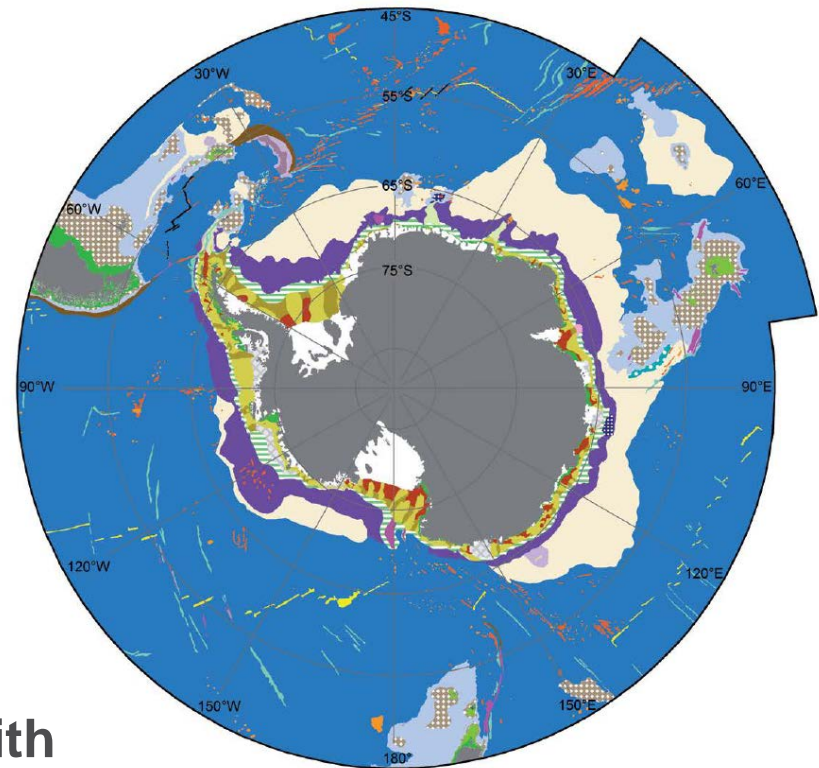
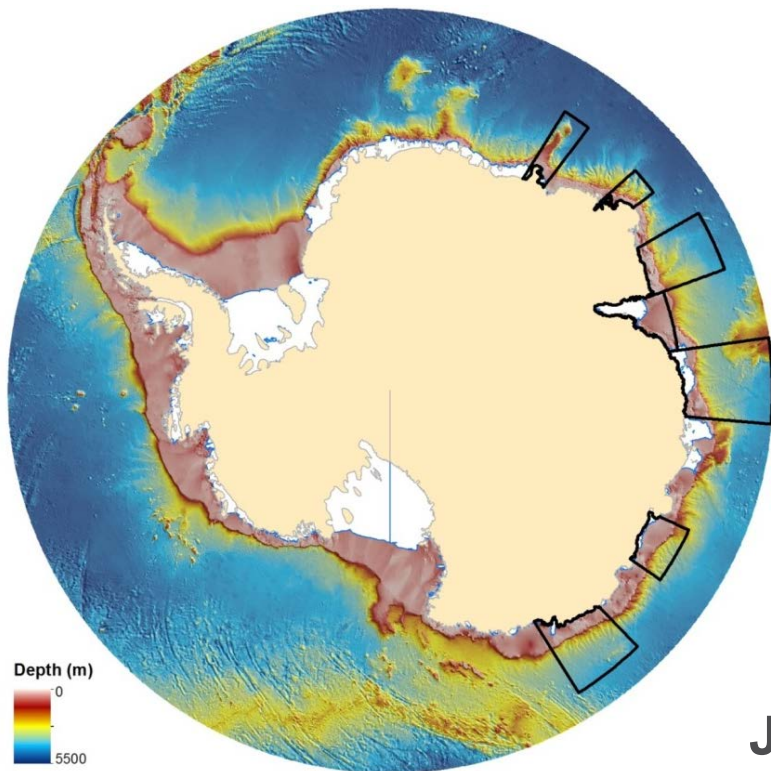




Studies of seafloor geomorphology across various spatial scales in Antarctica



Jodie Smith

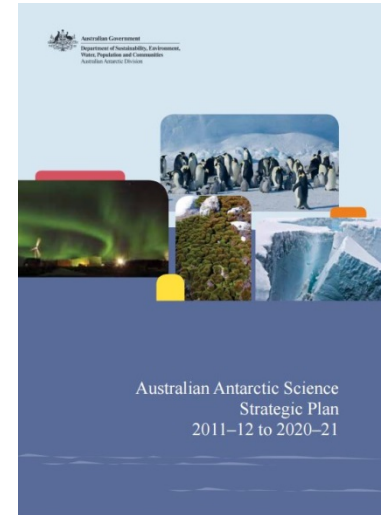
Outline

- Applications of bathymetry data and seafloor geomorphology information
- Examples across different spatial scales:
 - Continental Scale – Marine Protected Areas in East Antarctica
 - Regional Scale – Vulnerable Marine Ecosystems in George V Land
 - Local Scale – Davis (Vestfold Hills) and Casey (Windmill Islands) stations
- Current and Future work
 - Cape Darnley study with NIPR
 - Geoscience Australia activities this season (16/17)
 - Australia's new icebreaker

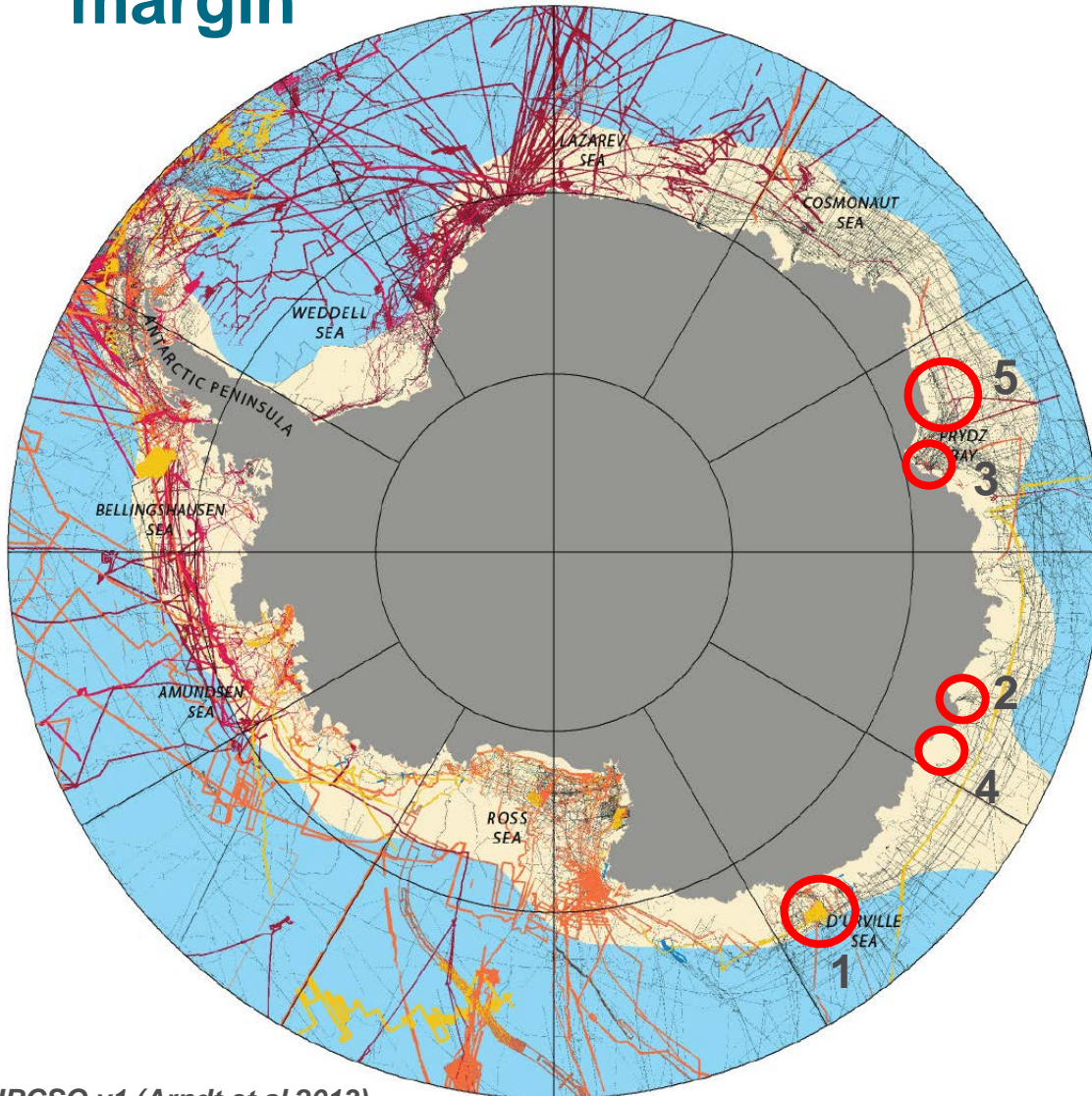
Applied Science

Bathymetry and Seafloor Geomorphology used for:

- **Scientific research:**
 - understanding oceanography
 - identifying benthic habitats
 - informing paleoclimate studies
 - understanding past ice sheet dynamics
- **Marine environmental management:**
 - development of Marine Protected Areas
 - identify vulnerable habitats
- **Logistical requirements:**
 - updating nautical charts



Bathymetry coverage around Antarctic continental margin



- Very little detailed bathymetry coverage in East Antarctica
- Mostly single beam
- Exceptions:
 - Mertz-George V Land (1)
 - Nearshore surveys at Casey (2) and Davis (3)
 - Totten Glacier (NSF Palmer) (4)
 - MacRobertson Land/Cape Darnley (5)

IBCSO v1 (Arndt et al 2013)

CONTINENTAL SCALE

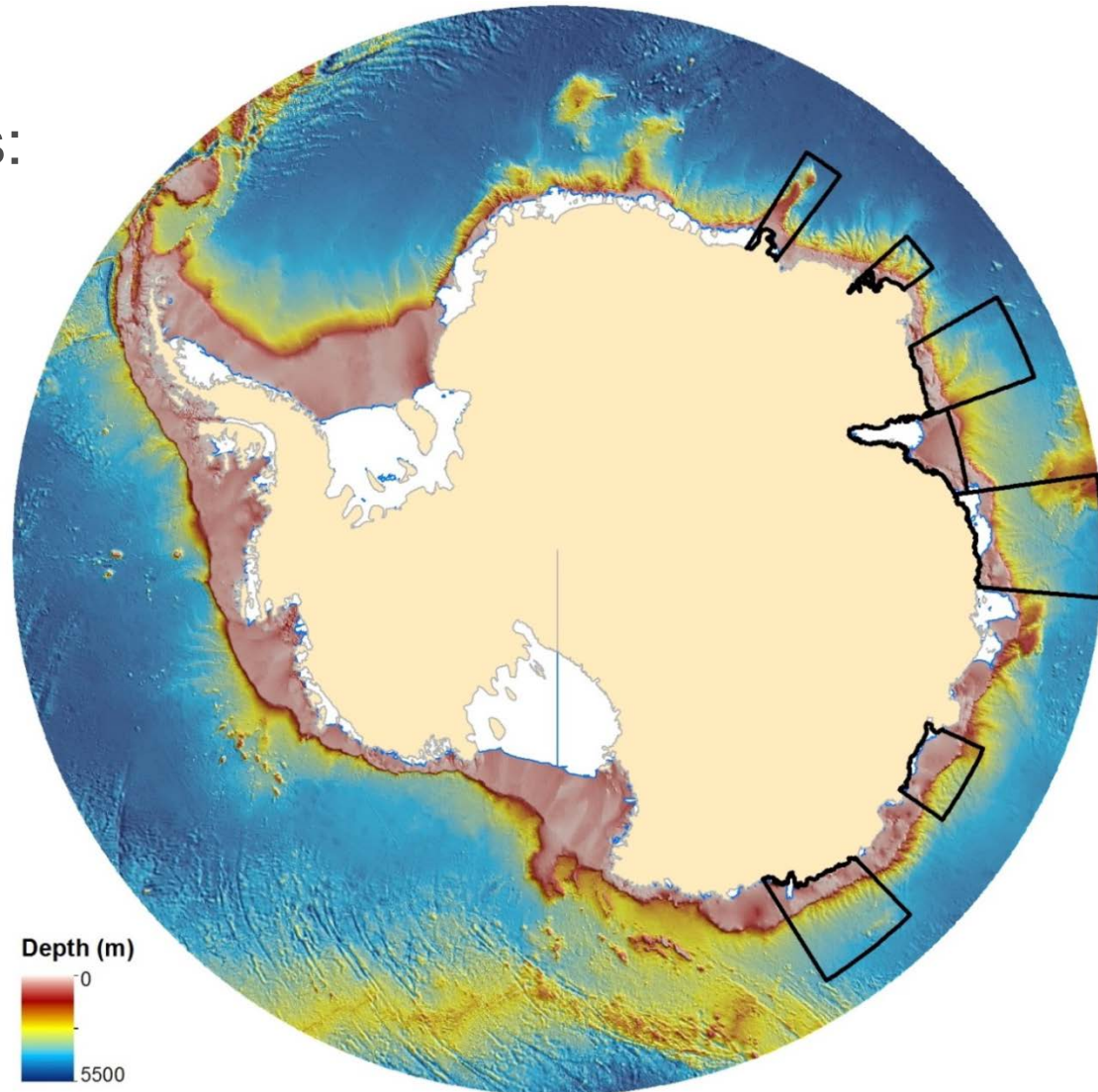
Representative system of Marine Protected Areas (MPAs) in East Antarctica

