

***Ward Hunt Ice Shelf, Ellesmere Island,
Nunavut, Canada: Change Detection With
Real and Synthetic Aperture Radar Since 1981***

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With thanks to NASA for data credits, ASF for continued reliable service, and Derek Mueller & Warwick Vincent (Université Laval, Québec, Canada) for asking me to participate in their investigation of Ward Hunt Ice Shelf.

Background

(some ancient history)



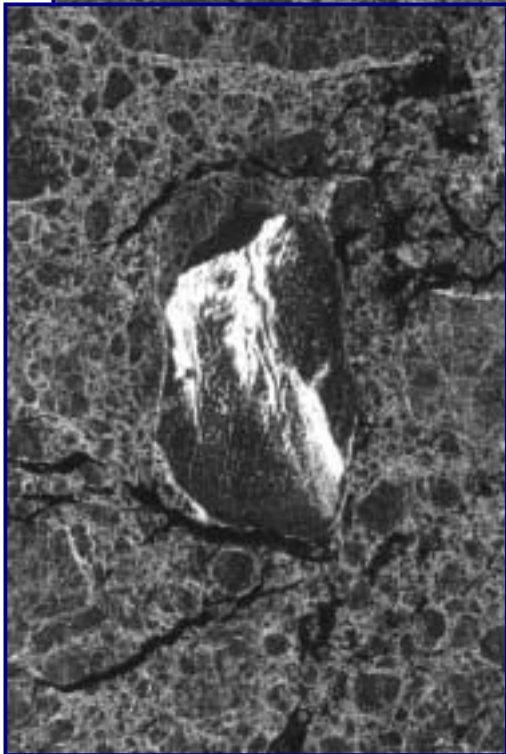
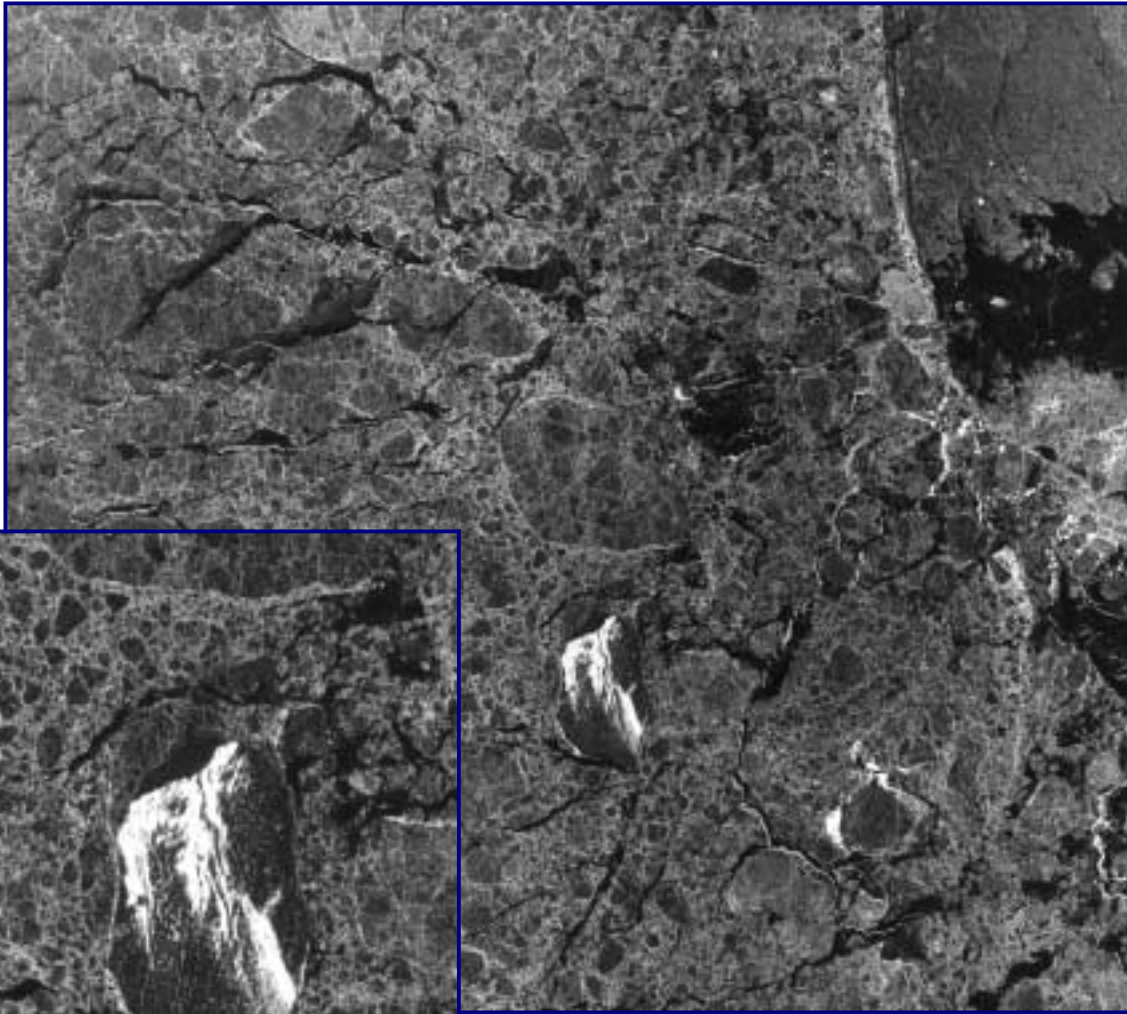
Drilling platform in the Beaufort Sea

