

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

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# Background

(some ancient history)

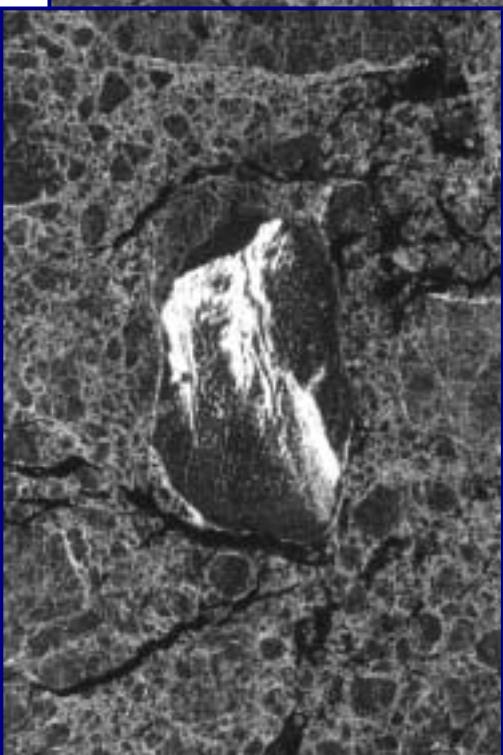


Drilling platform in the Beaufort Sea