- Proposal: submitted by Australia-France-EU, currently under consideration by Antarctic Marine conservation body (CCAMLR)
- Aim: Protect vulnerable pelagic and benthic ecosystems from disruption and disturbance (e.g. fishing)
- Proposed for pelagic and benthic values

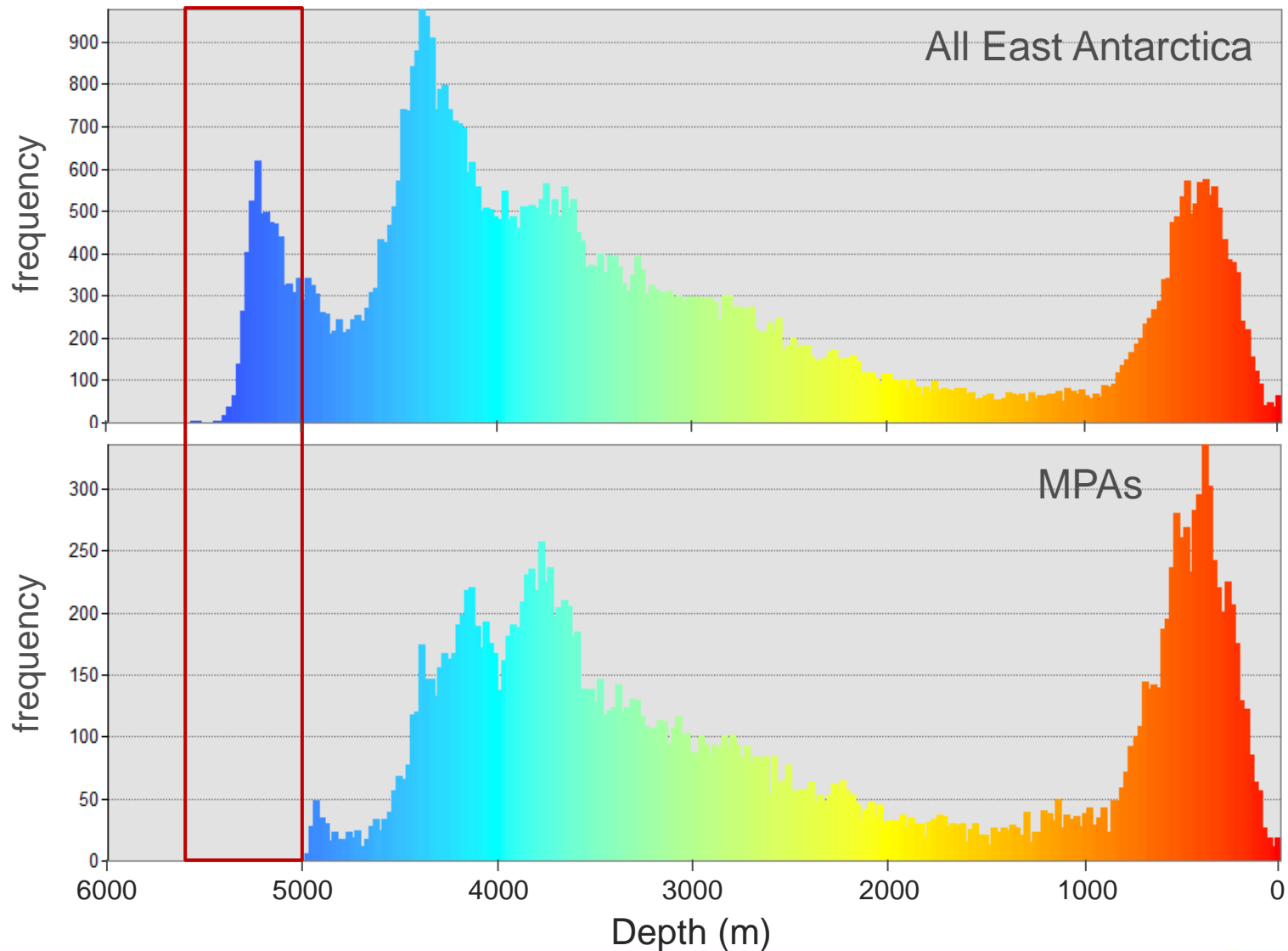


Proposed MPAs for East Antarctica

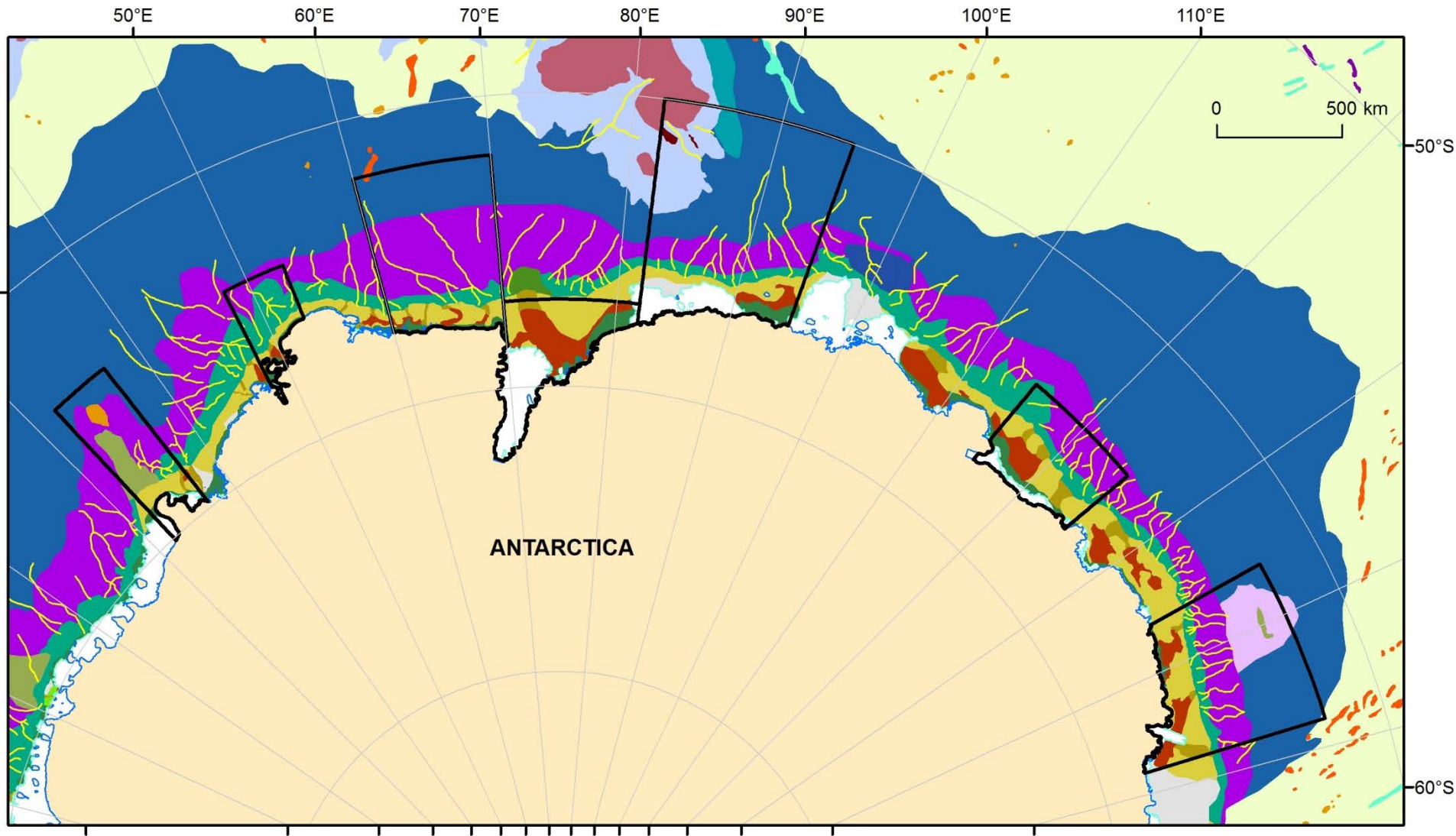
- Defined using physical and biological datasets:
 - pelagic
 - benthic (video, seafloor substrate, bathymetry, geomorphology)



How well do MPAs represent bathymetry?

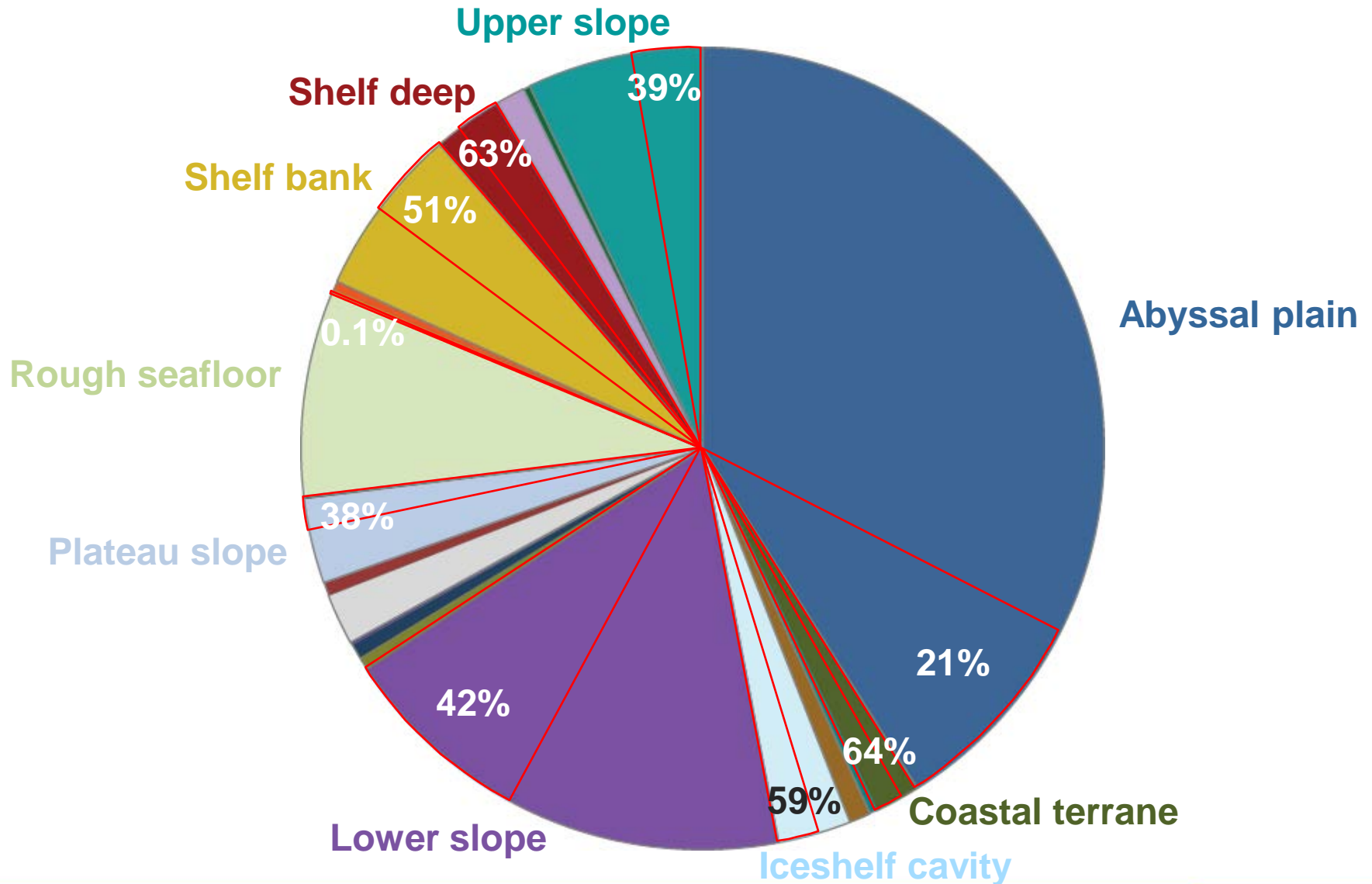


Seabed morphology



O'Brien et al., 2009

How well do MPAs represent geomorphic features?



