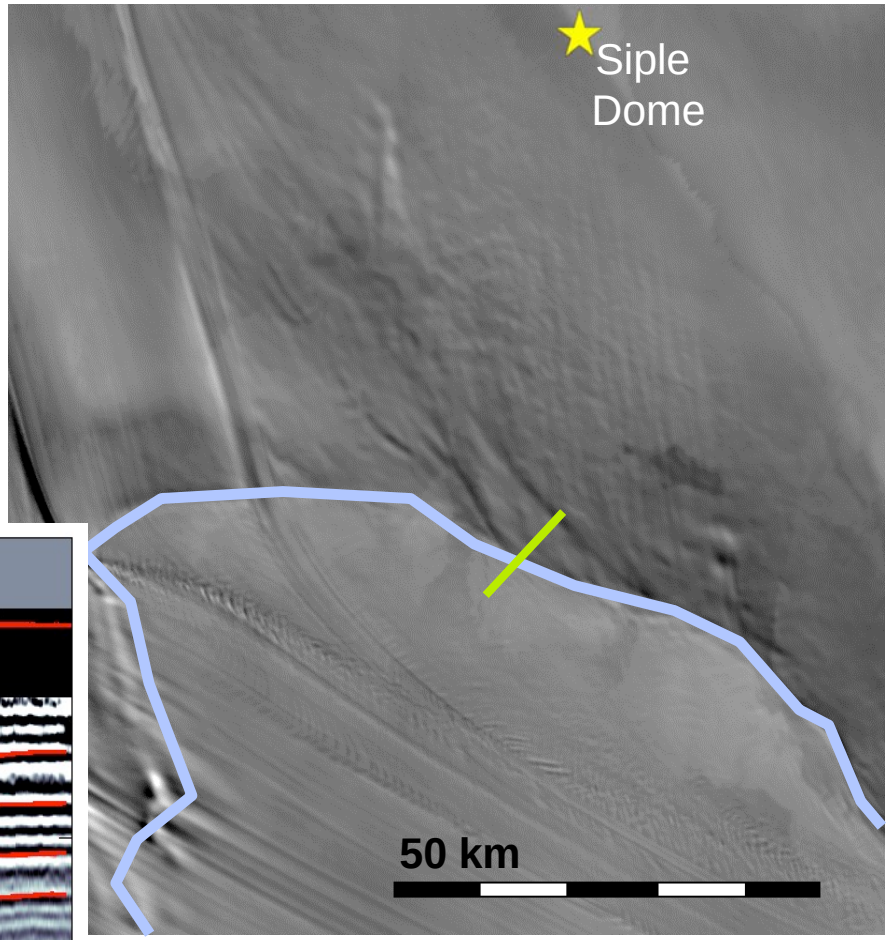
10 km west of previous profile

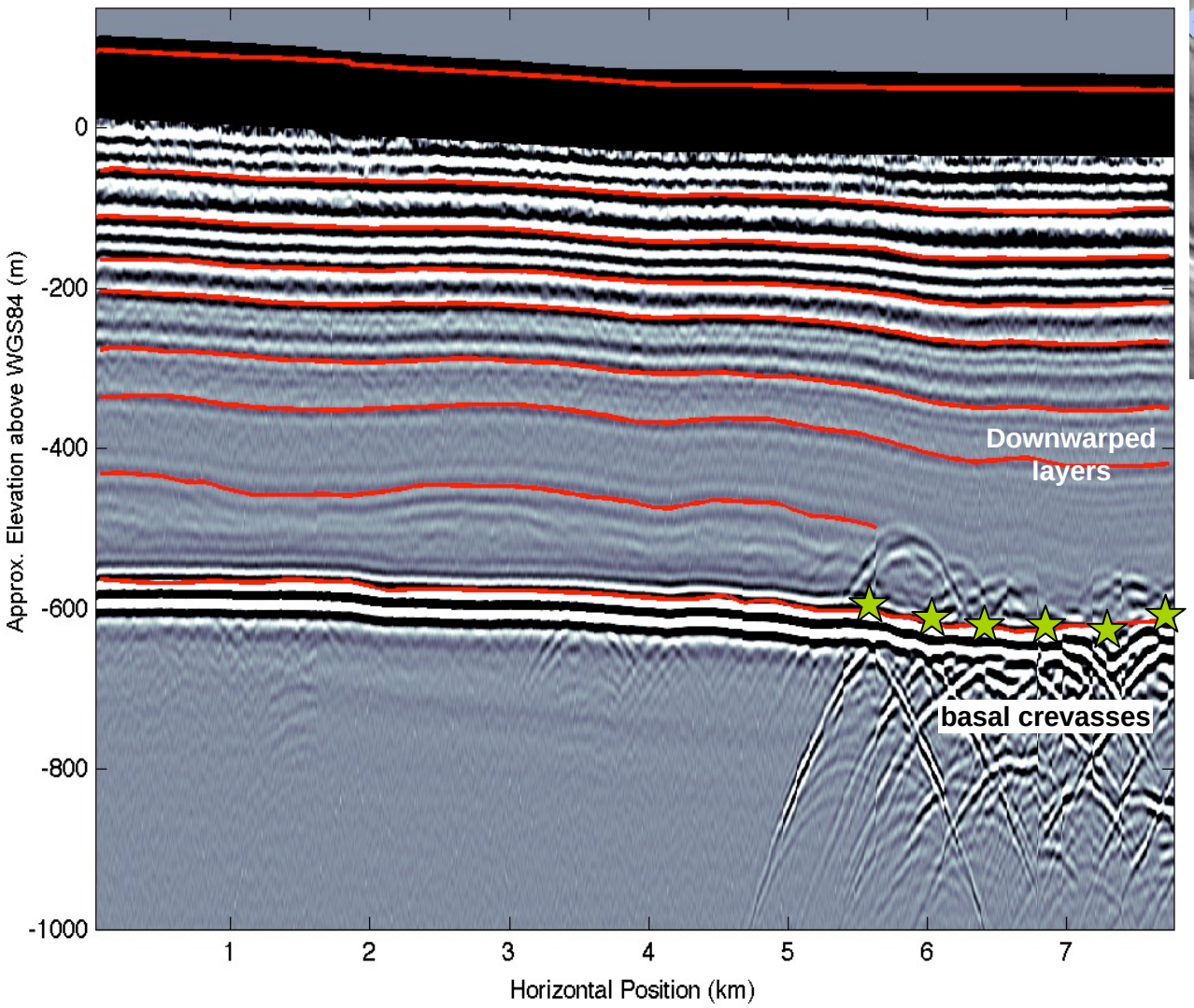




characteristics match basal melt

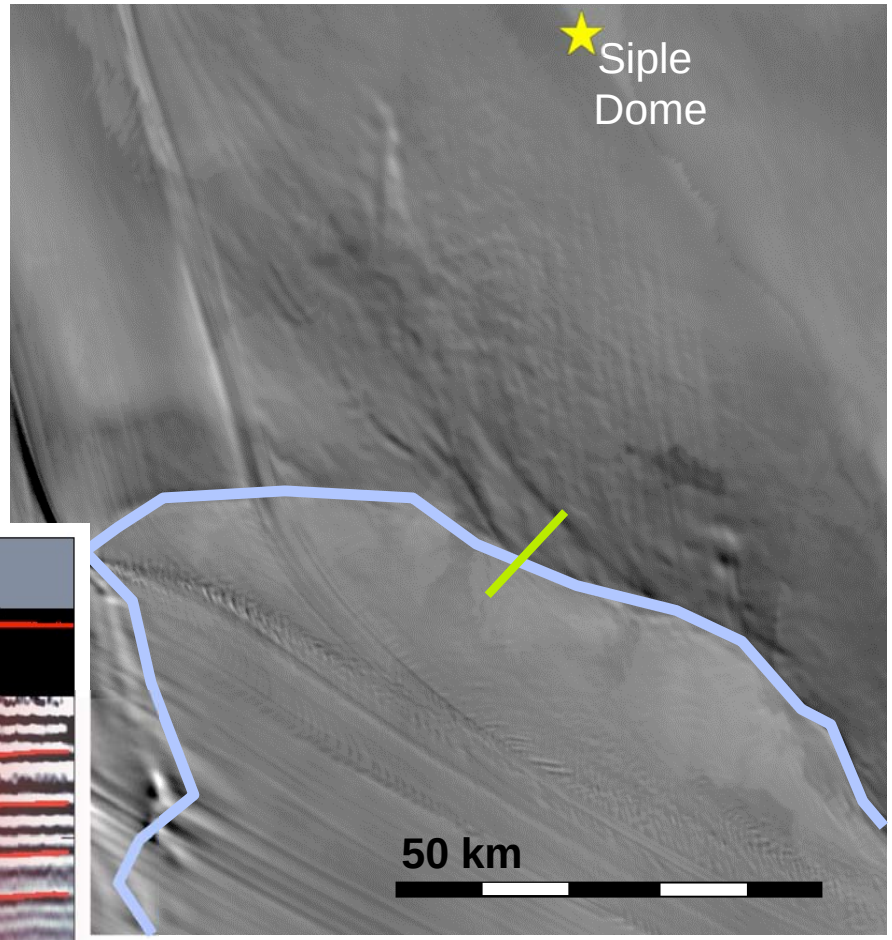
- downwarp amplitude grows with depth

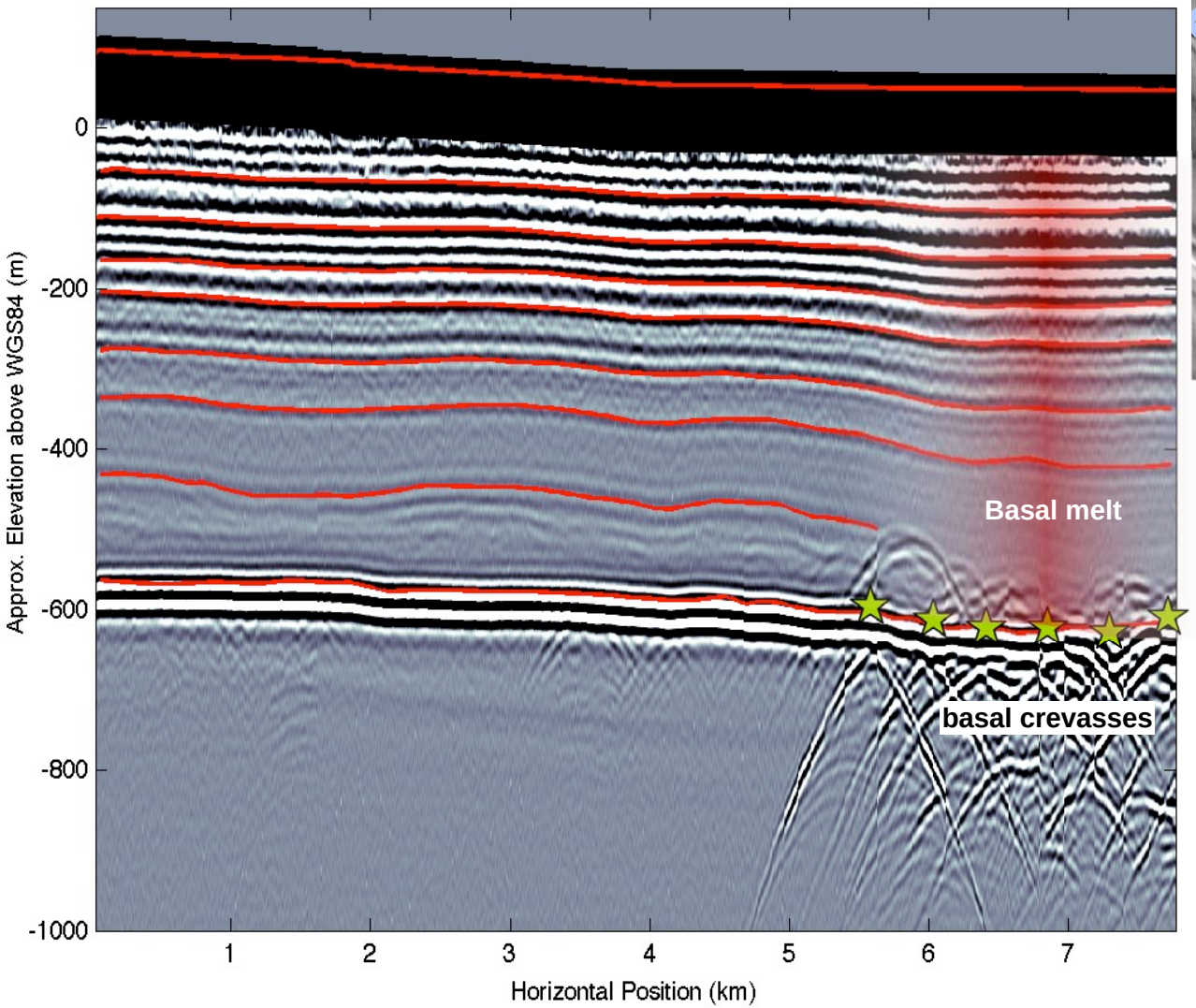




characteristics match basal melt

- downwarp amplitude grows with depth
- melt region is a bit broader (~4 km)
- melt is coincident with basal crevasses