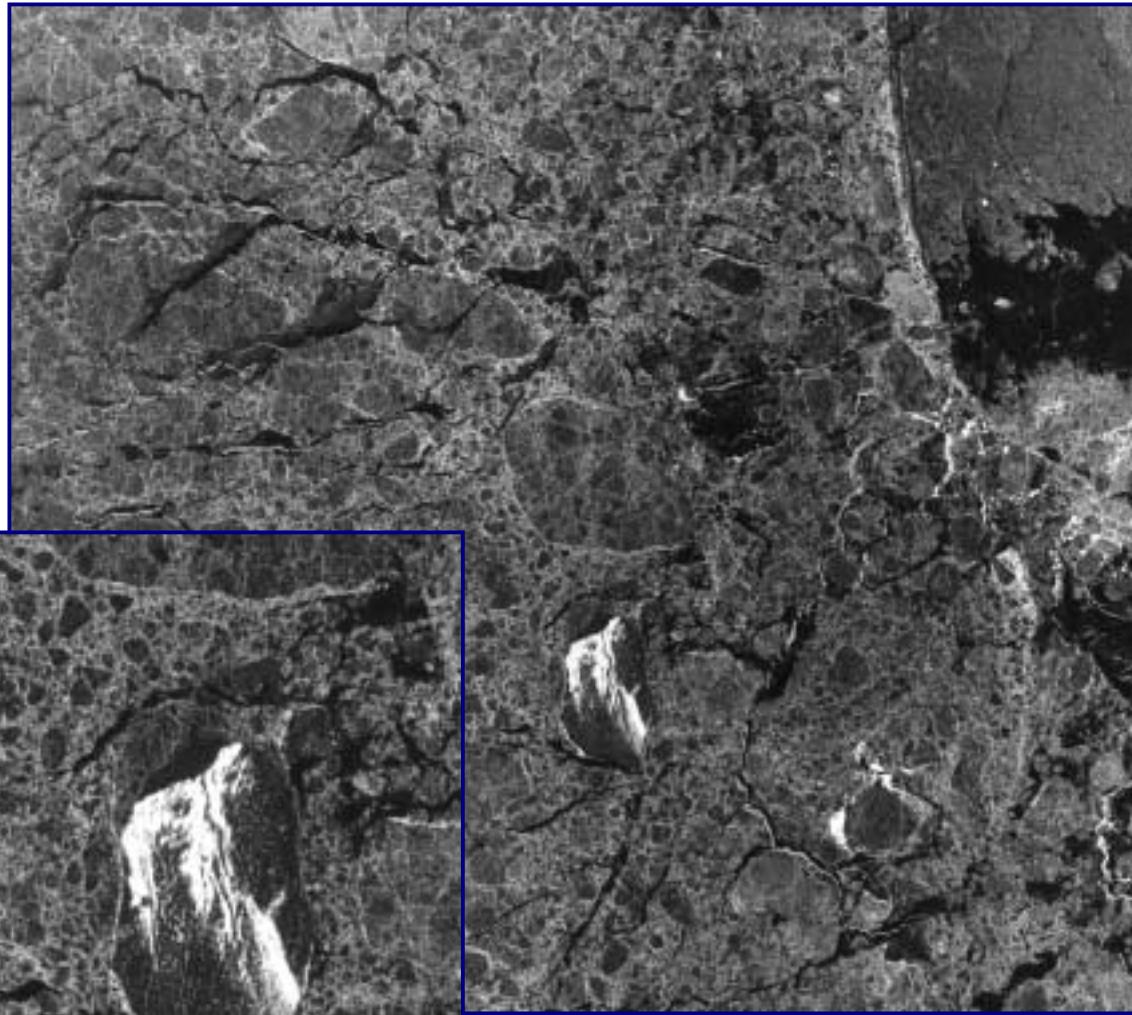


Ice island (iceberg)



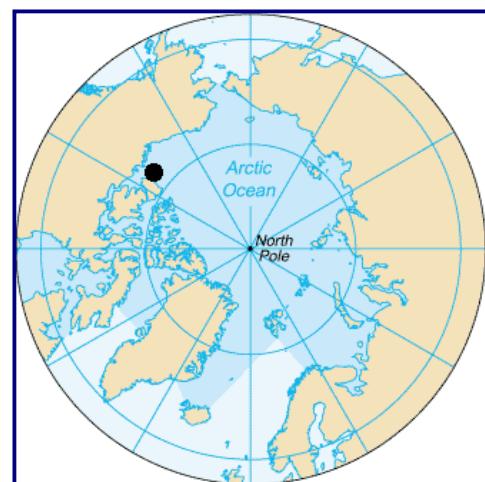


L band,  $\lambda = 235$  mm,  
swath width 100 km.

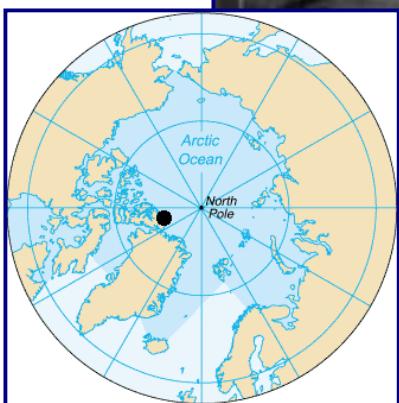
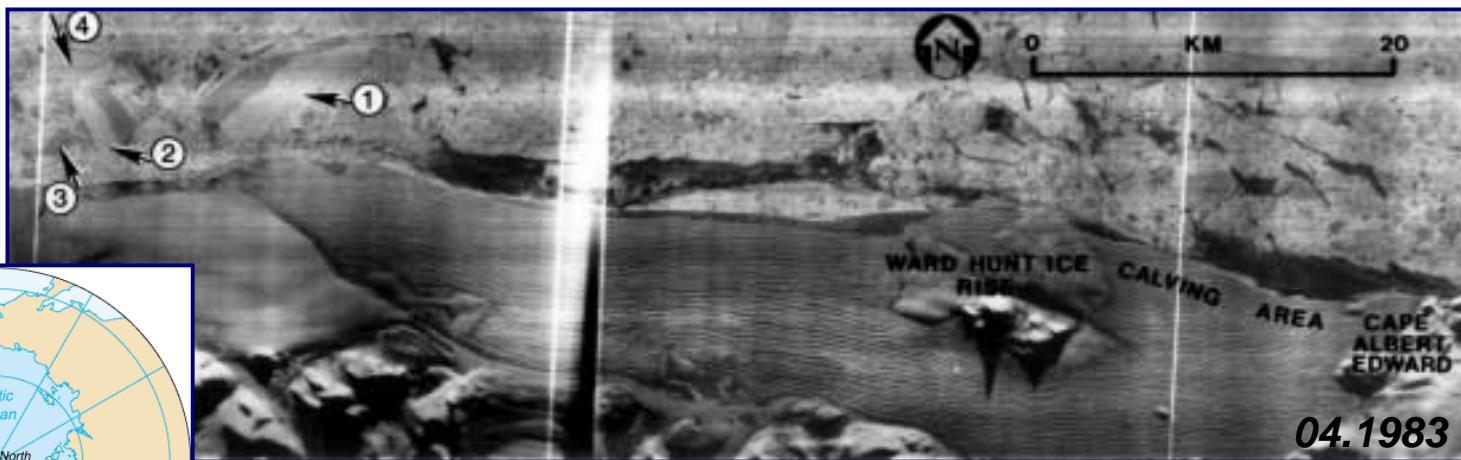