REGIONAL SCALE

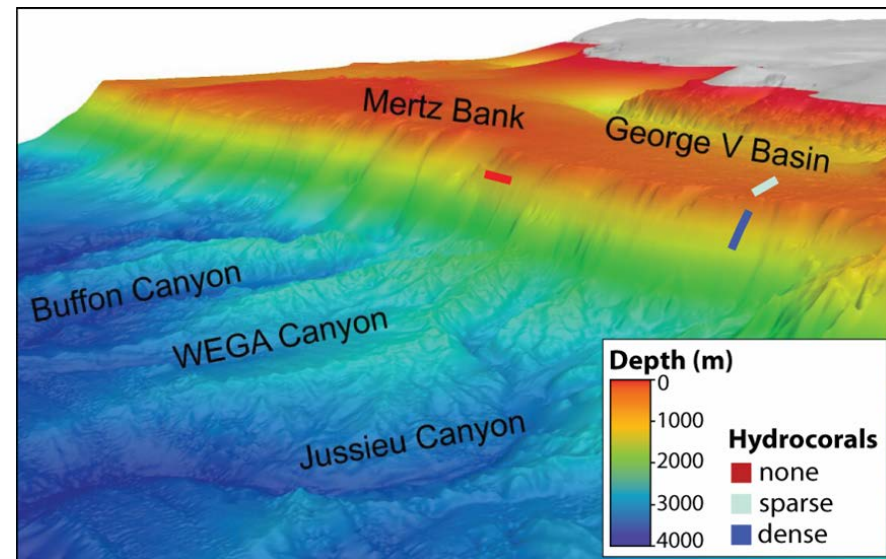
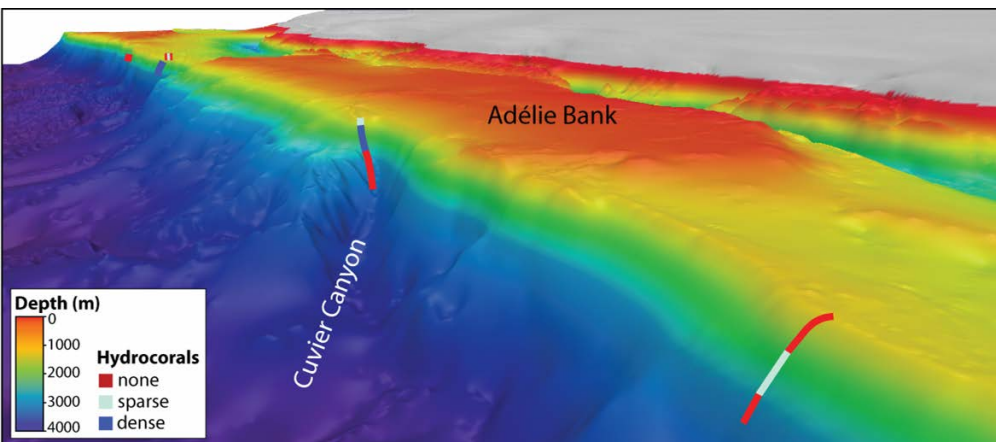
Vulnerable Marine Ecosystems on George V Shelf

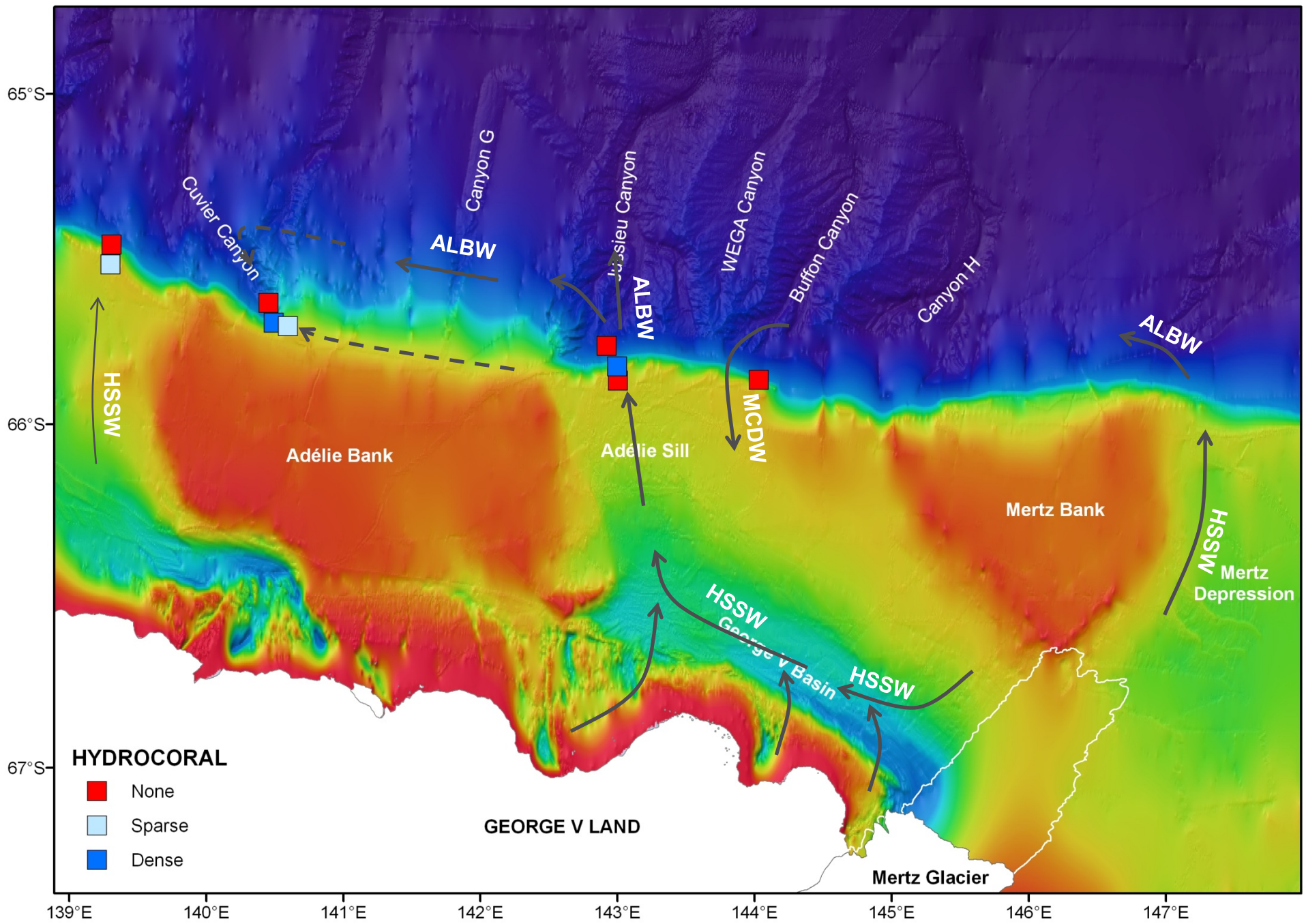


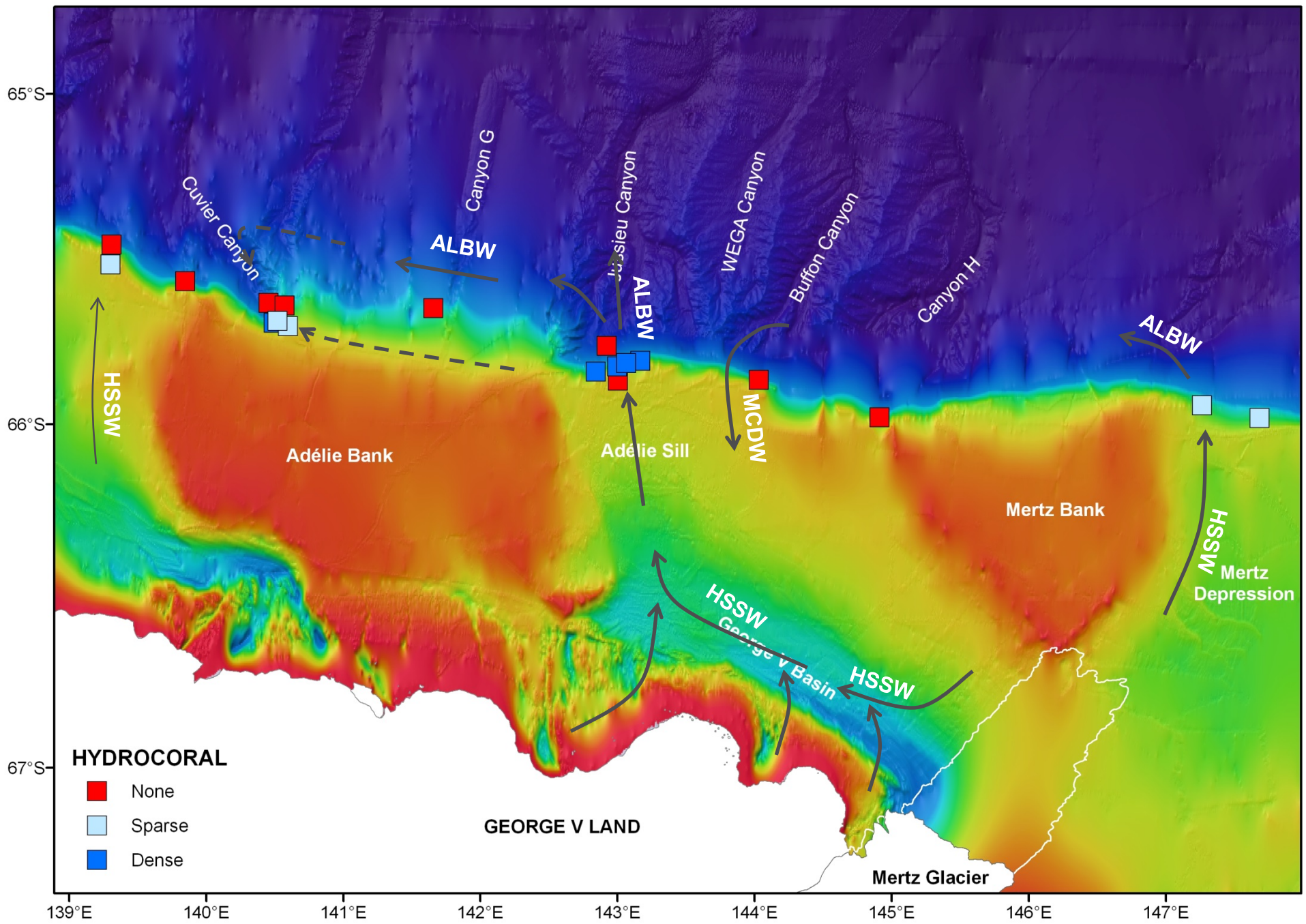
- Hydrocoral communities identified during CEAMARC survey 2007/8
- Protected as Vulnerable Marine Ecosystems (VMEs) in 2009
- Can we predict their location elsewhere?

Potential locations

- Analysed physical datasets (bathymetry, geomorphology, substrate, ocean currents, iceberg scouring)
- Predicted to occur:
 - Below iceberg keel depth limits (600-950 m)
 - Influence of dense bottom water – rich in organic matter
 - Near shelf-incised canyons