Ice island (iceberg)



Seasat SAR image of
Fletcher's Ice Island,
T-3, ~ 5 km x 10 km.

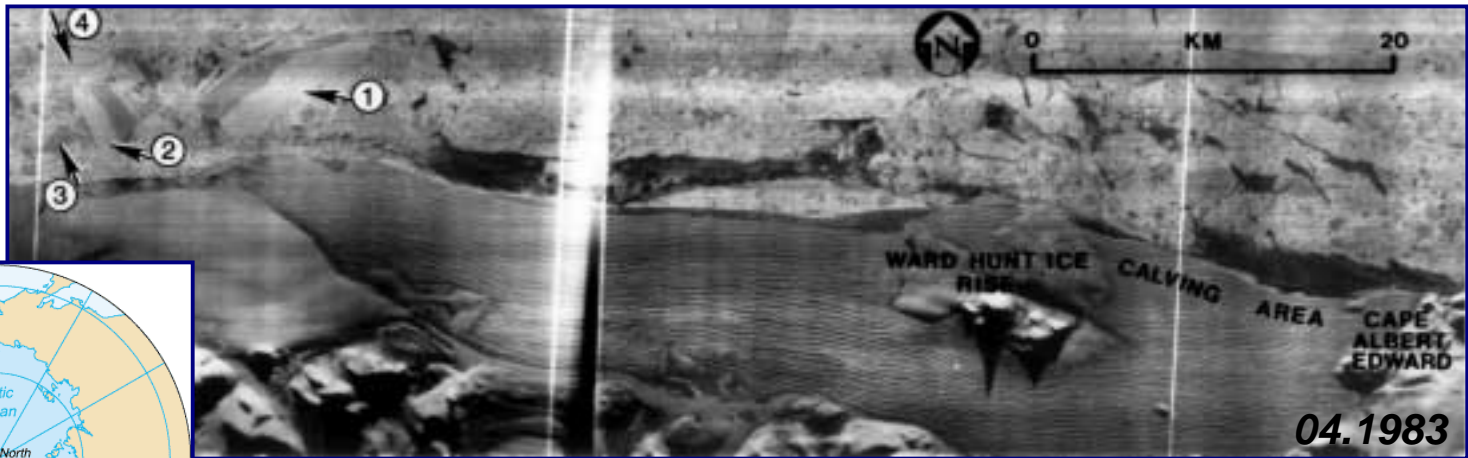
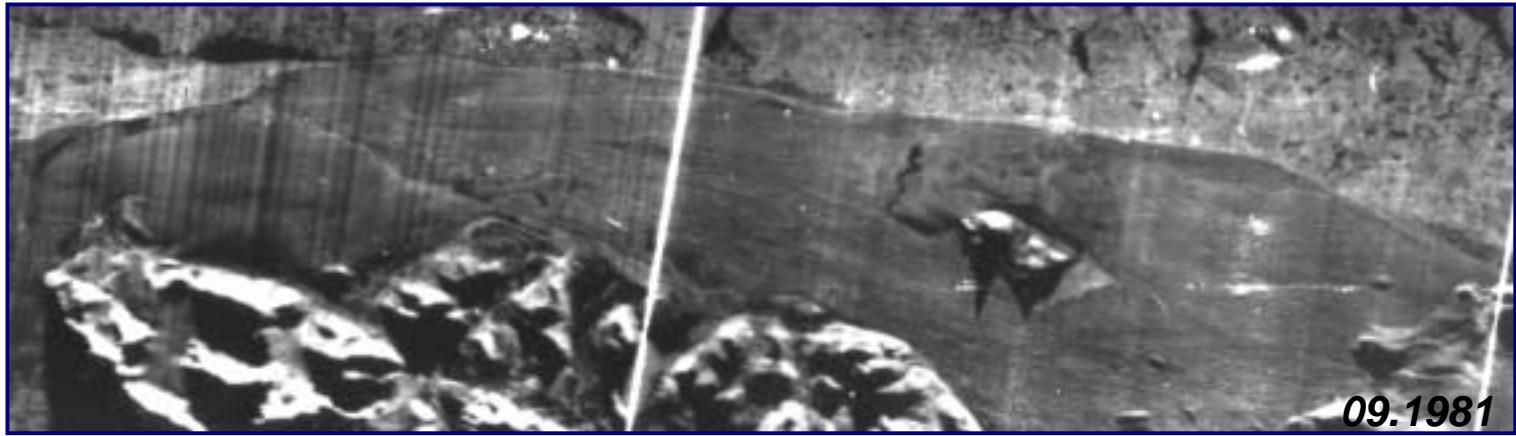
3 October 1978.