Seasat SAR image of  
Fletcher's Ice Island,  
T-3, ~ 5 km x 10 km.

3 October 1978.



## Airborne Real Aperture Radar Images The Ward Hunt Ice Shelf



X band,  $\lambda = 32.5$  mm

1: Hobson's Choice Ice Island

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

Hobson's Choice Ice Island



~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.

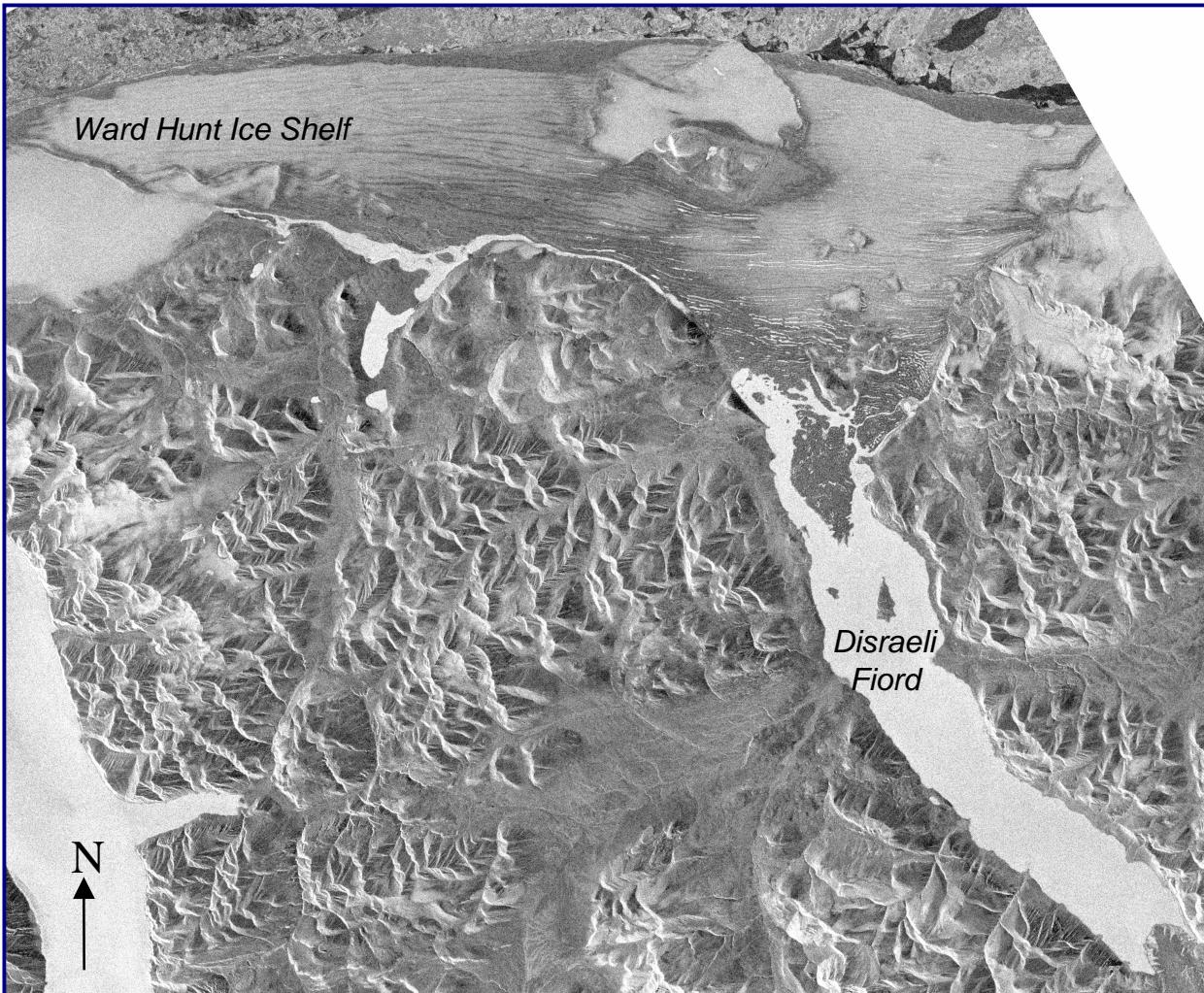