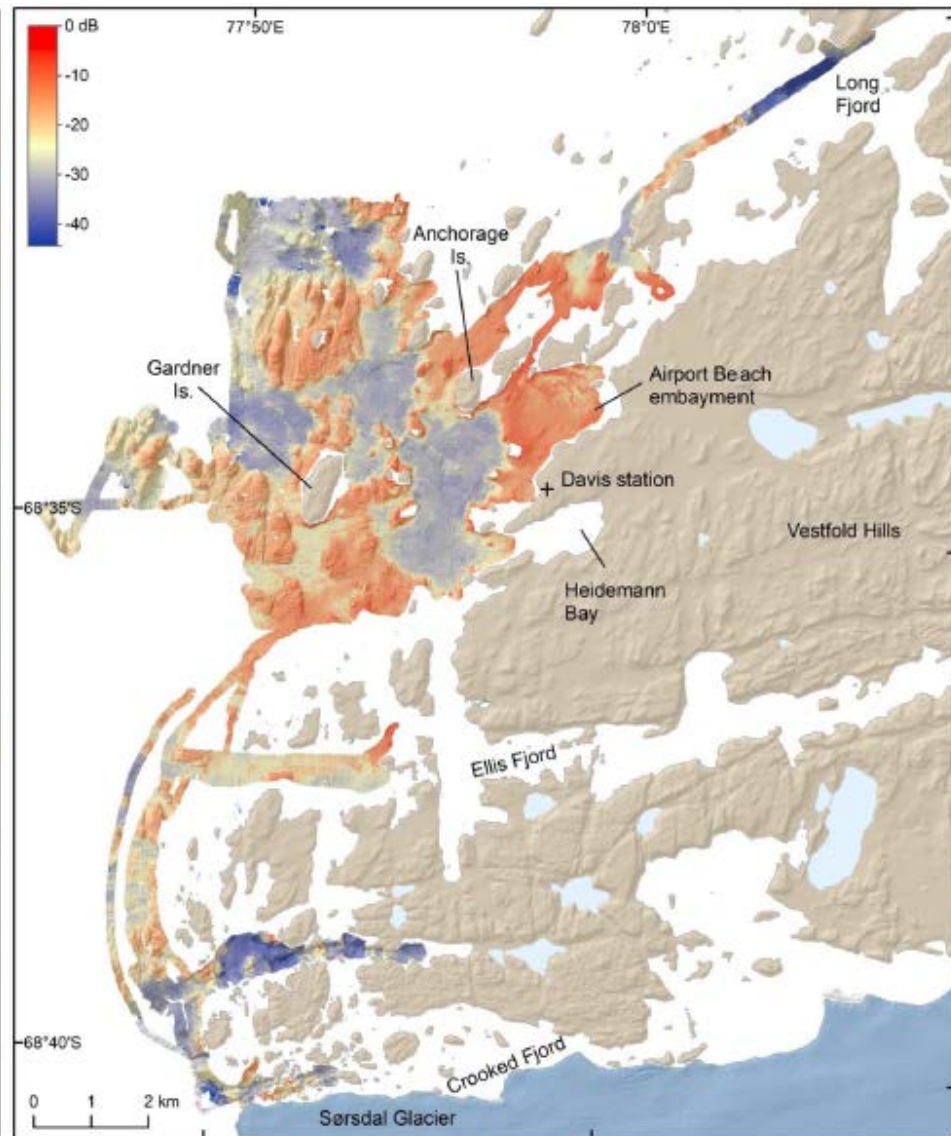
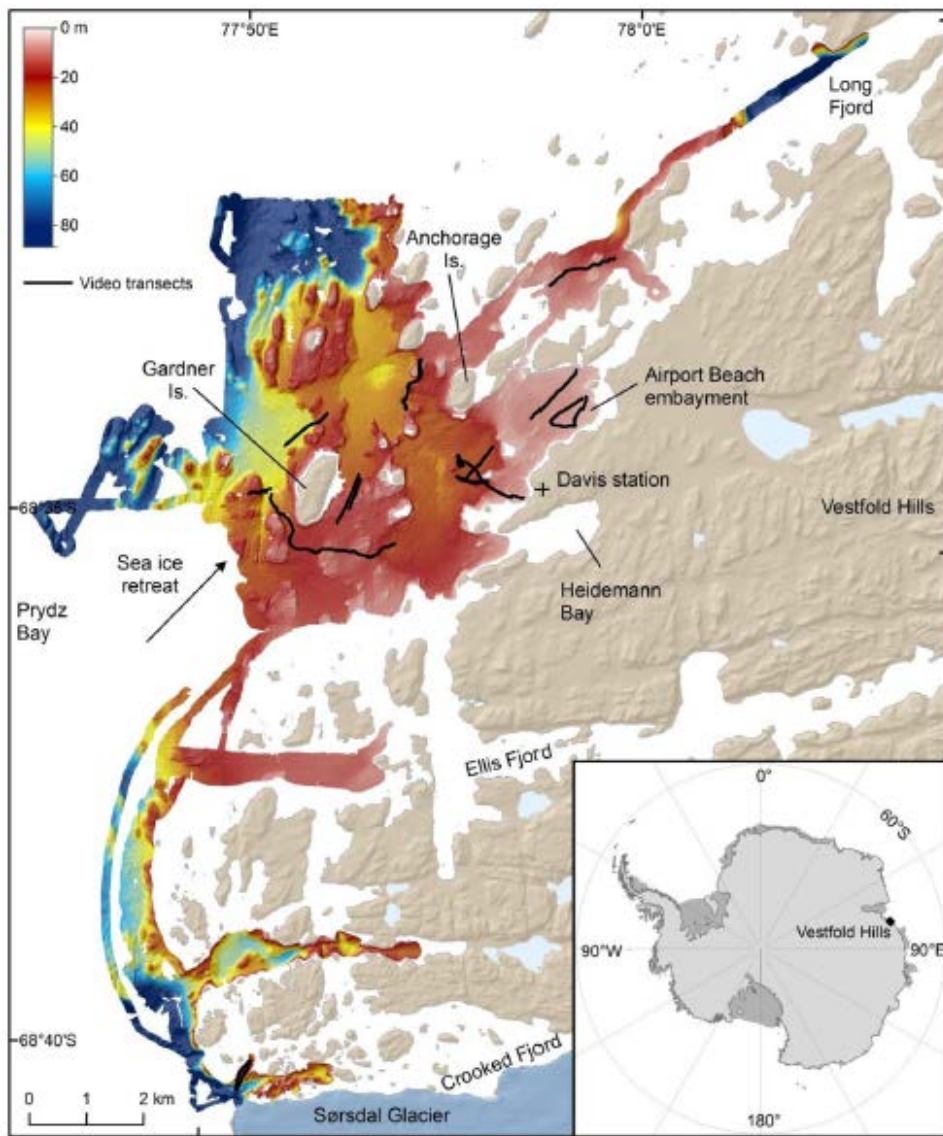


LOCAL SCALE

High-resolution mapping at Davis station, Vestfold Hills



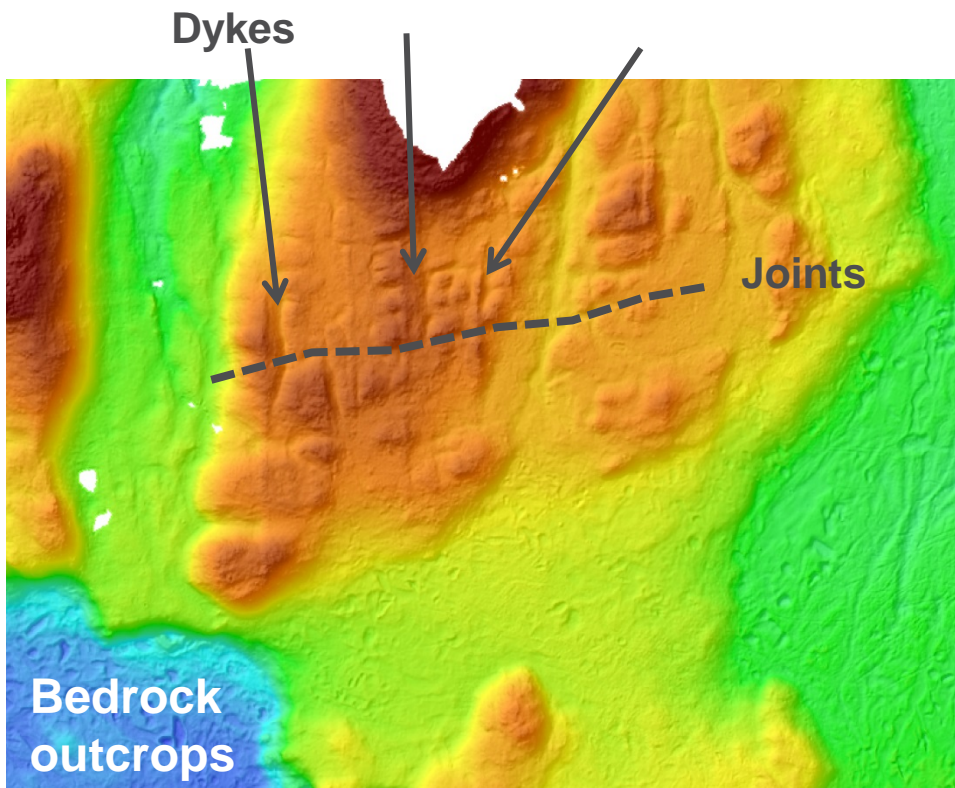
- Kongsberg EM3002 dual head MBES (300kHz system)
- RV *Howard Burton* (8.5 m workboat)



- 42 km² survey area, up to 300 m water depth
- Bathymetry and backscatter – 2 m grids

Seafloor Features

- Lack of glacial features
- Extension of onshore landforms
- Example 1: Bedrock features

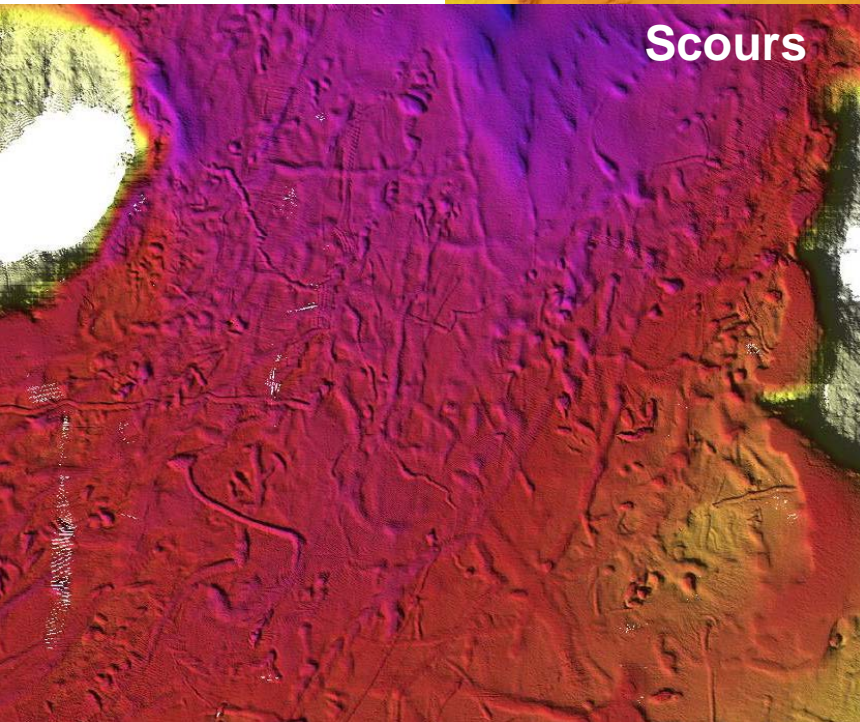
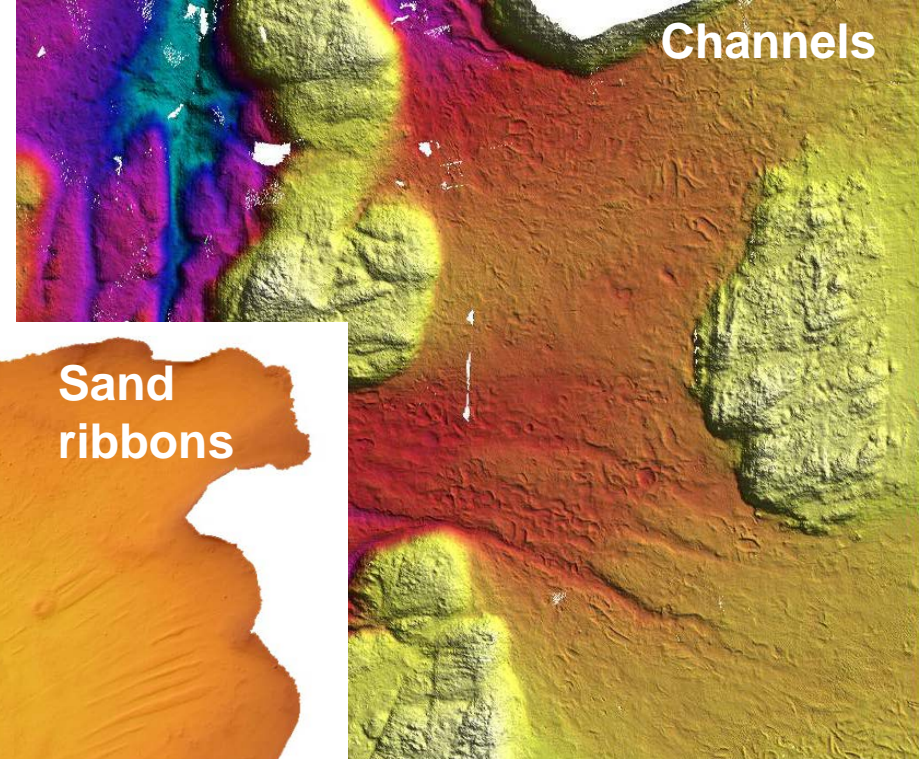