L band, $\lambda = 235$ mm,
swath width 100 km.



Airborne Real Aperture Radar Images The Ward Hunt Ice Shelf



X band, $\lambda = 32.5$ mm

1: Hobson's Choice Ice Island



Hobson's Choice Ice Island

The origin of the ribbed texture in radar images of the Ellesmere ice shelves and ice islands.



~3 km x 5 km



Markham Ice Shelf

Rolling topography
of ridges and troughs,
 $\lambda = \sim 250$ m.

Origin of the rolls?
Uncertain.

Airborne X band real aperture radar,
September 1981. Spatial resolution, ~200 m.



RADAR
Imaging:
The Old
& The New



RADARSAT-1 C band synthetic aperture radar,
30 August 2002. Fine beam mode,
spatial resolution ~ 12.5 m,
 $\lambda = 57$ mm.

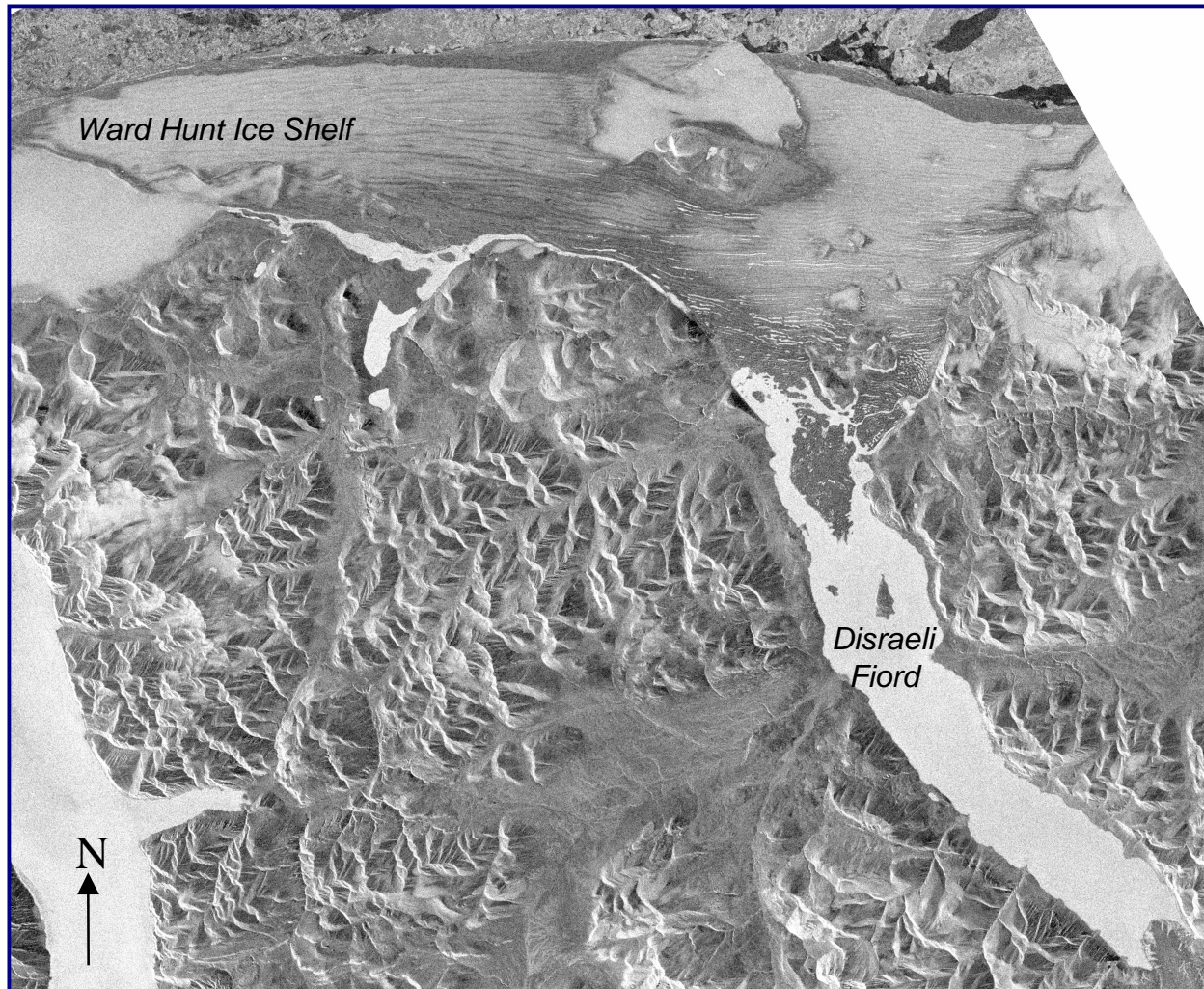
*Ice Island
Calving,
August
2002*



~ 6 km² of ice shelf &
~25 km² of multiyear
landfast sea ice.

RADARSAT-1 Standard Beam

Ward Hunt Ice Shelf & Disraeli Fiord



Area: ~440 km²,
the largest ice
shelf in the Arctic
(Barbados, 432 km²;
Grenada, 341 km²).

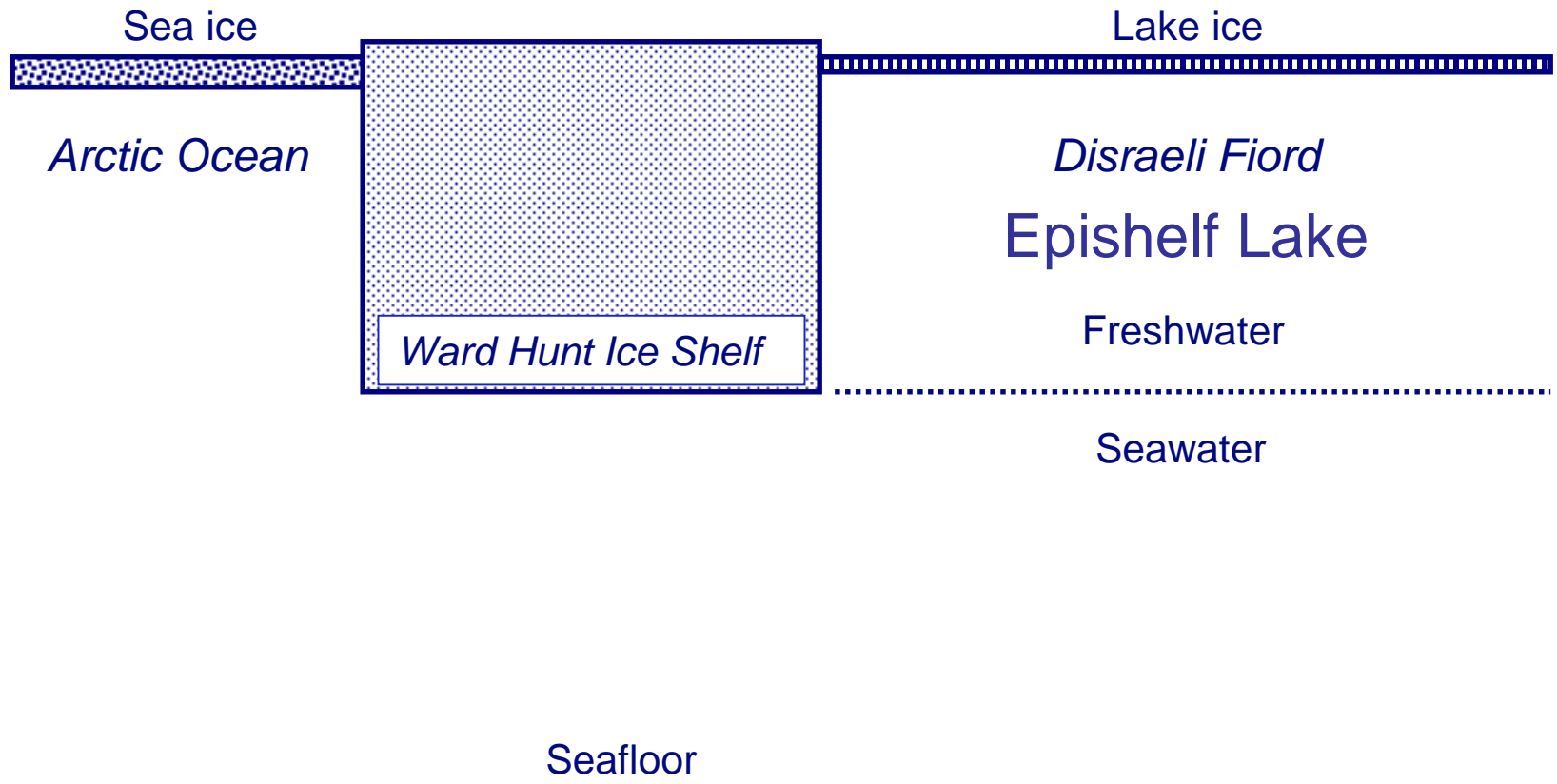
Origin: sea ice.