*Ice Island  
Calving,  
August  
2002*

~ 6 km<sup>2</sup> of ice shelf &  
~25 km<sup>2</sup> of multiyear  
landfast sea ice.



RADARSAT-1 Standard Beam

# *Ward Hunt Ice Shelf & Disraeli Fiord*



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

26 May 1998

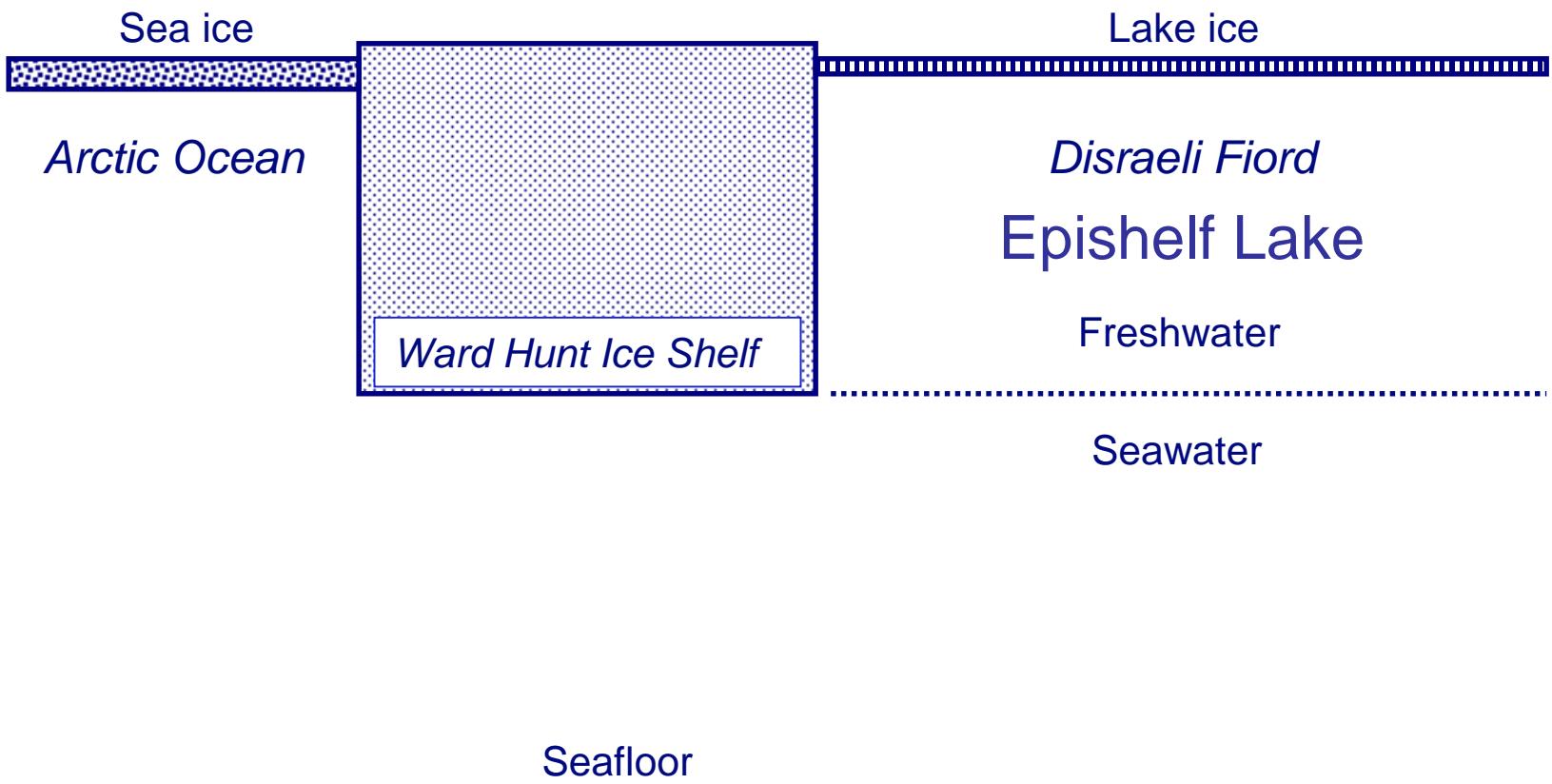
Area: ~440 km<sup>2</sup>,  
the largest ice  
shelf in the Arctic