Seafloor Features

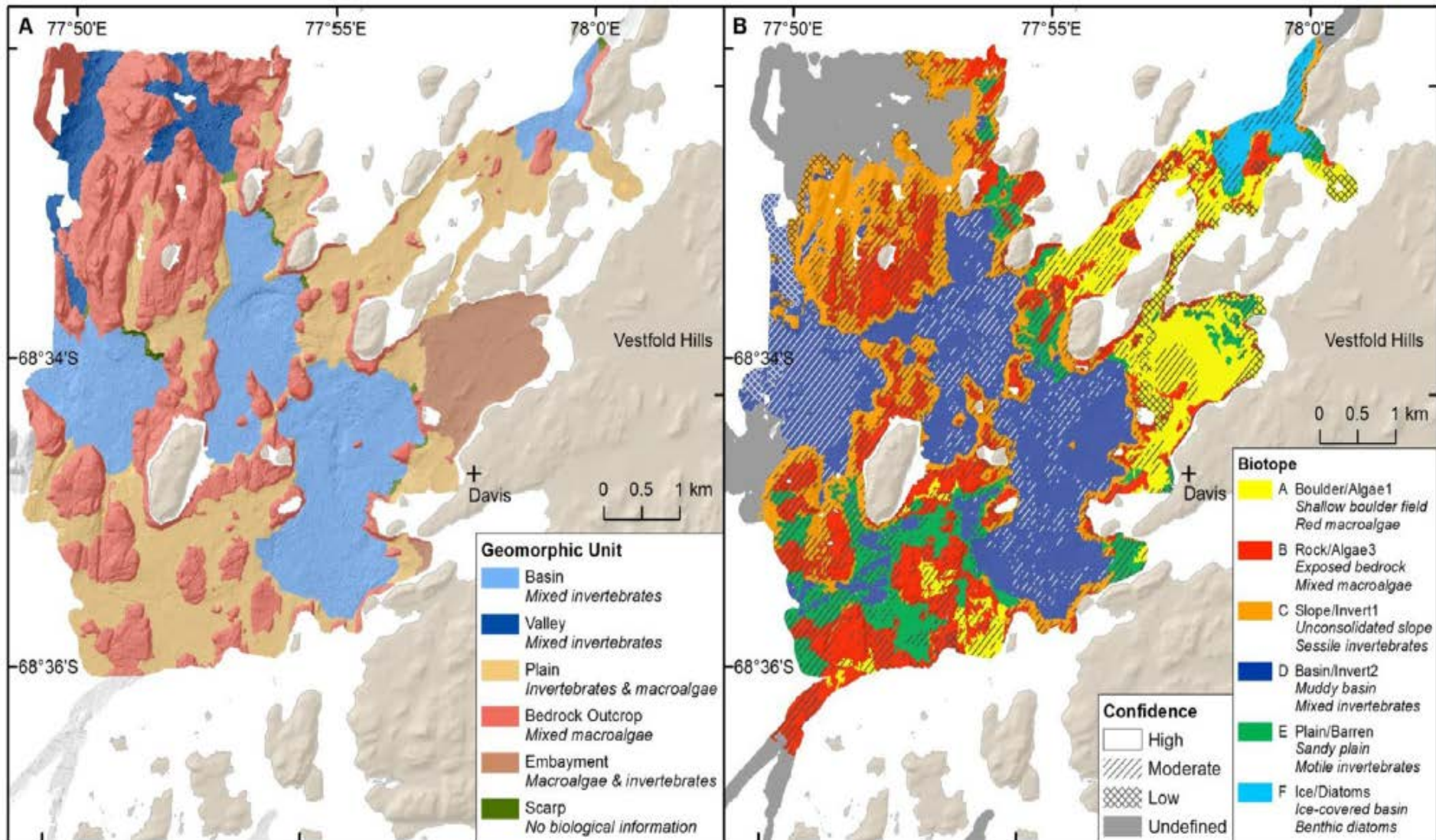
- Lack of glacial features
- Extension of onshore landforms
- Example 1: Bedrock features
- Example 2: Boulder fields



Hydrodynamics

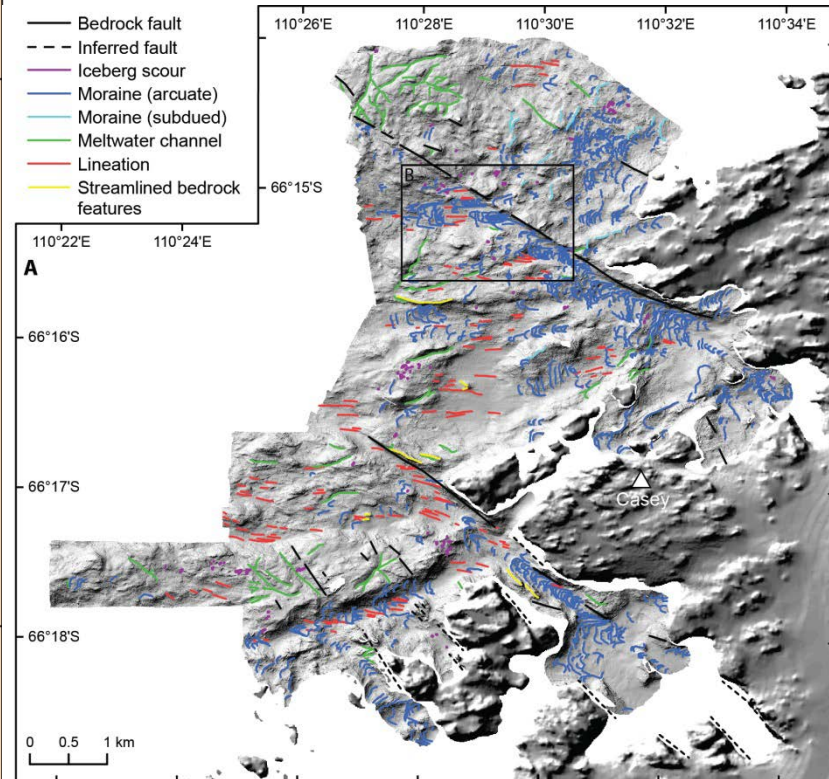
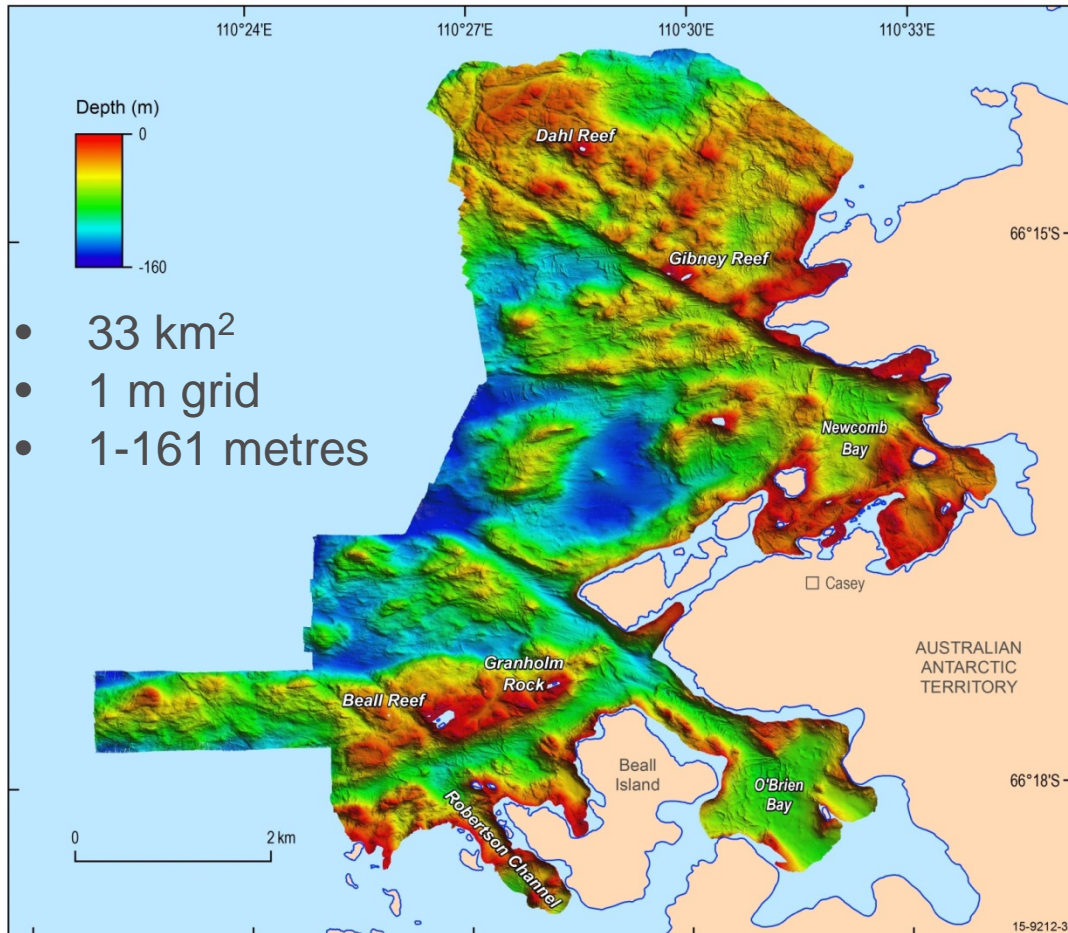


New Geomorphic and Benthic Habitat Maps



LOCAL SCALE

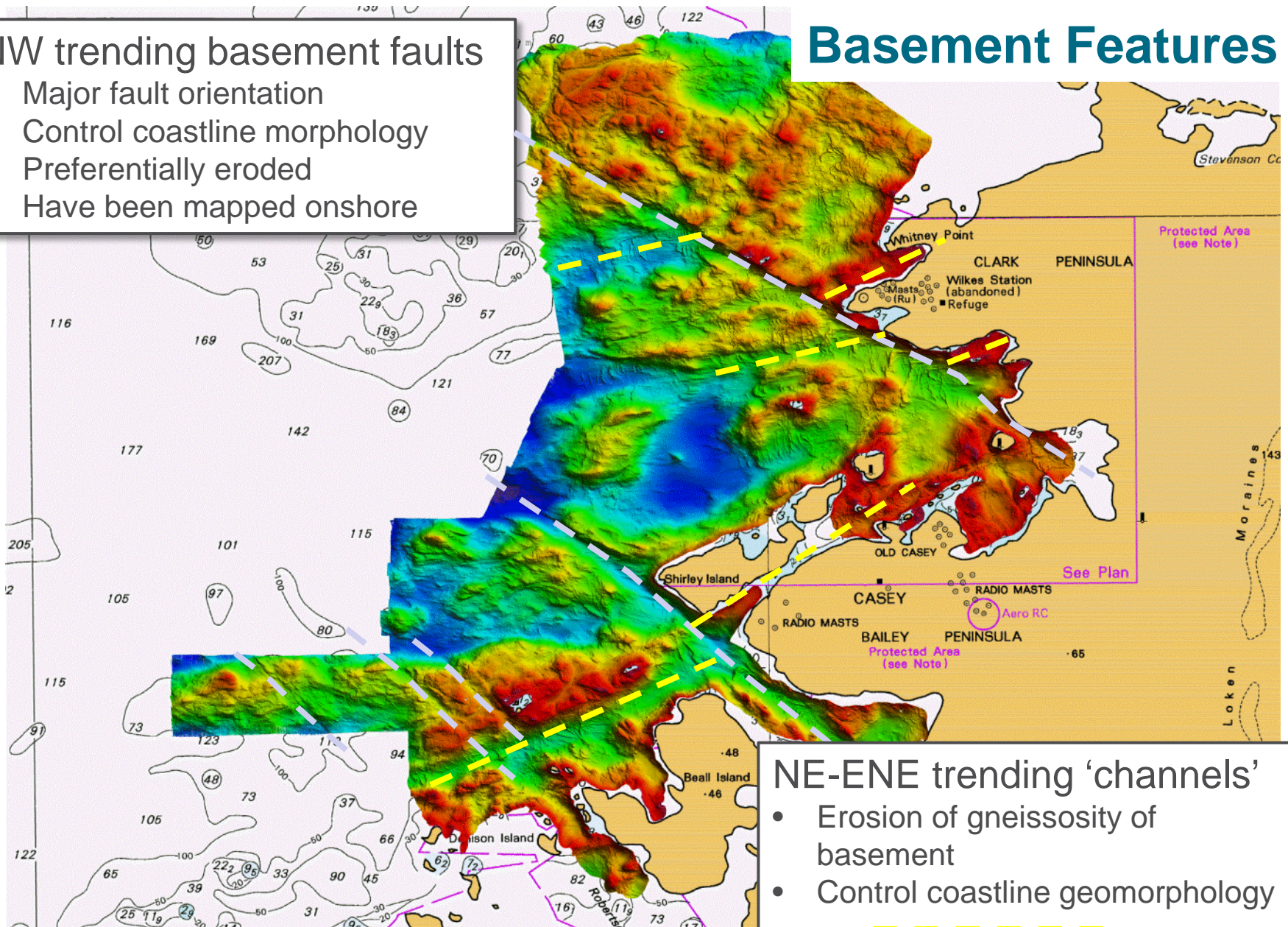
High-resolution mapping at Casey station, Windmill Islands



NW trending basement faults

- Major fault orientation
- Control coastline morphology
- Preferentially eroded
- Have been mapped onshore