Age: 3000-4000 y.

RADARSAT-1 Standard Beam sub-scene, ~55 km wide

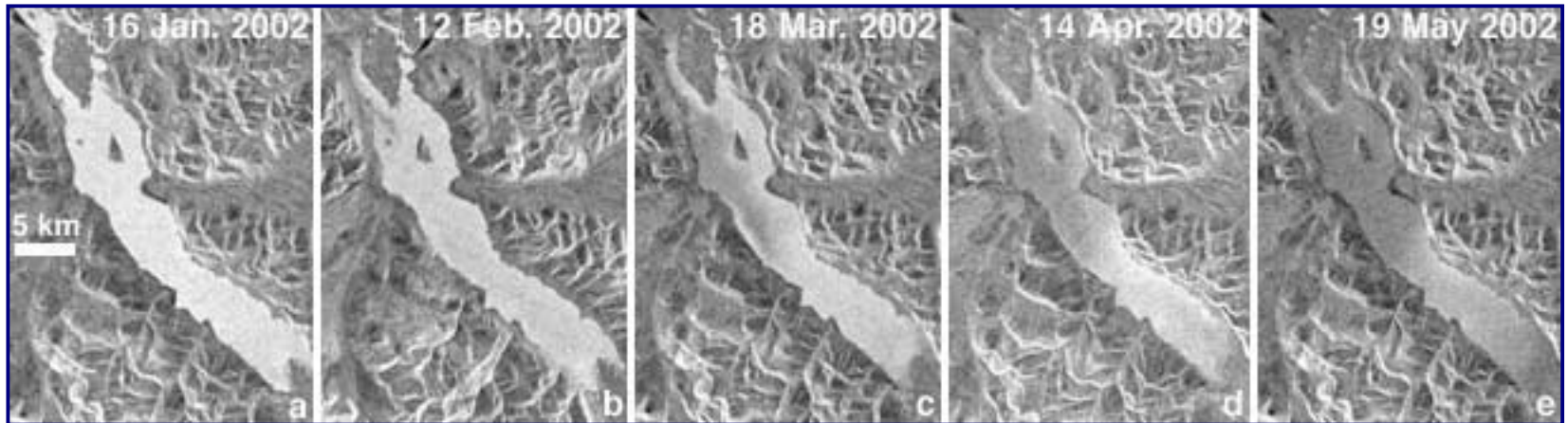
26 May 1998

Why is there strong backscatter from Disraeli Fiord?



The ice shelf acts as a hanging dam that impounds snow and ice meltwater behind it in an epishelf lake. The ice on Disraeli Fiord grows from freshwater, i.e., it is lake ice. Hence the strong backscatter/bright signature.