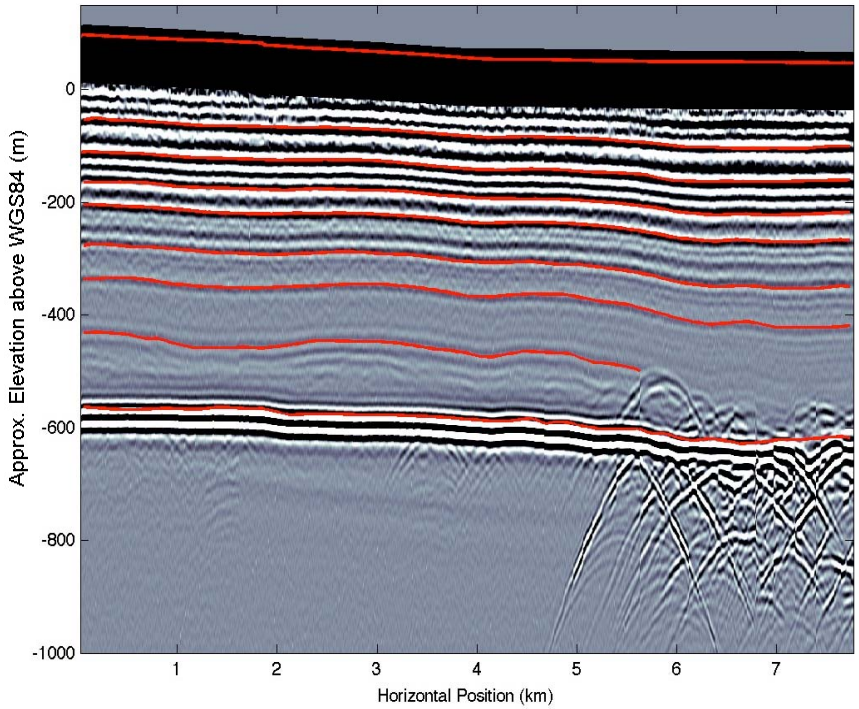


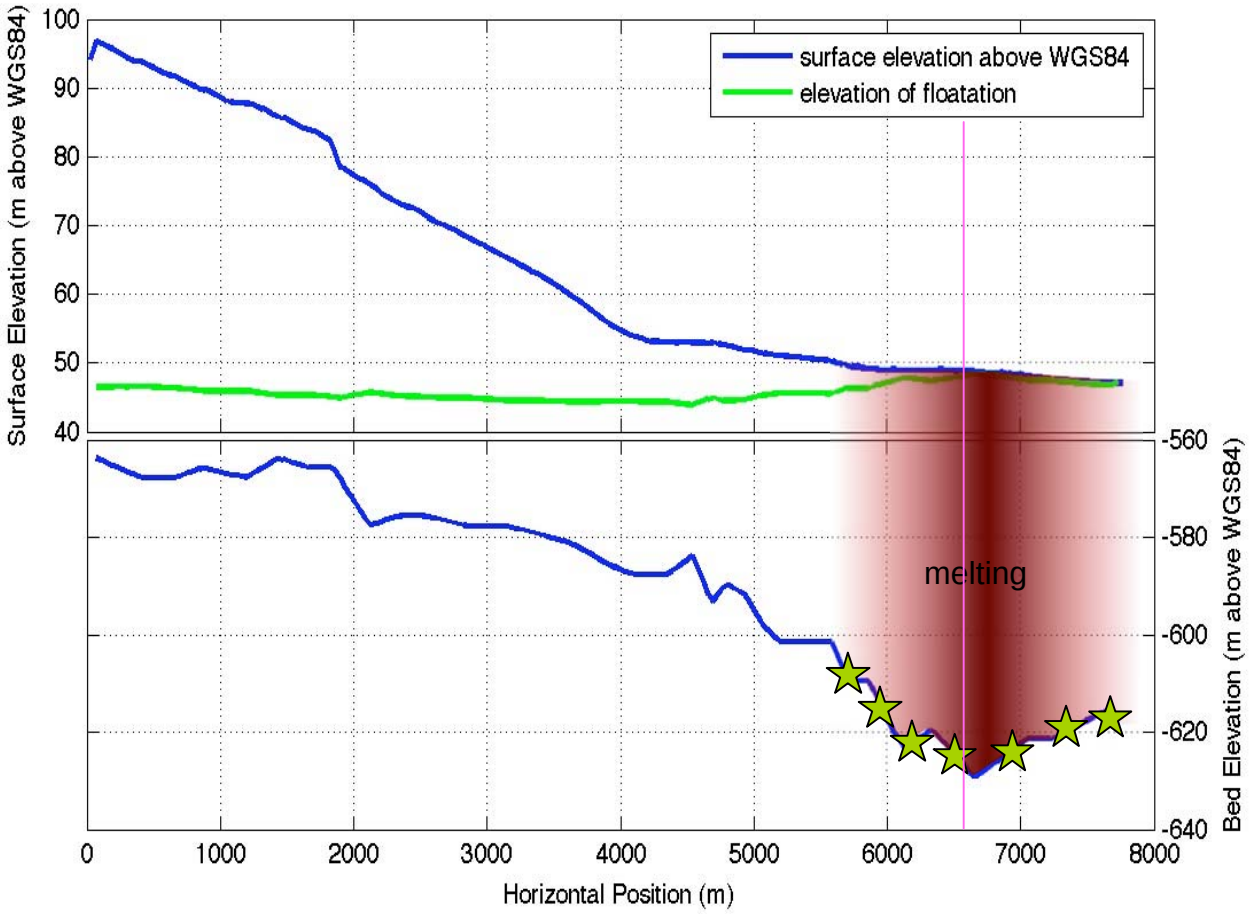


proximity to grounding line

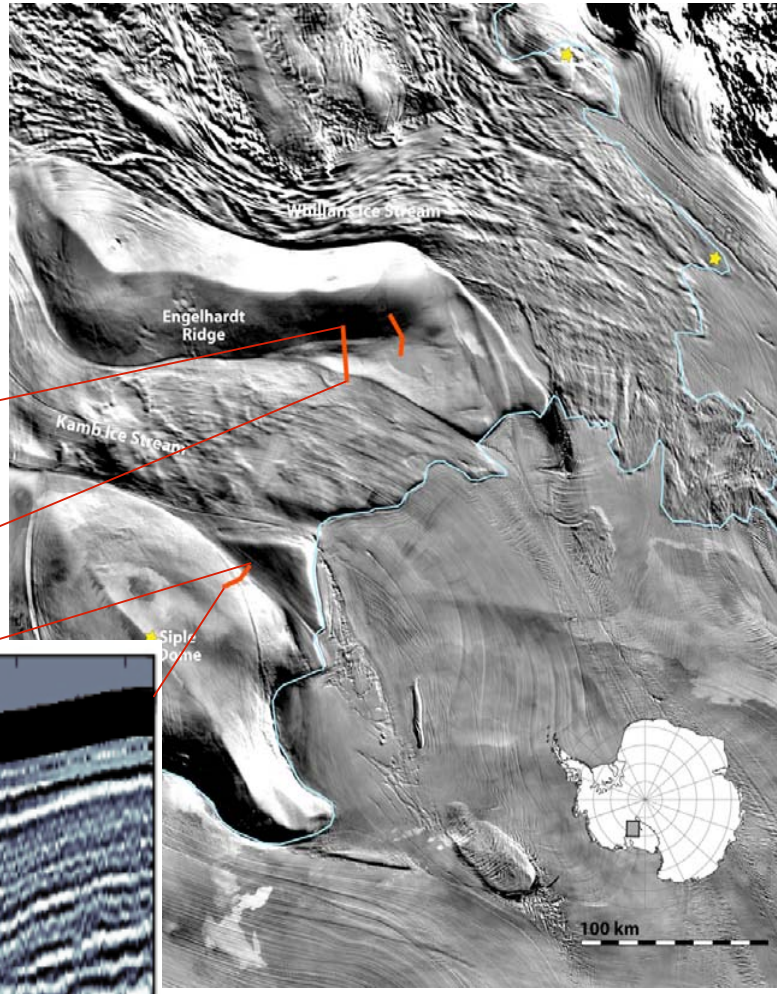
- melt is co-located with grounding line
- crevasses appear upstream of grounding line