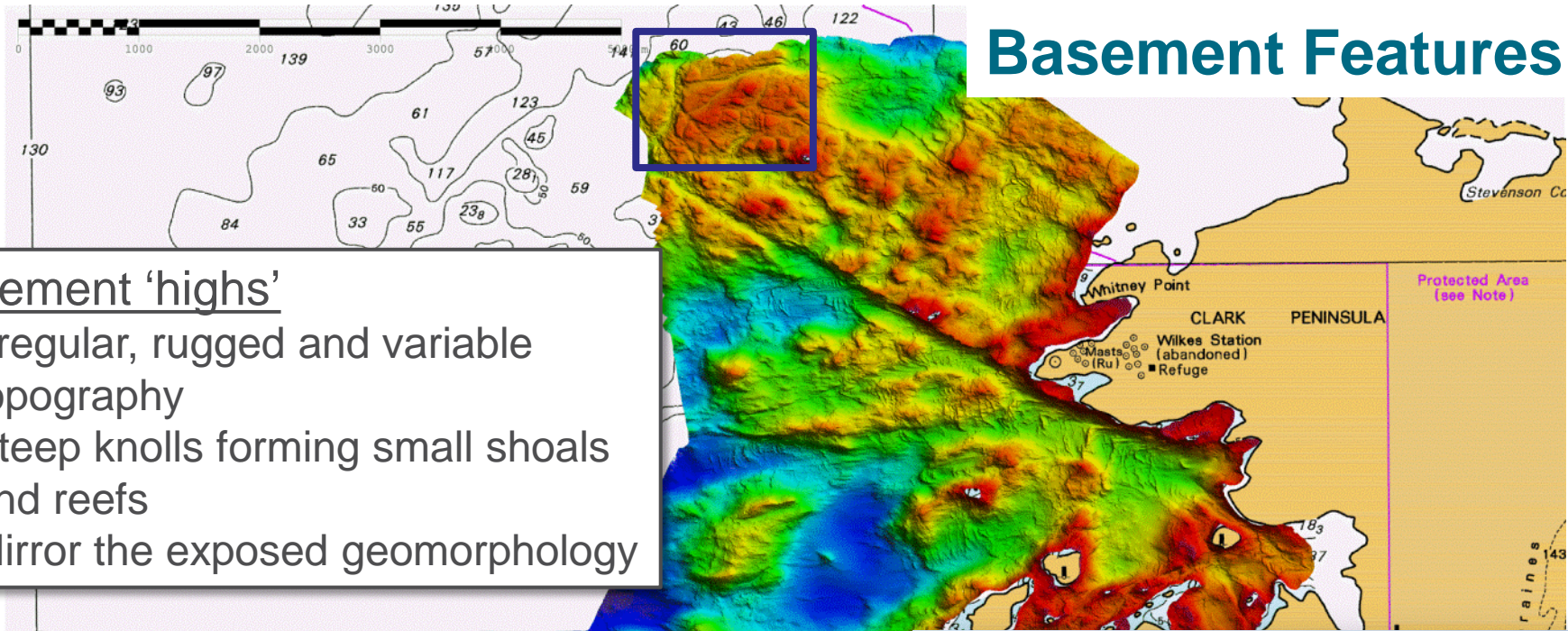
Basement Features



NE-ENE trending 'channels'

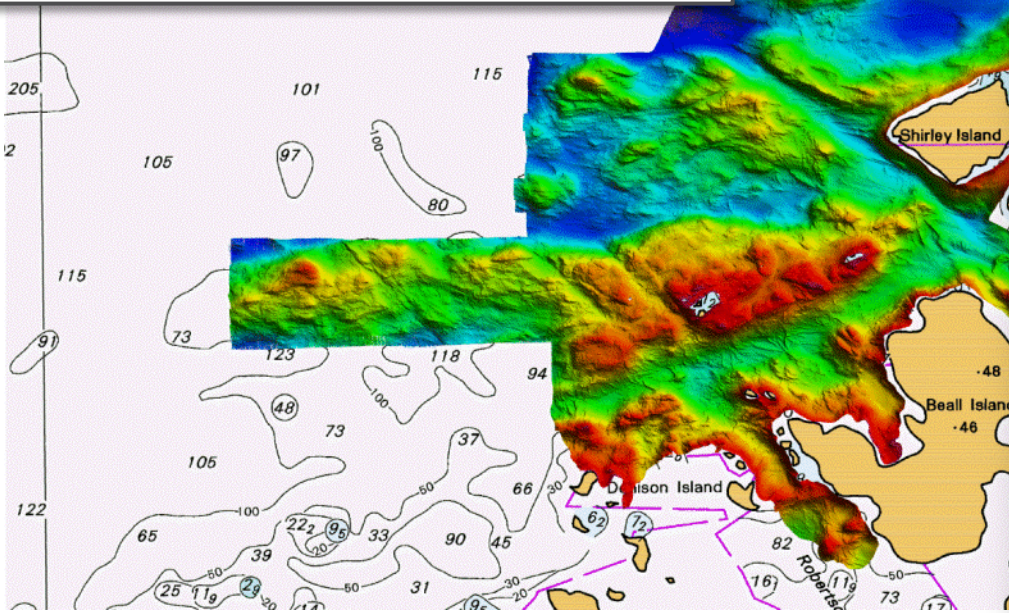
- Erosion of gneissosity of basement
- Control coastline geomorphology

Basement Features



Basement 'highs'

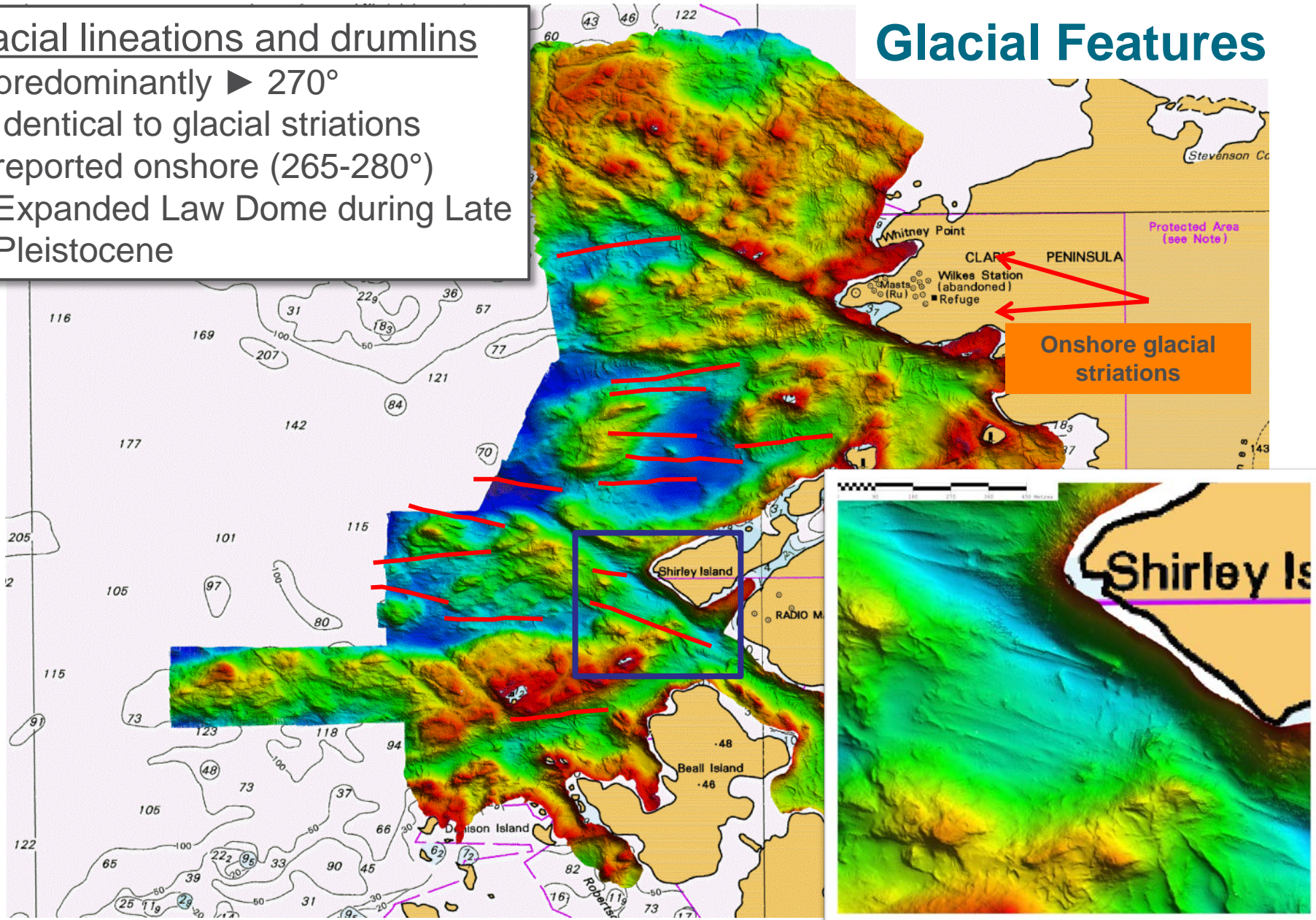
- Irregular, rugged and variable topography
- Steep knolls forming small shoals and reefs
- Mirror the exposed geomorphology



Glacial lineations and drumlins

- predominantly ► 270°
- Identical to glacial striations reported onshore (265-280°)
- Expanded Law Dome during Late Pleistocene