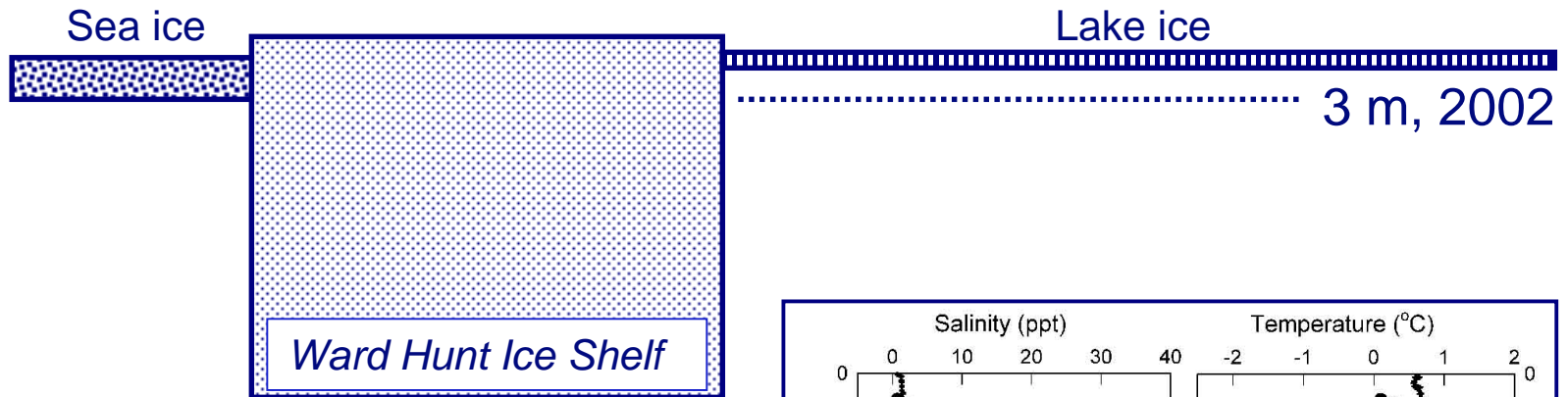
The Backscatter From The Disraeli Fiord Ice Cover Changed In Early 2002



RADARSAT-1 ScanSAR sub-scenes

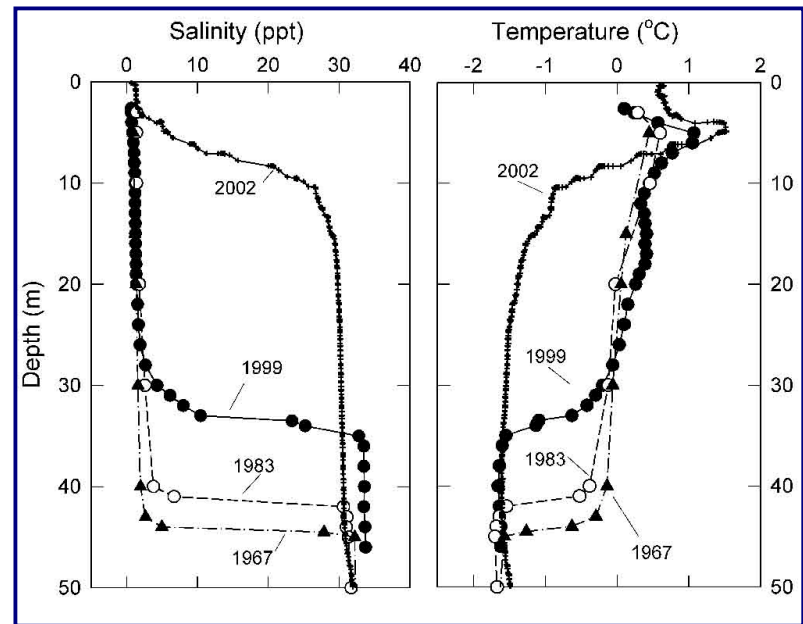
Why?