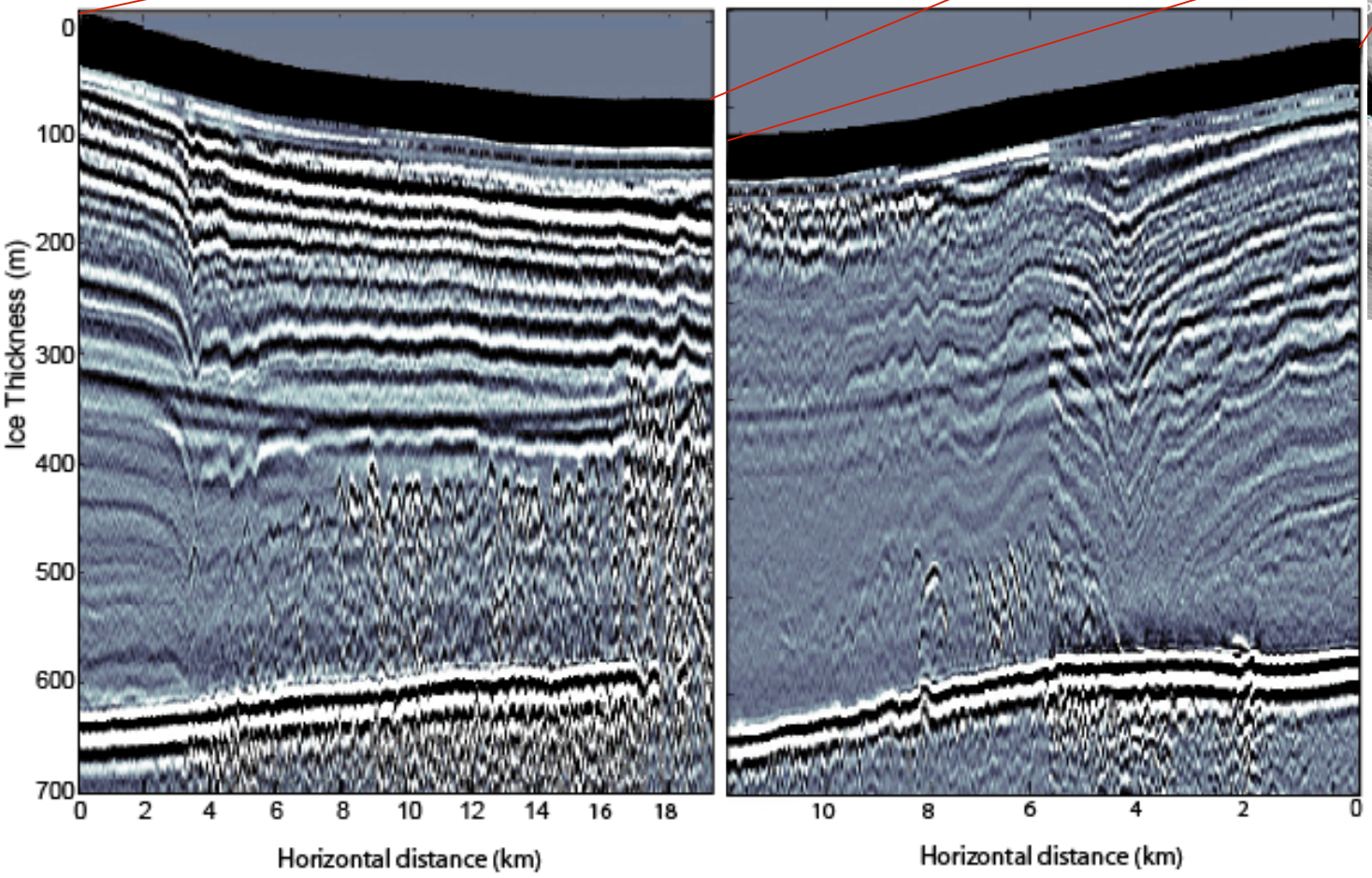
possibly indicates no grounding line movement?