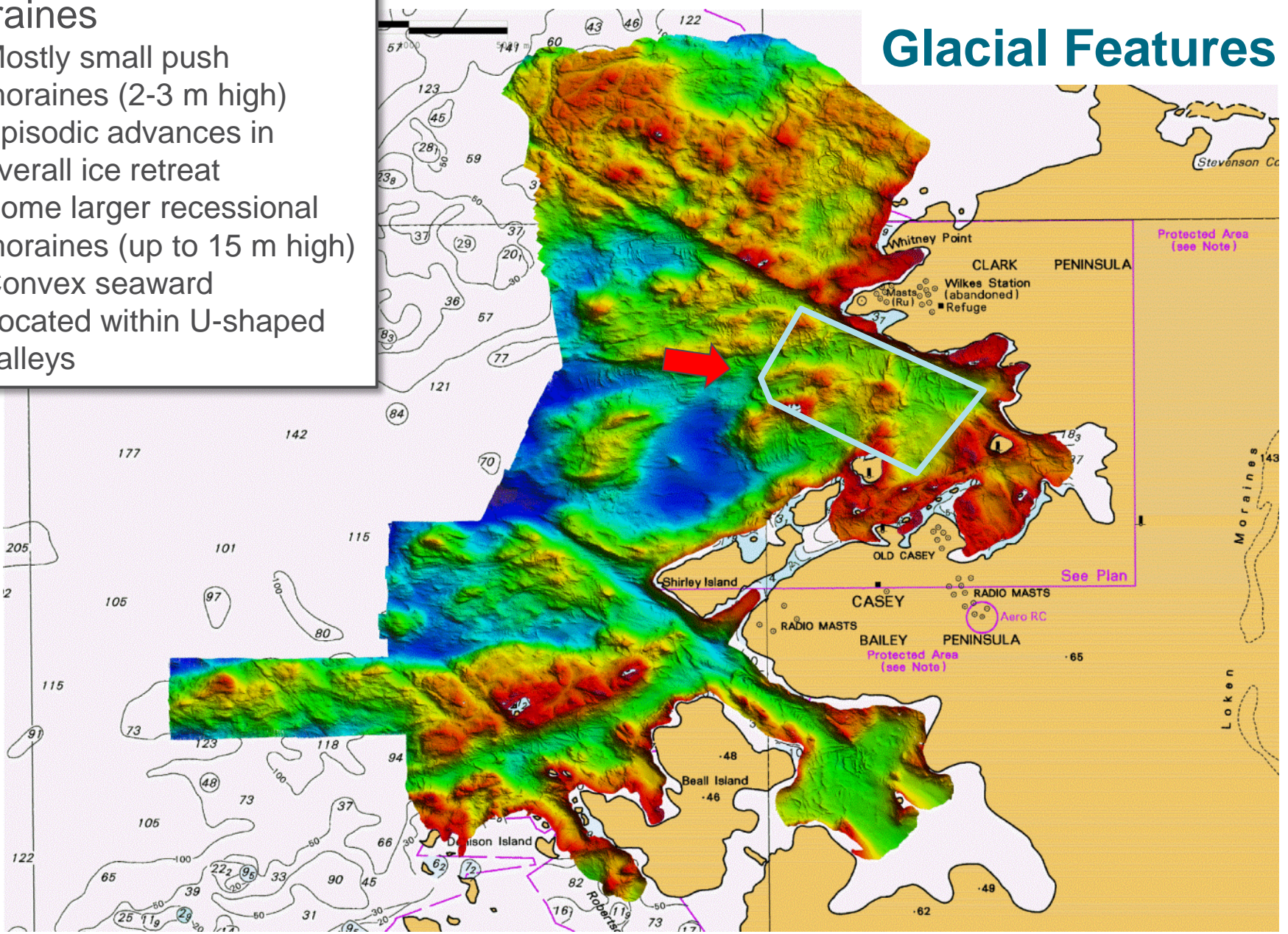
Glacial Features

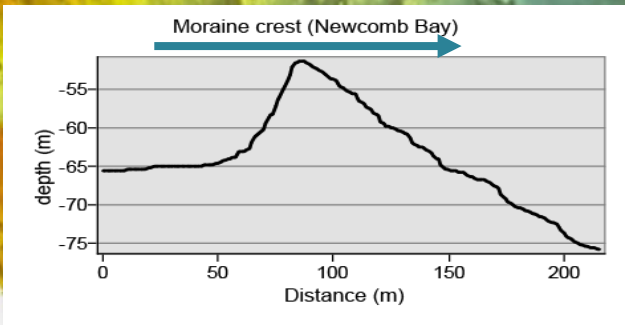
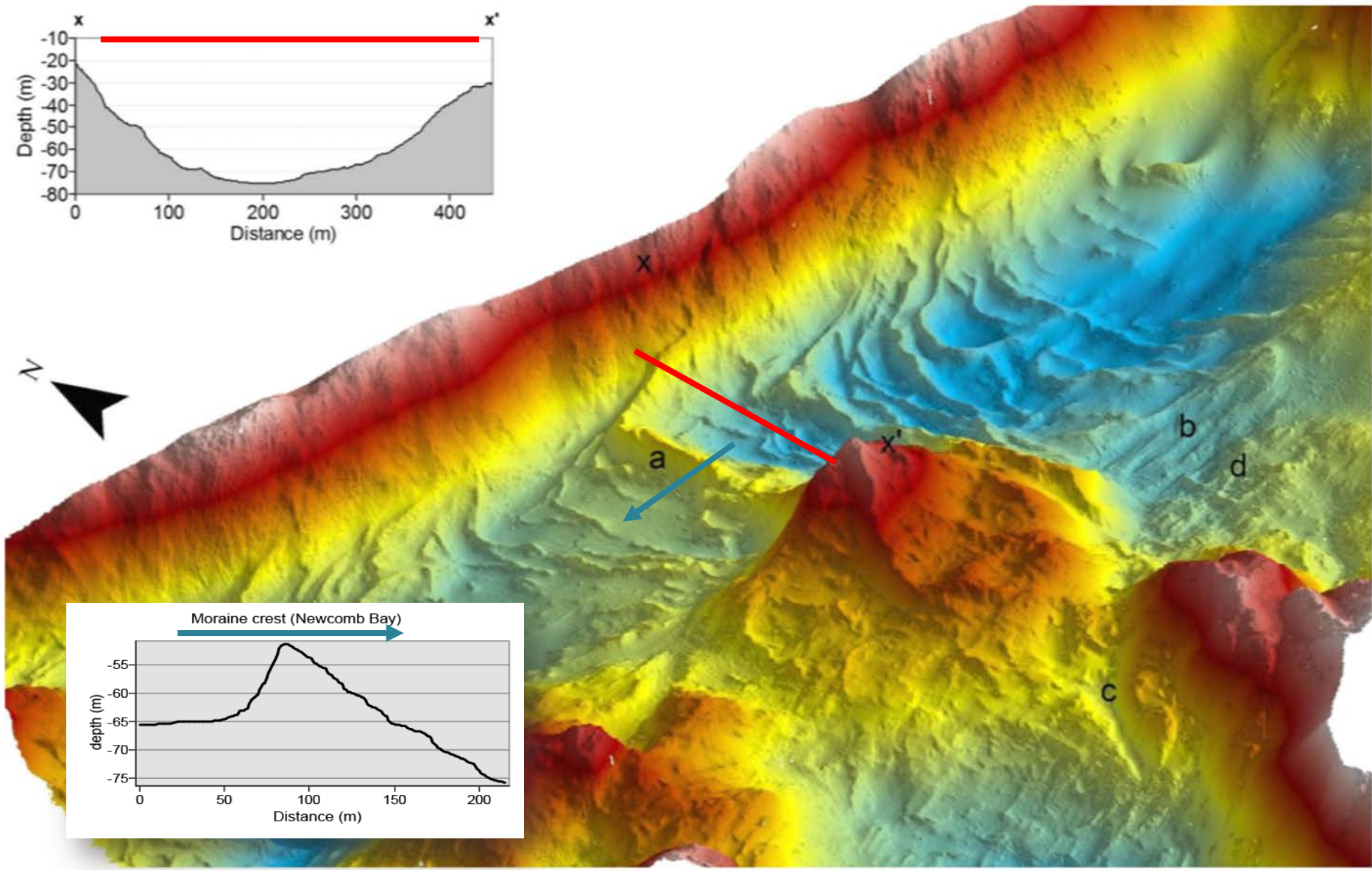
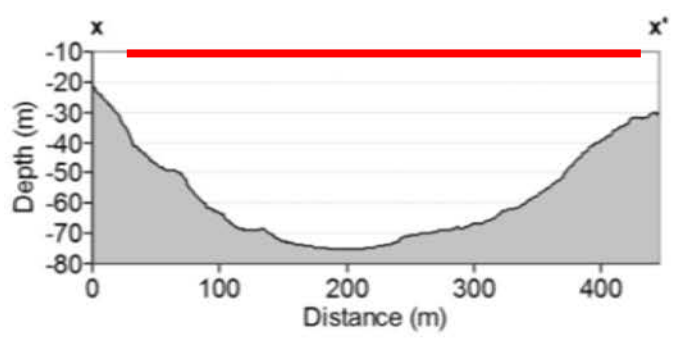


Moraines

- Mostly small push moraines (2-3 m high)
- Episodic advances in overall ice retreat
- Some larger recessional moraines (up to 15 m high)
- Convex seaward
- Located within U-shaped valleys

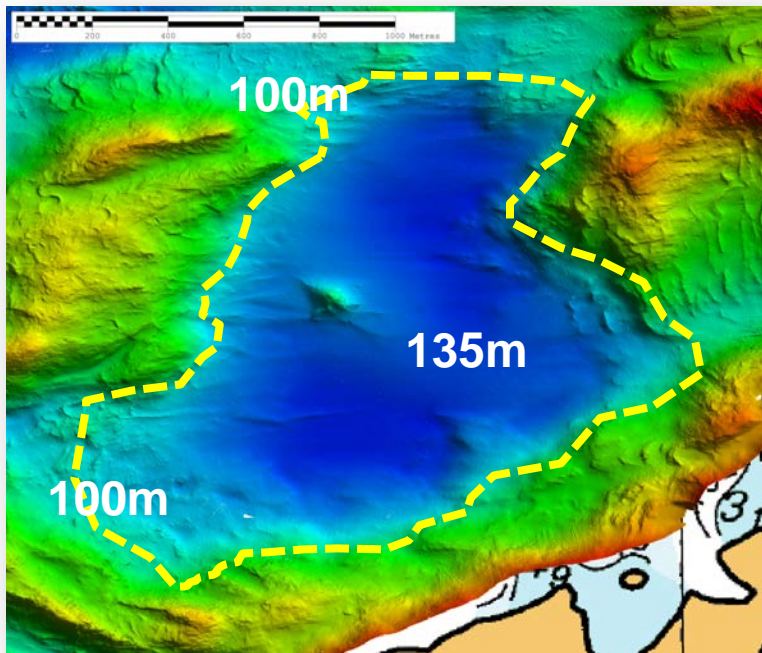
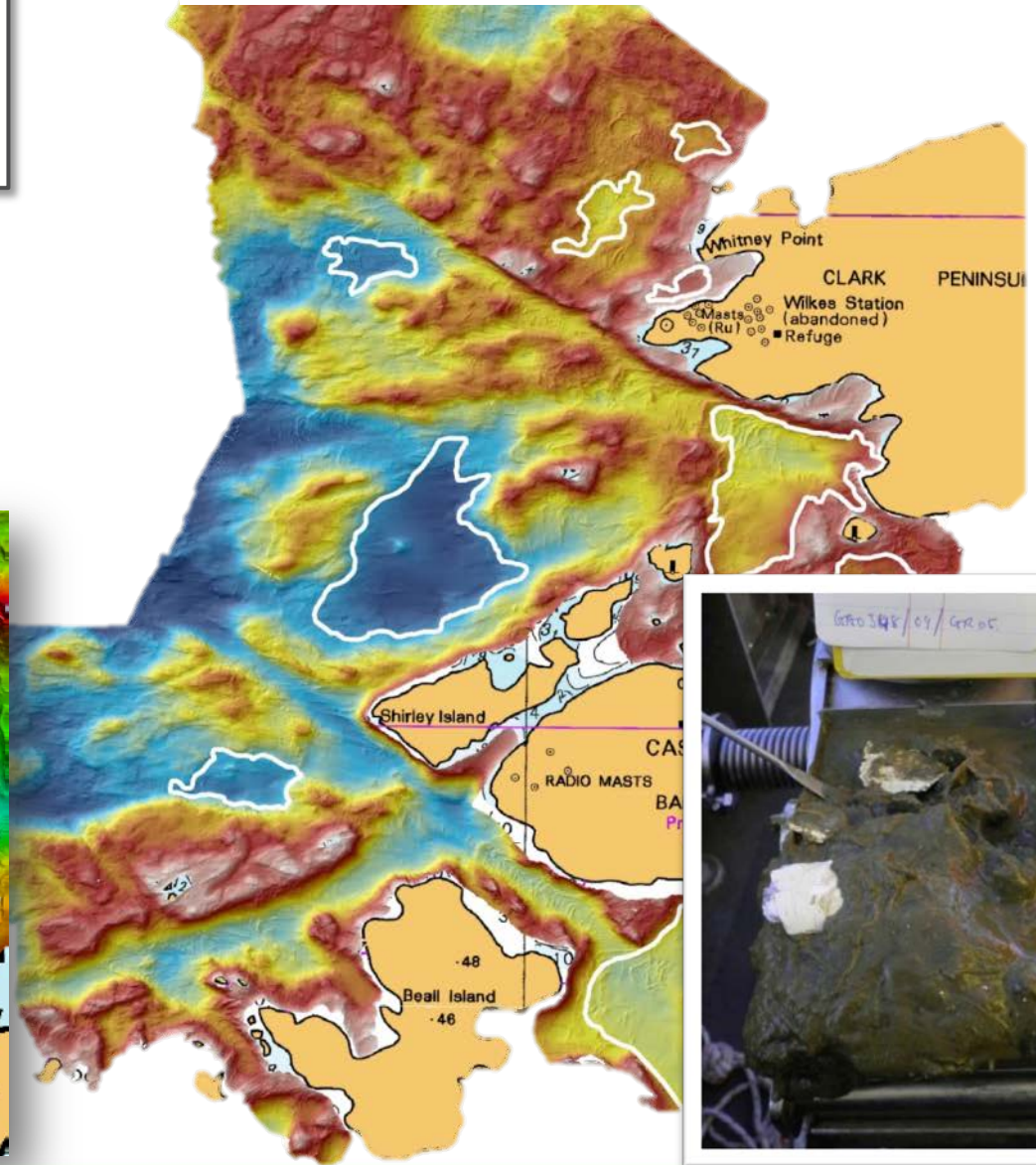
Glacial Features





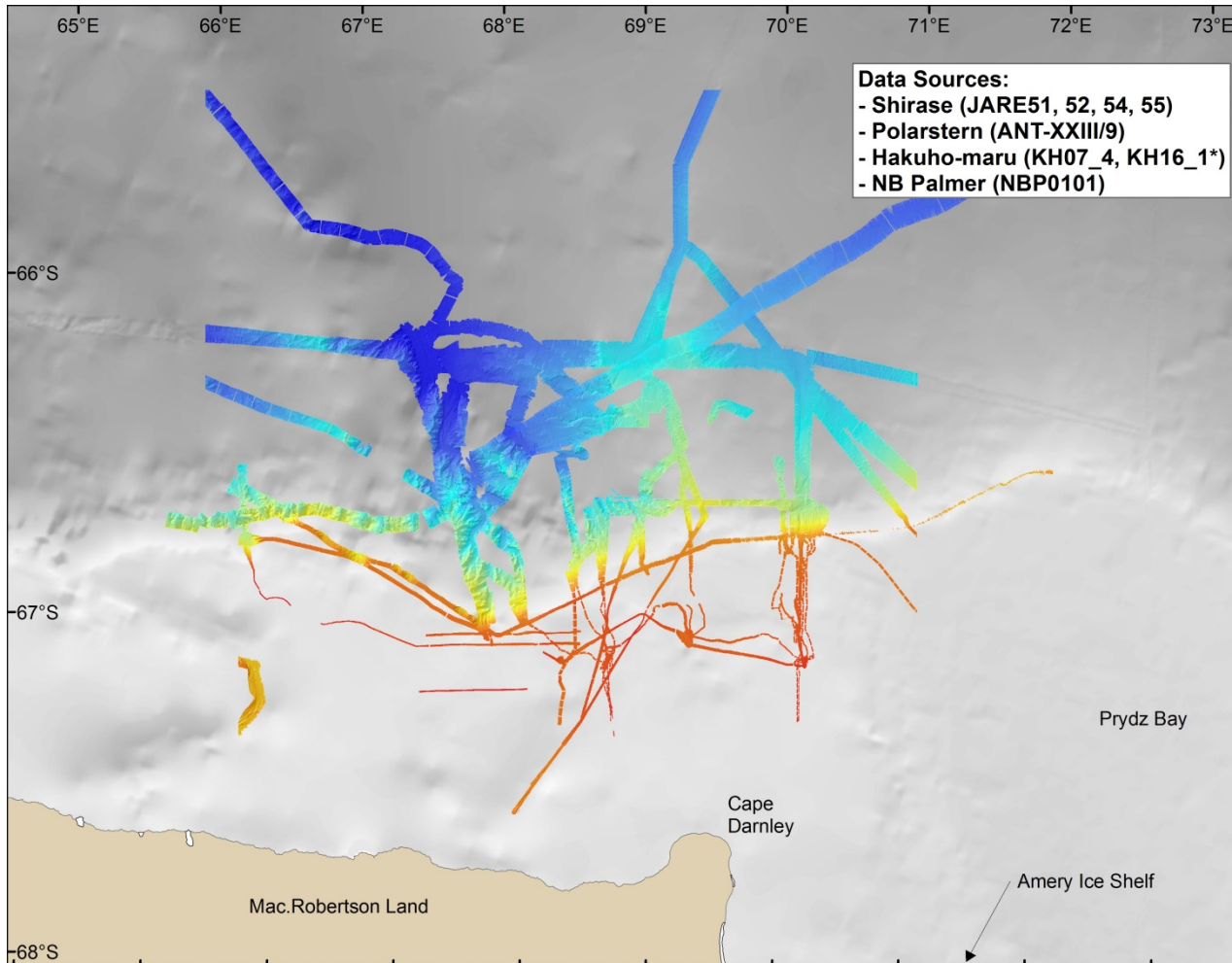
- 'Enclosed' basins and depressions
- Post-glacial sedimentation
- Target for deglaciation history for coring
- Unknown sediment thickness