(Barbados, 432 km<sup>2</sup>;  
Grenada, 341 km<sup>2</sup>).

Origin: sea ice.

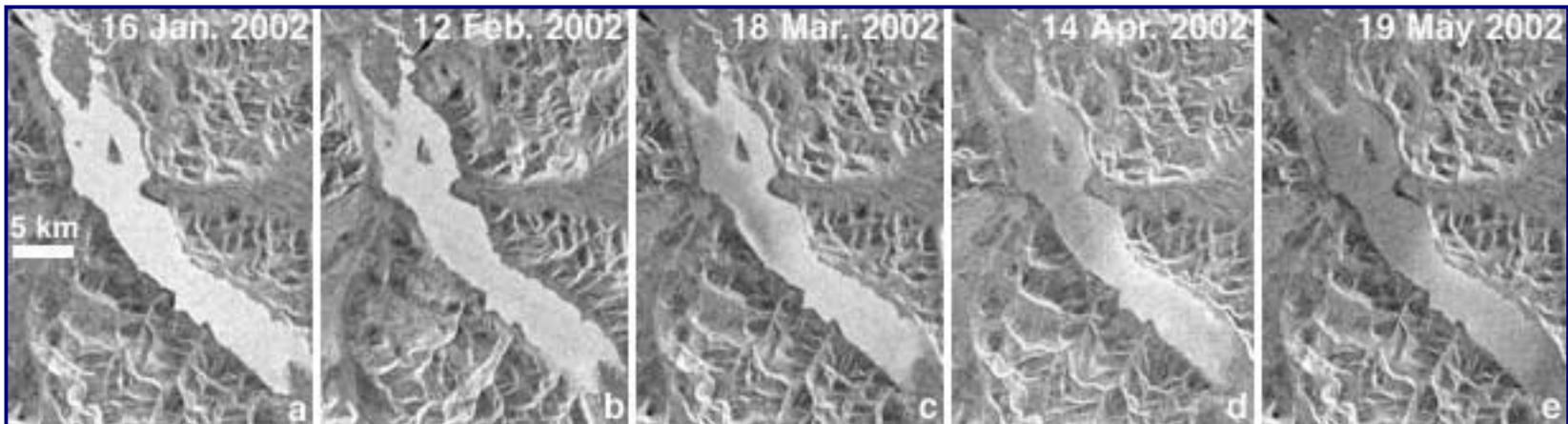
Age: 3000-4000 y.