analogy to Kamb Ice Stream features

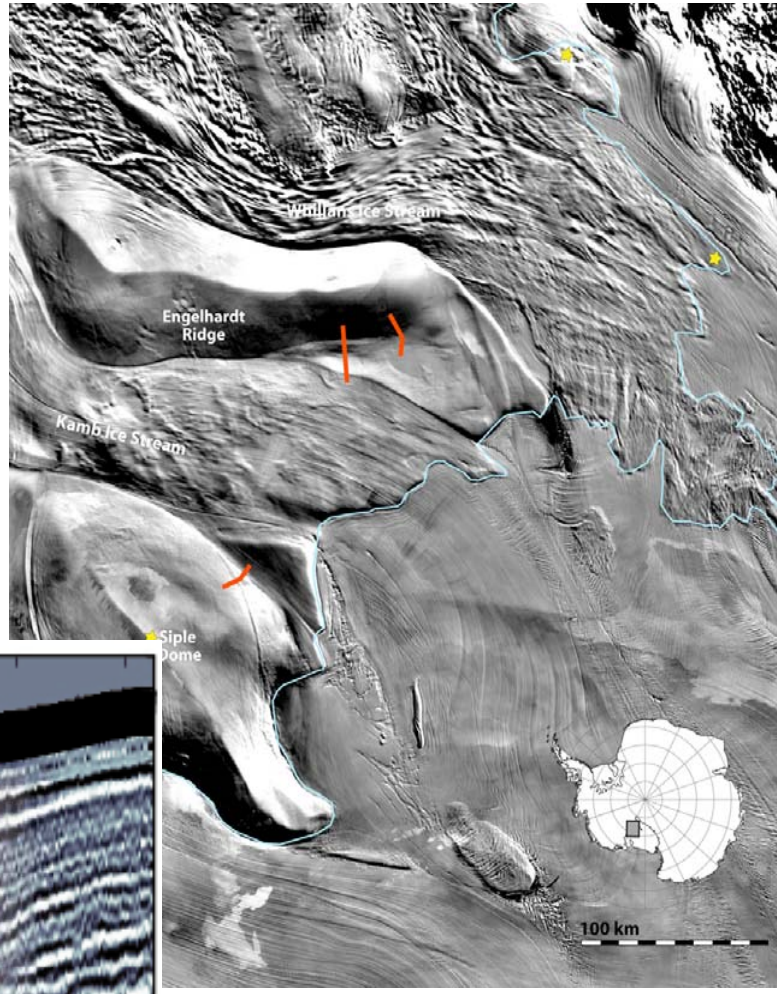


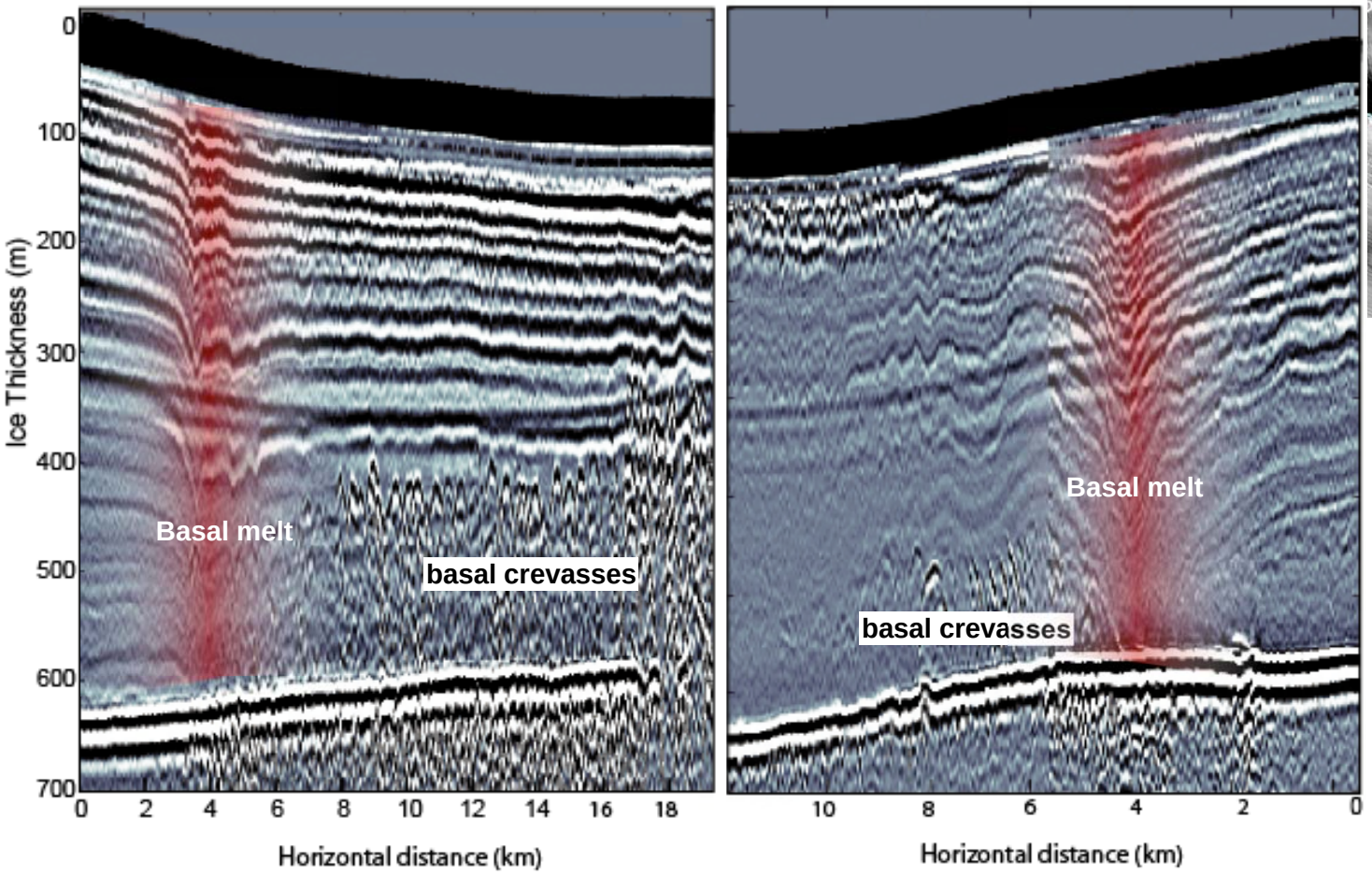


From: Catania et al., 2005

analogy to Kamb Ice Stream features

- downwarp amplitude grows with depth
- deep layers are truncated by the bed