Disraeli Fiord: The Epishelf Lake All But Disappears



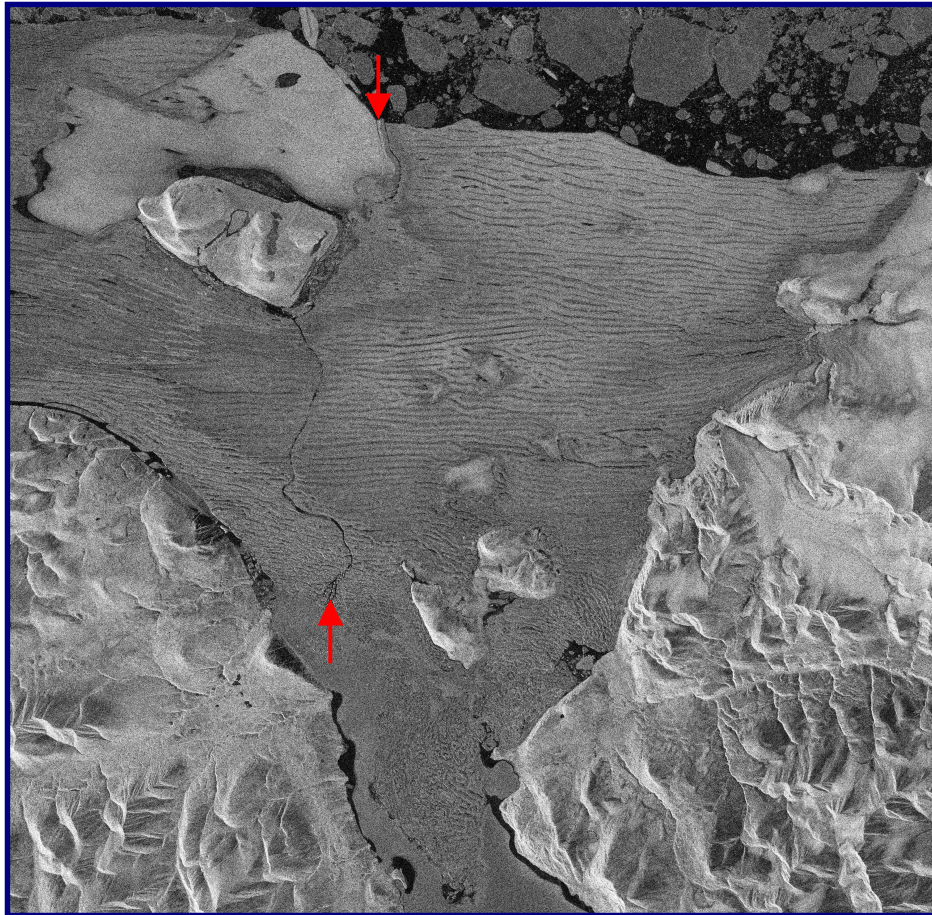
It seems unlikely that the ice shelf thinned by 25 m in 12 months.

How do we explain the catastrophic drainage of the epishelf lake?



3.5 km³ of freshwater lost, 1999-2002

The Ward Hunt Ice Shelf Cracks Up



RADARSAT-1 Fine Beam

30 August 2002

A serpentine fracture began to appear in April 2000.

By July 2002 it was fully developed and extended from the southern to the northern edge, and from the top to the bottom of the ice shelf.



The epishelf lake drained via the serpentine crack.