# *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.

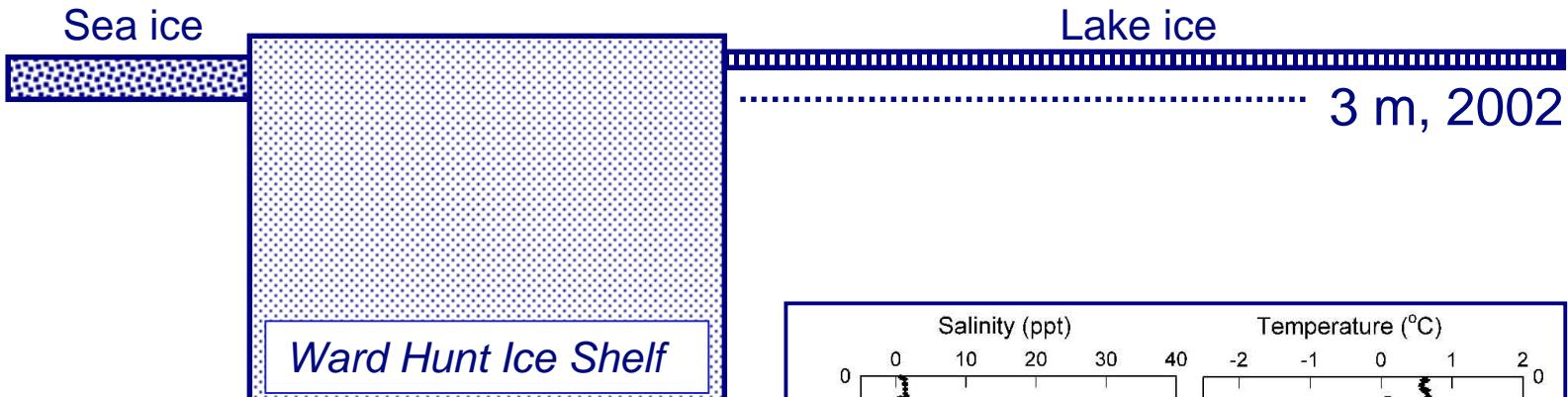
# *The Backscatter From The Disraeli Fiord Ice Cover Changed In Early 2002*