- melt region is very focused (~2 km)
- melt occurs on both sides of KIS





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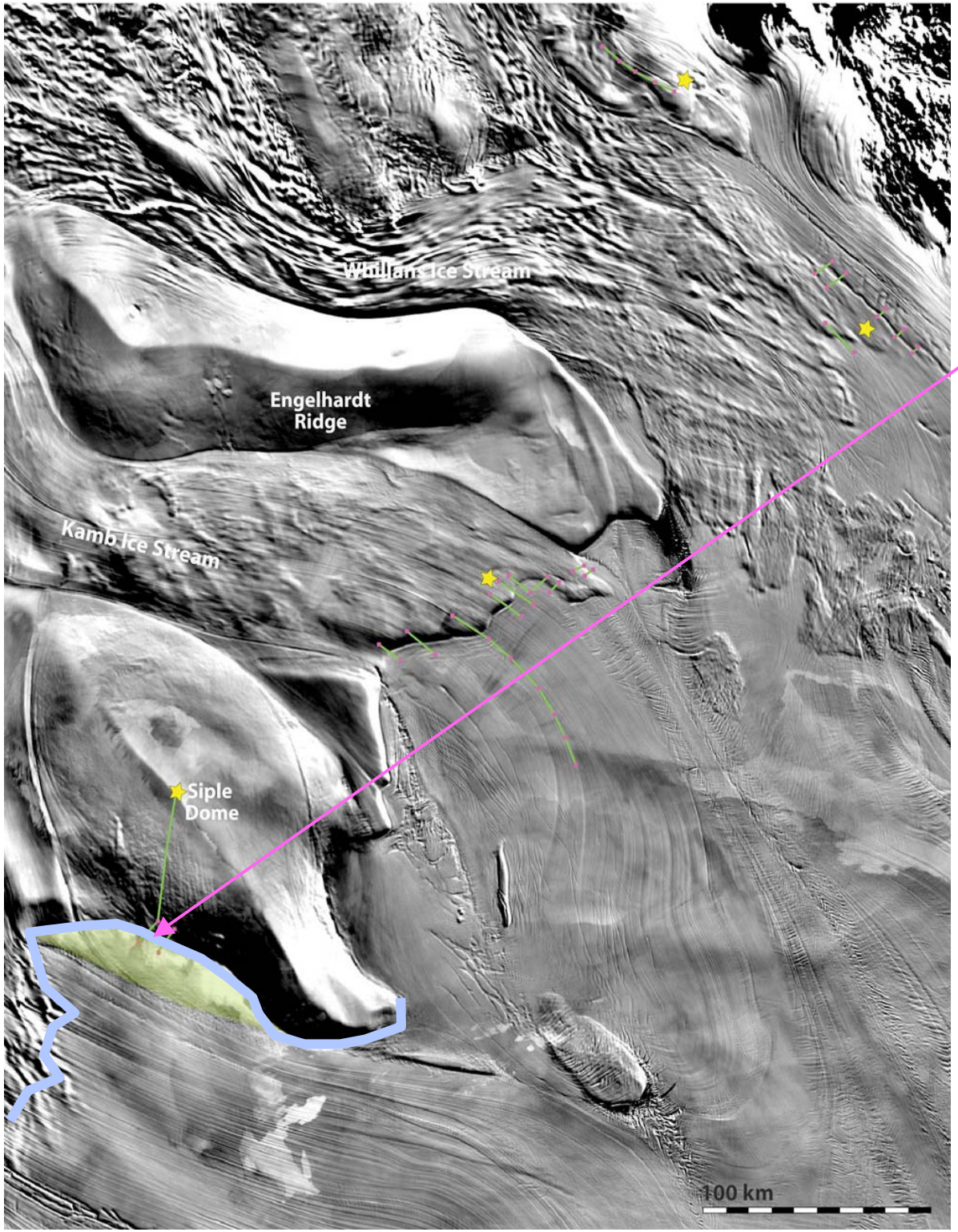
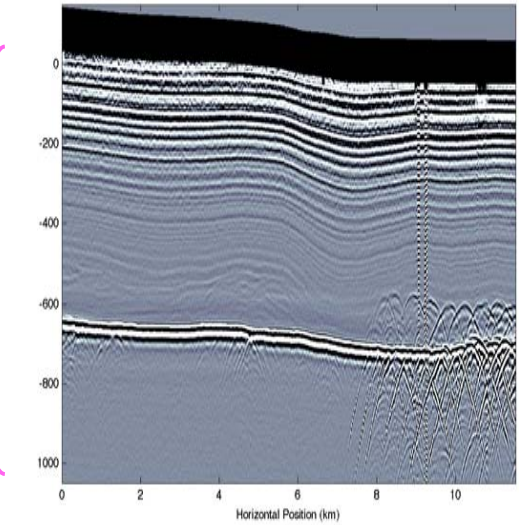
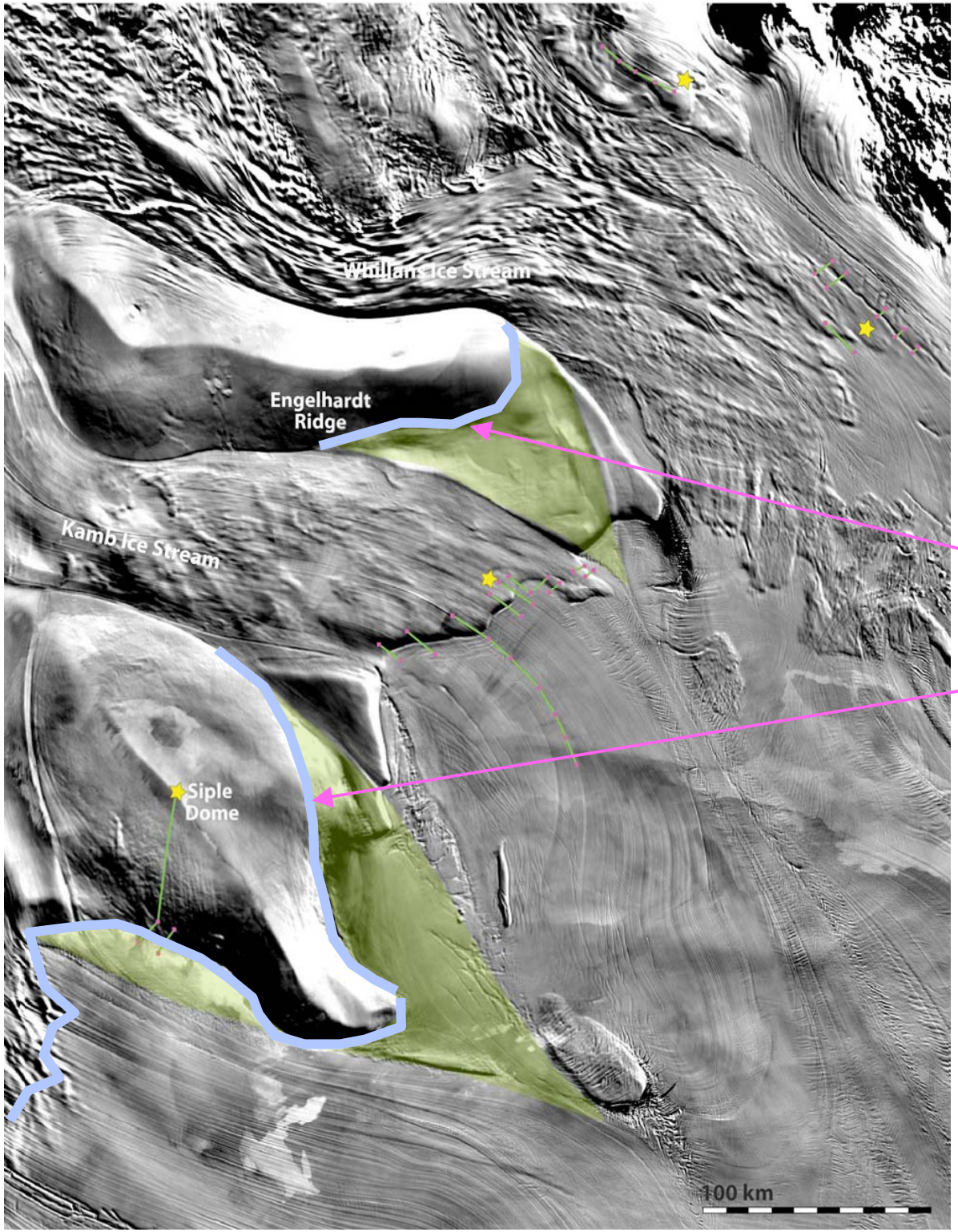