Fractures in the Ward Hunt Ice Shelf

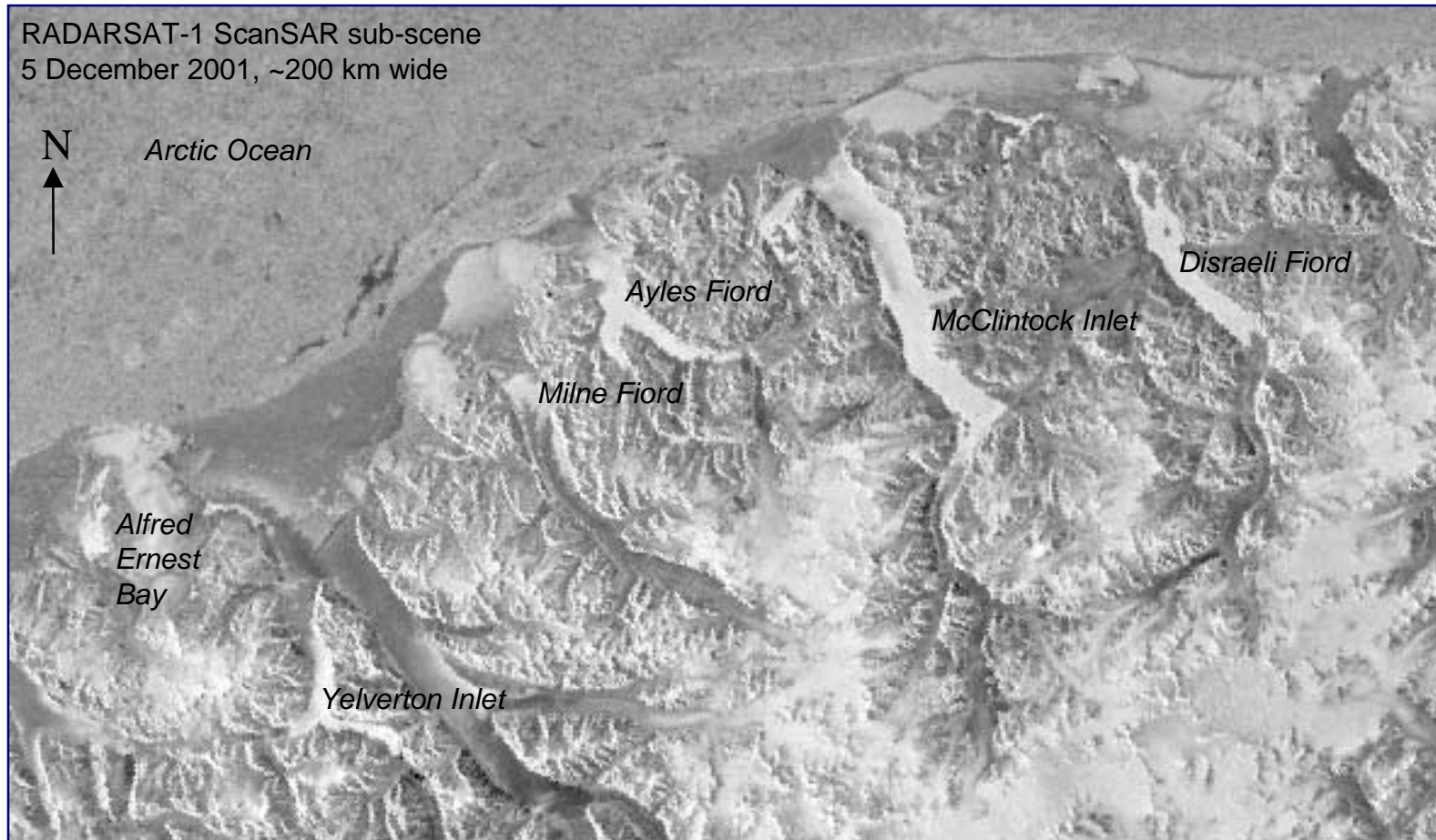


July 2002



July 2002

Epishelf Lakes of Northernmost Ellesmere Is.



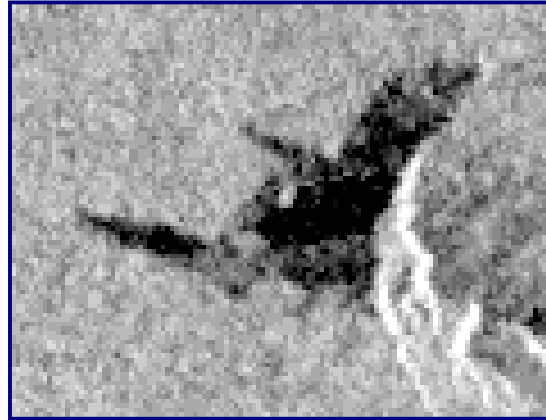
“... significant hydrographic changes at these locations might be detected by changes in backscatter from the ice. For example, if an ice dam failed and the stratification broke down ... the SAR signature of the ice would become darker as the ice began to grow from seawater or brackish water.” [Jeffries, 2002: USGS Satellite Image Atlas of the World - North America].

Meanwhile back in Alaska

Mentasta Lake

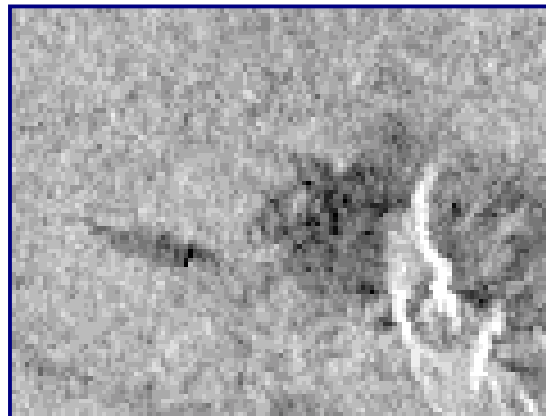
RADARSAT-1
ScanSAR
sub-scenes,
~6 km along
bottom

26 October 2002



Before

Magnitude 7.9 earthquake,
3 November 2002



After

12 November 2002