RADARSAT-1 ScanSAR sub-scenes

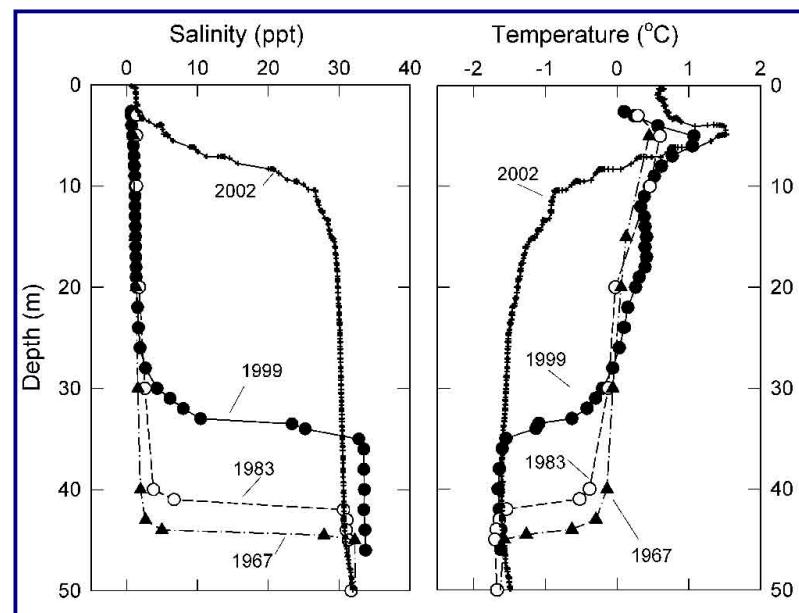
*Why?*

# *Disraeli Fiord: The Epishelf Lake All But Disappears*



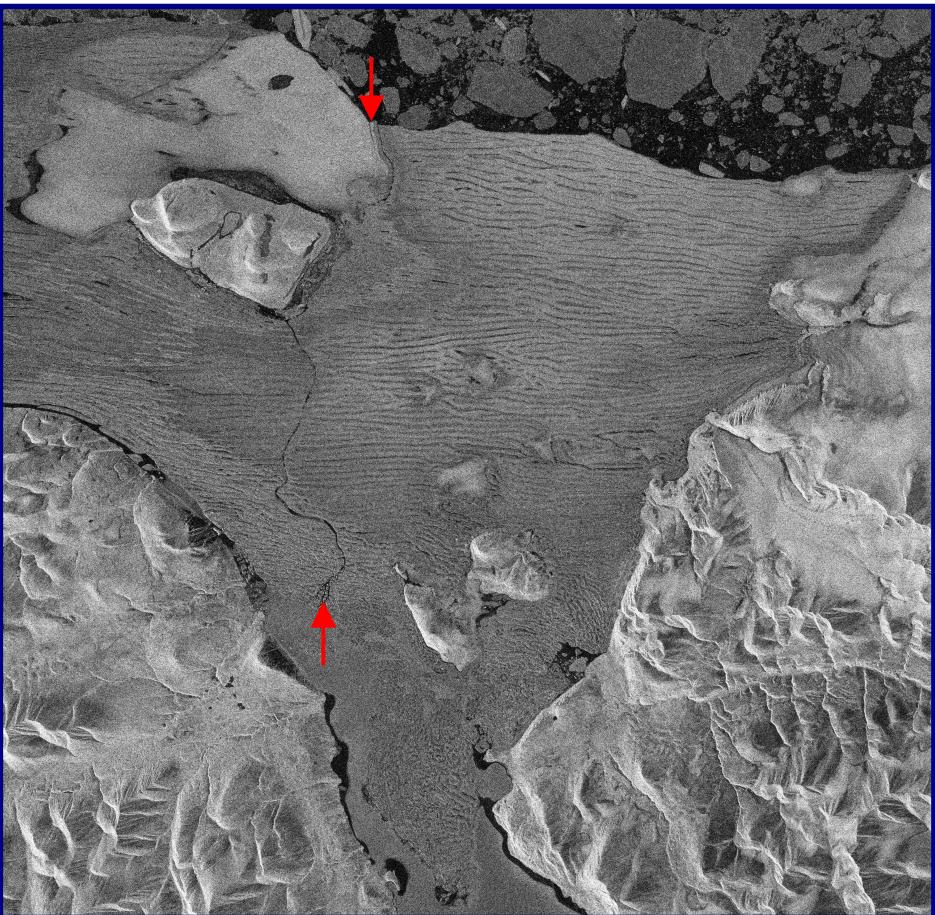
It seems unlikely that the ice shelf thinned by 25 m in 12 months.