Engelhardt
Ridge
Kamb Ice Stream
Siple
Dome
100 km

SDM


0
-200
-400
-600
-800
1000
0
2
4
6
8
10
Horizontal Position (km)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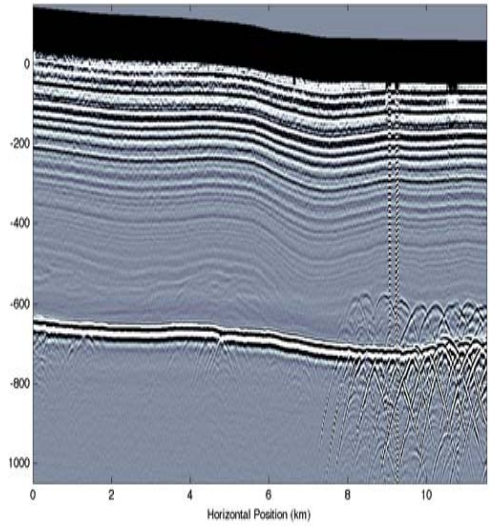
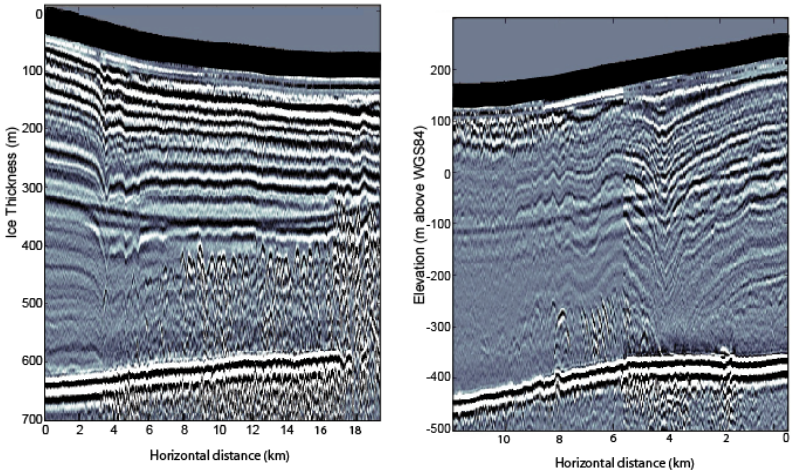
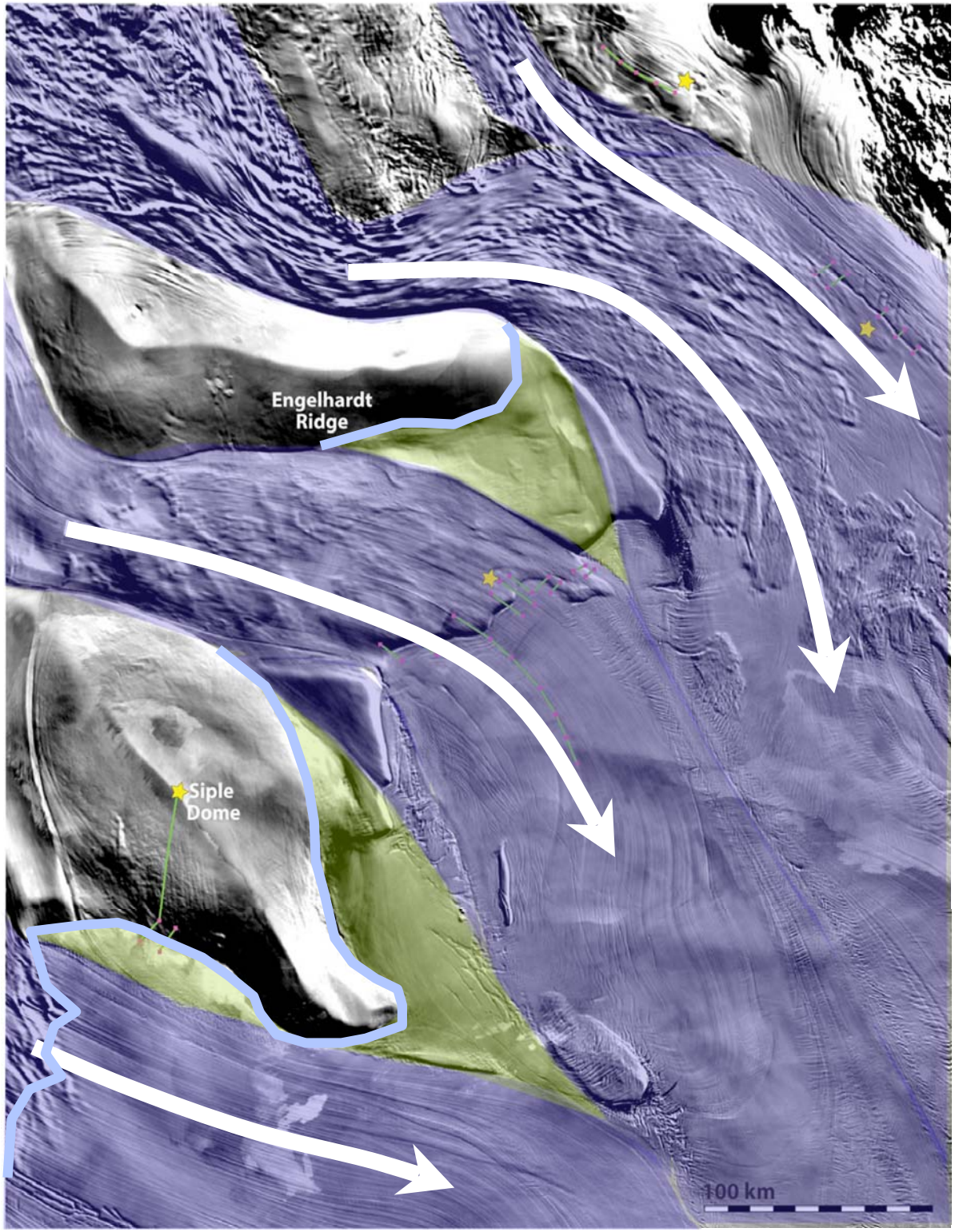

0
-200
-400
-600
-800
1000
0
2
4
6
8
10
Horizontal Position (km)

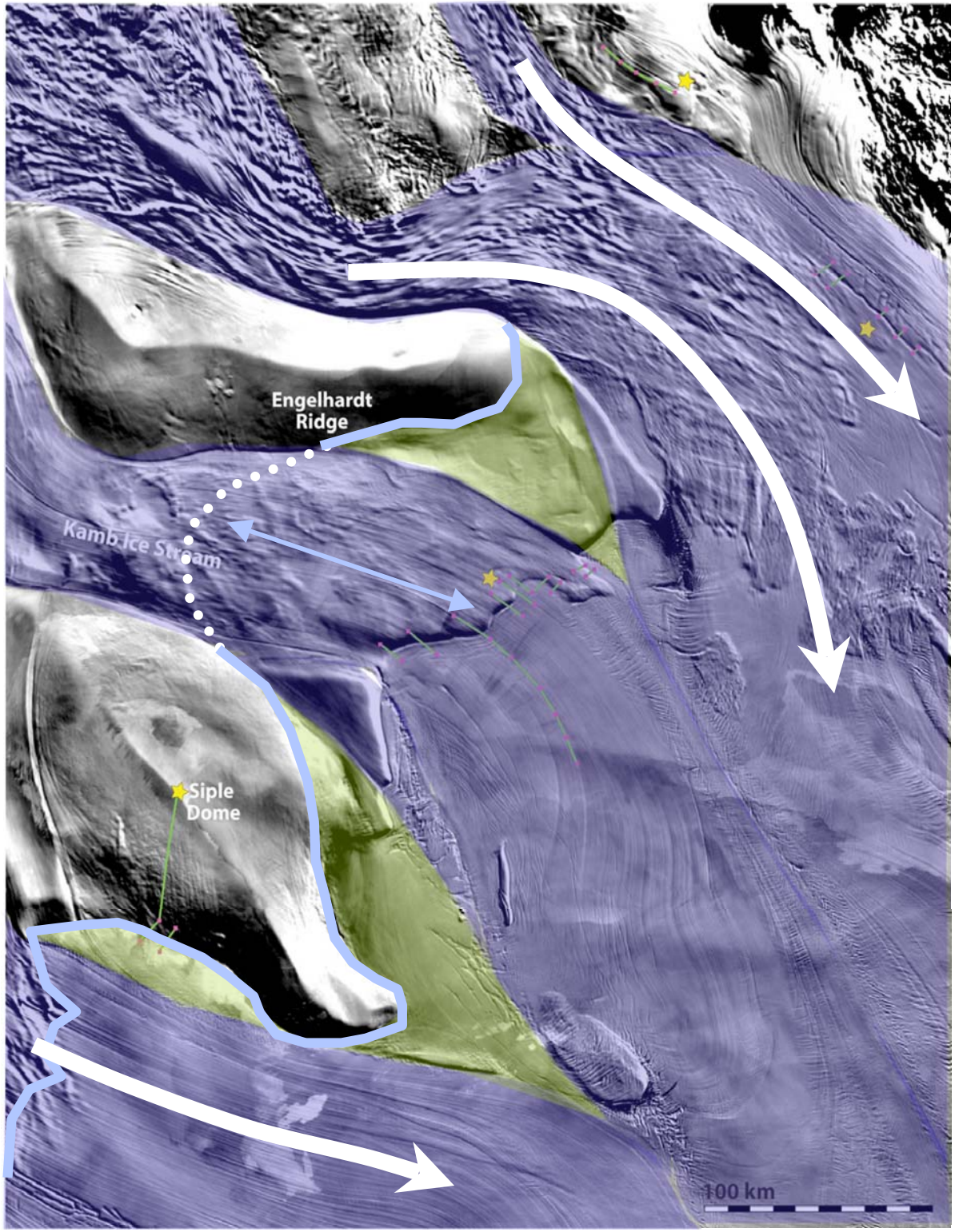

Ice Thickness (m)
0
100
200
300
400
500
600
700
0
2
4
6
8
10
12
14
16
18
Horizontal distance (km)
Elevation (m above WGS84)
200
100
0
-100
-200
-300
-400
-500
10
8
6
4
2
0
Horizontal distance (km)

Kamb



So what?

- we hypothesize that KIS had large slow-flowing FLOATING regions outside of fast-flowing ice streams in the past