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



3.5 km<sup>3</sup> 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



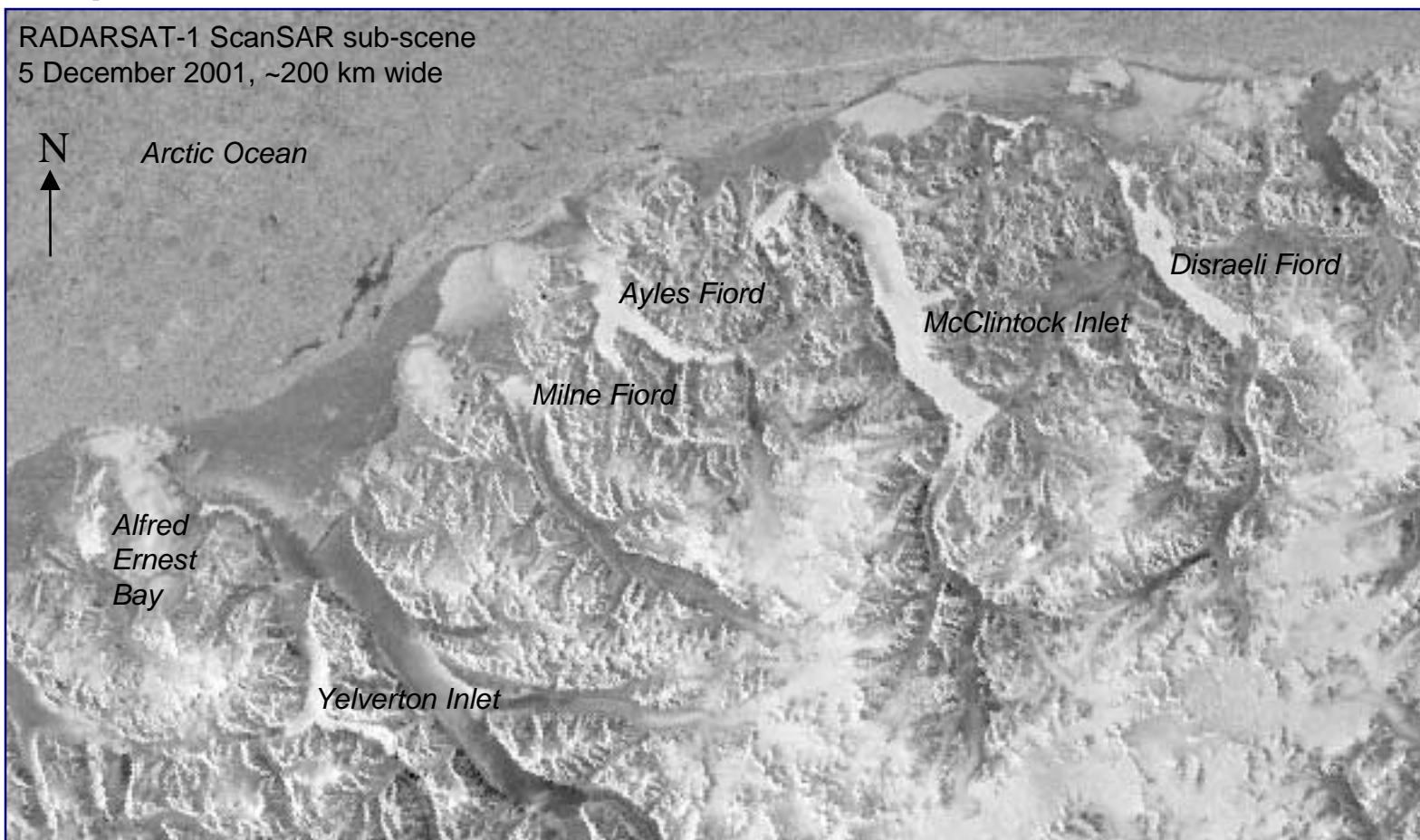
July 2002

## Legend

— Crack
<b>Status</b>
■ ES
■ I
■ IL
■ IR
■ IS
■ MY
<b>Name</b>
■ IS Lost (Aug8)
■ IS Lost (>Aug11)
■ MY Lost (Aug8)

# *Epishef Lakes of Northernmost Ellesmere Is.*

RADARSAT-1 ScanSAR sub-scene  
5 December 2001, ~200 km wide

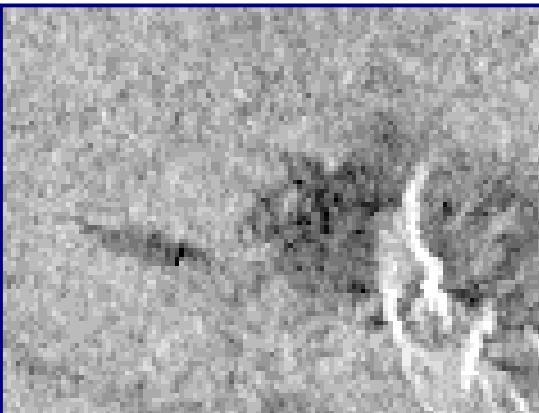
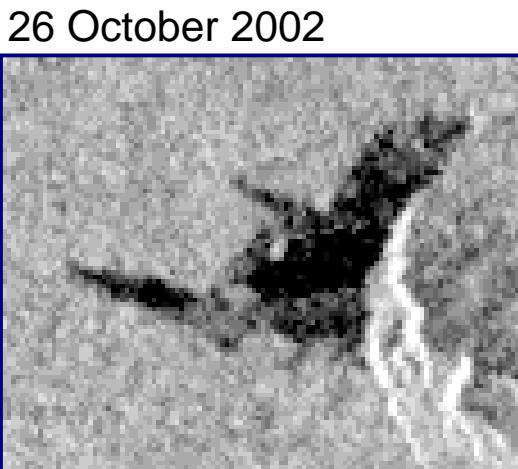


“... significant hydrographic changes at these locations might be detected by changes in backscatter from the ice. For example, if an ice dam failed and the stratification broke down ... the SAR signature of the ice would become darker as the ice began to grow from seawater or brackish water.” [Jeffries,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



Magnitude 7.9 earthquake,  
3 November 2002