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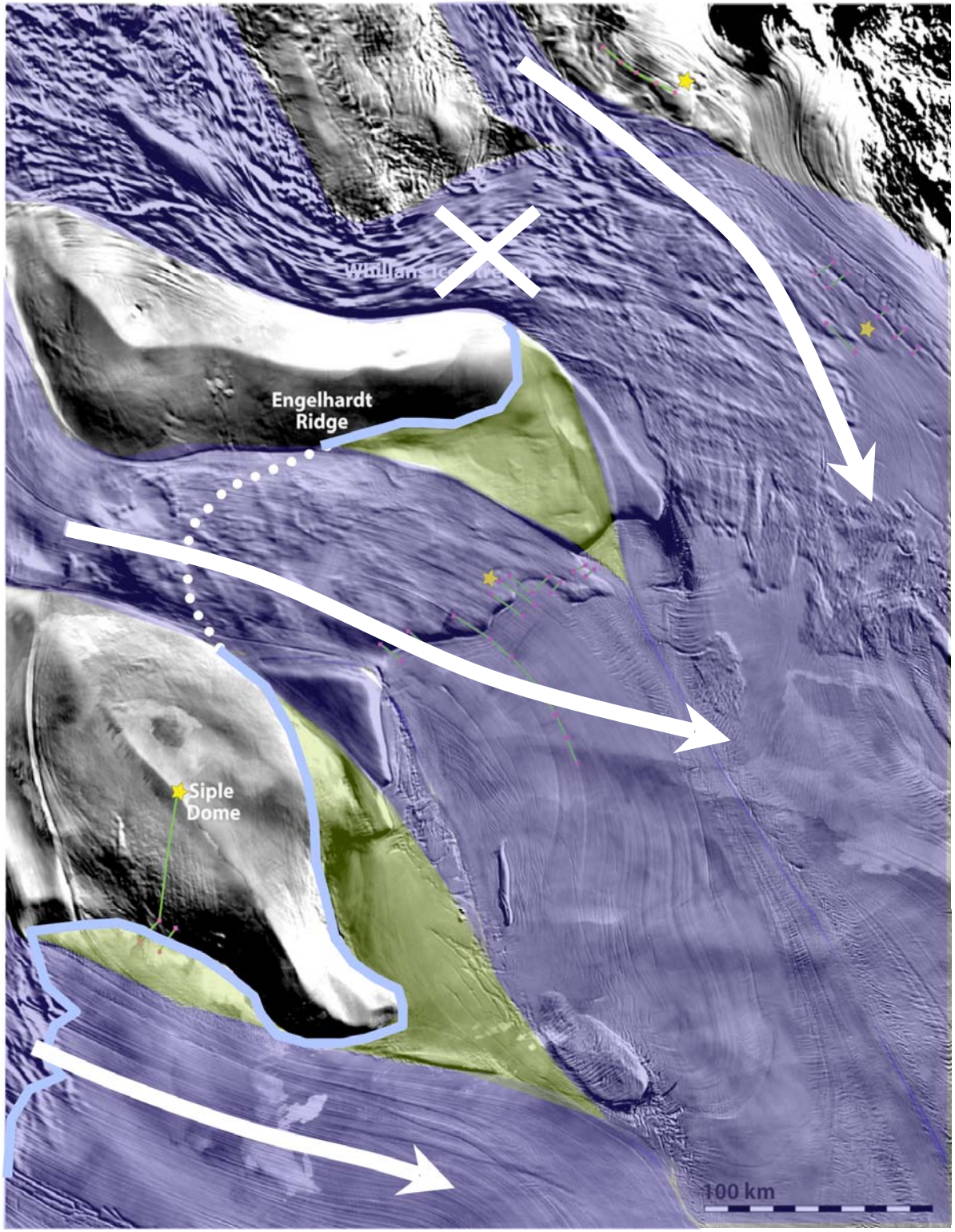
- substantiates argument that KIS experienced grounding line retreat prior to shutdown

- previous work indicates that this occurred between 550-300 YBP



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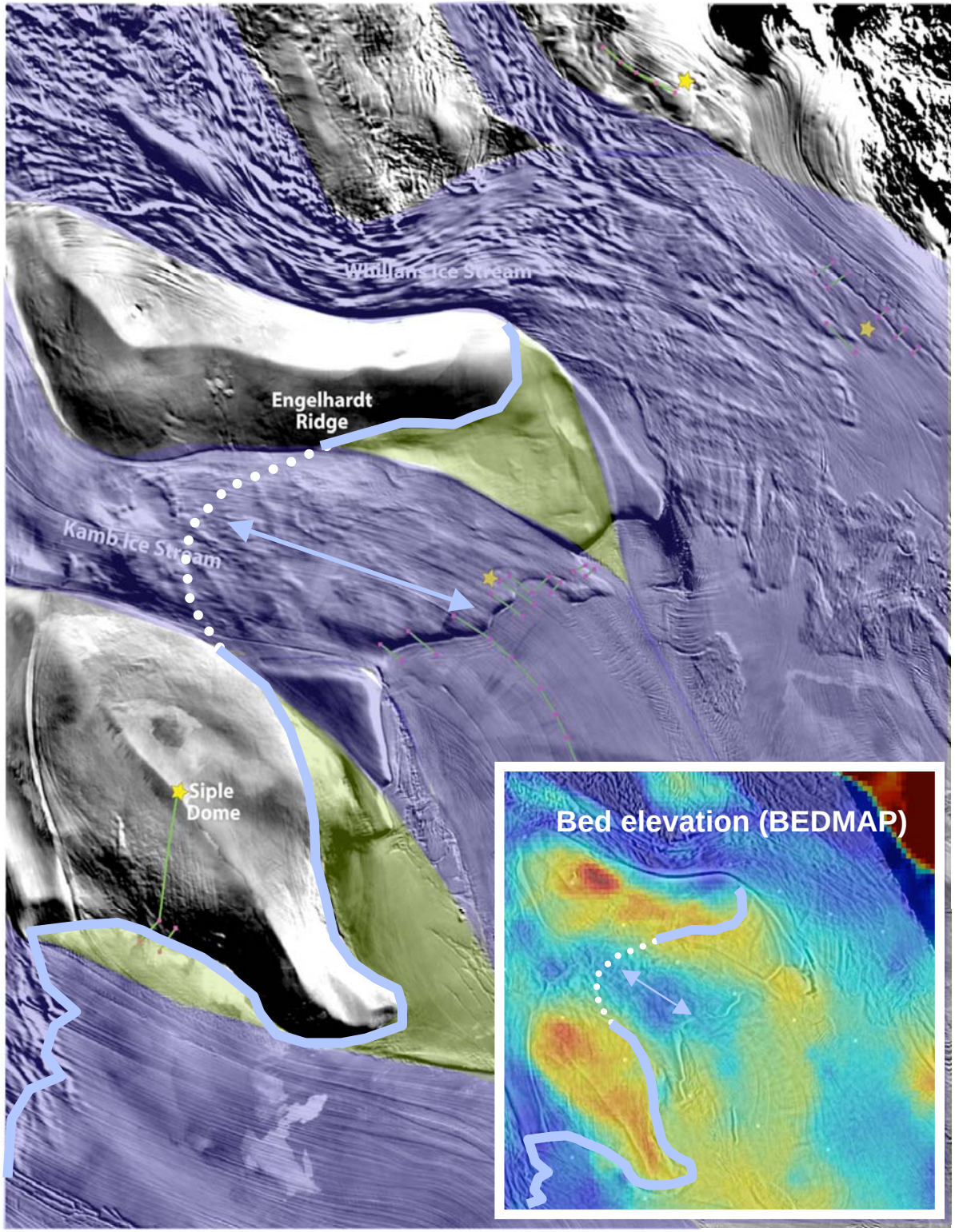

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- retreat is limited by subglacial topography and ice dynamics (ice stream still active at this time)

Conclusions…so far…

Ice flow history:

- modern analogy substantiates the idea that KIS experienced significant grounding line retreat in the past

- can use this "signature" to search for other possible grounding line locations

Grounding line processes:

- basal crevasses at grounding lines appear ~1km upstream from flotation

- basal melting can occur at grounding lines but can be highly variable (laterally, temporally)

- the mechanism for basal melt is uncertain but possible hypotheses include:
    - focused HSSW: one mode of ice shelf melt
    - fresh/warm waters emerging from ice stream margins

- variability in location and amount of basal melt may be related to:
    - exploitation of basal crevasses (providing access to colder ice)
    - coriolis force which might preferentially drive melting to one side of an embayment