Post-glacial marine basins



CURRENT WORK

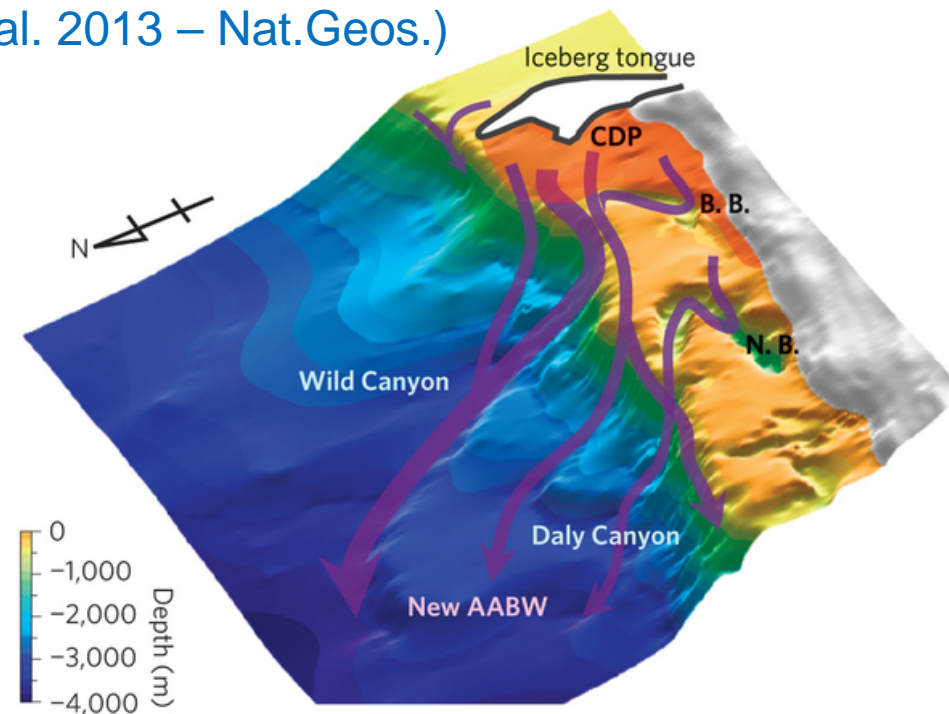
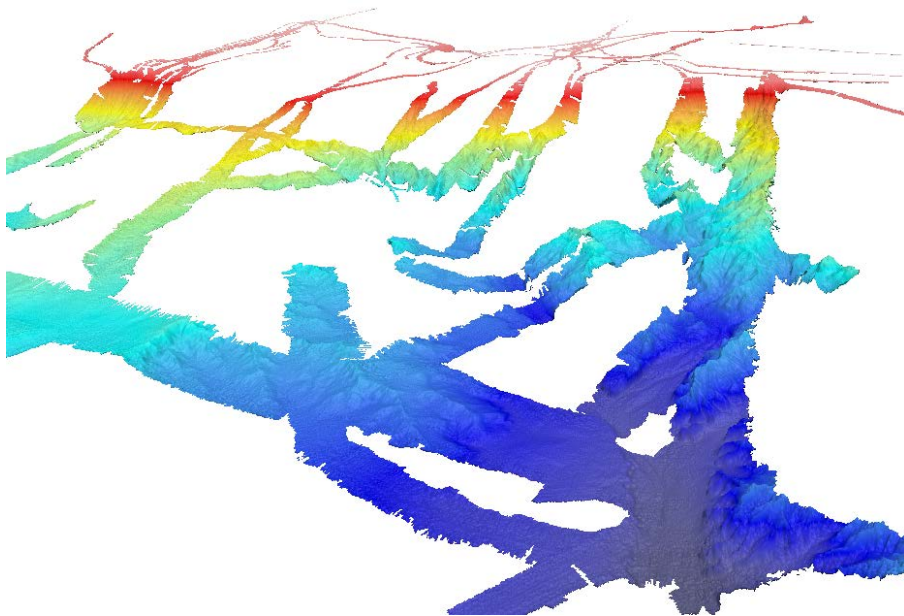
Cape Darnley Seafloor Geomorphology



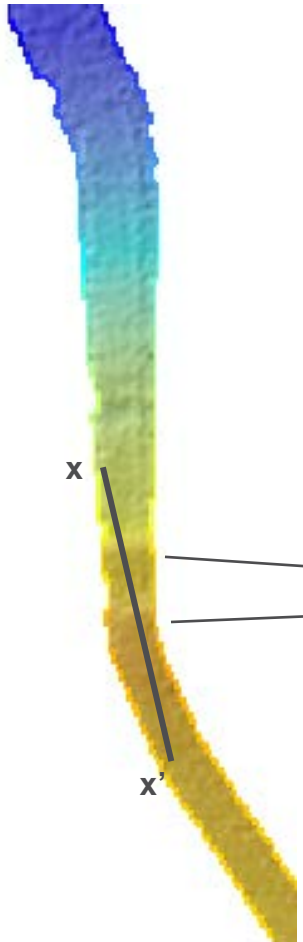
Cape Darnley Polynya

- Important site for Antarctic Bottom Water production
- Oceanography poorly constrained by lack of good bathymetry

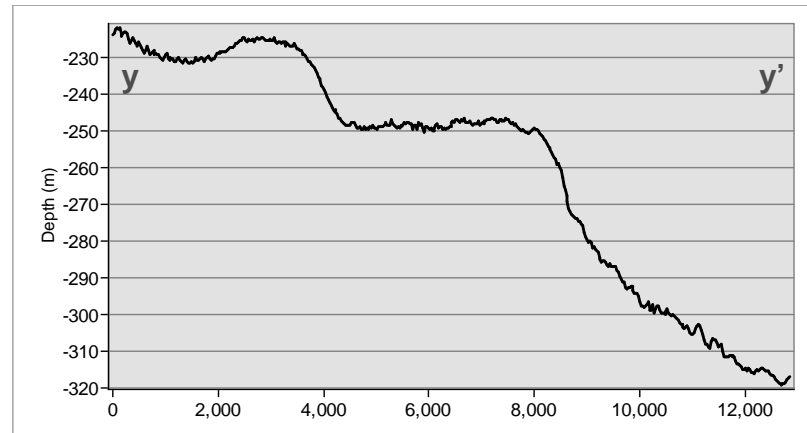
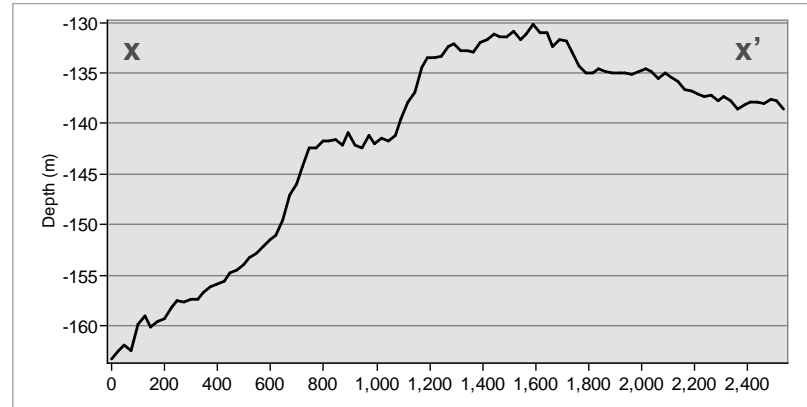
“We concluded ...there are inherent errors in ...the available bathymetric datasets, in particular the coastal region surrounding Cape Darnley” (Ohshima et al. 2013 – Nat.Geos.)



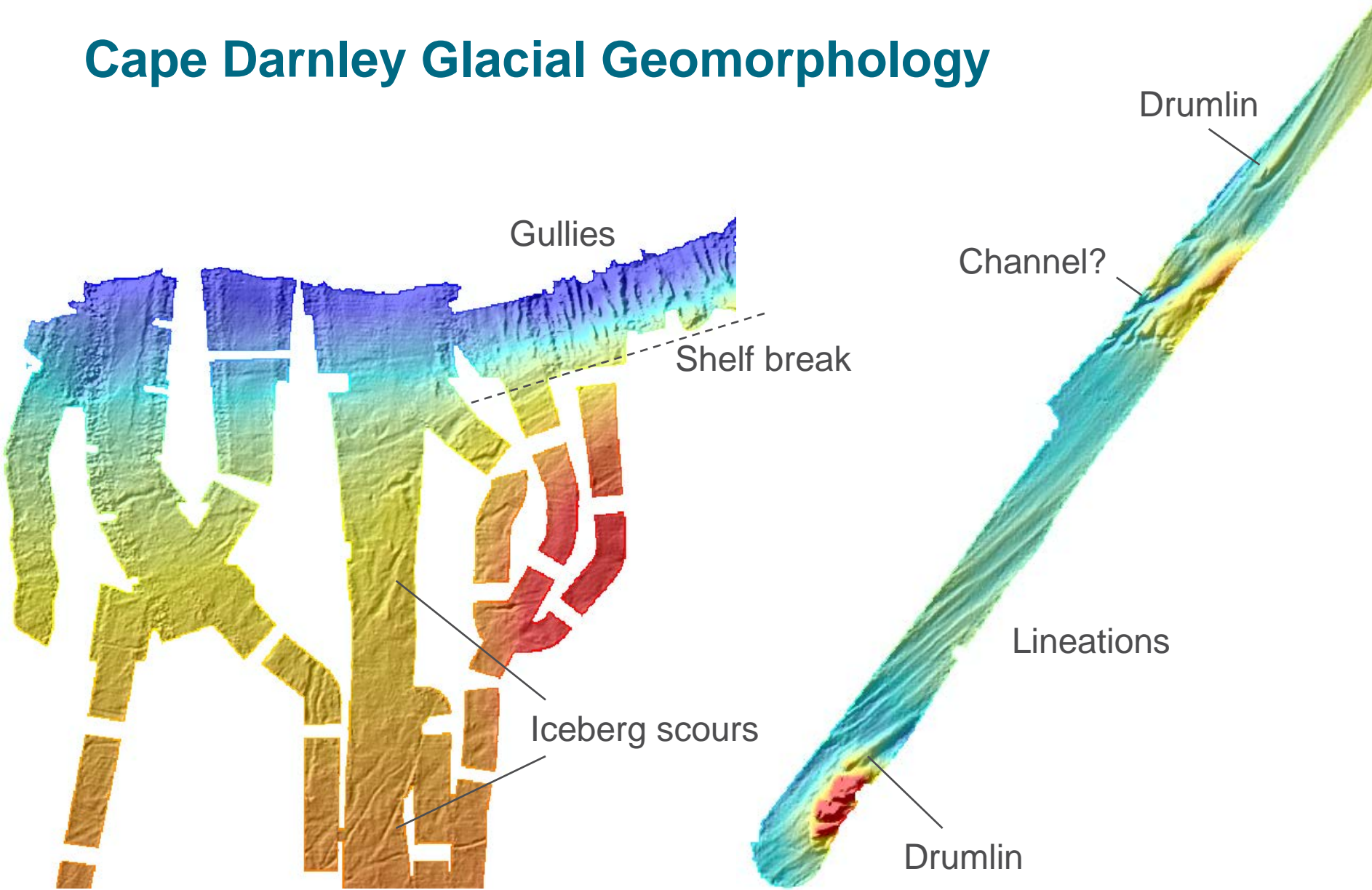
Cape Darnley Glacial Geomorphology



Ridges
- moraines?
- GZW?



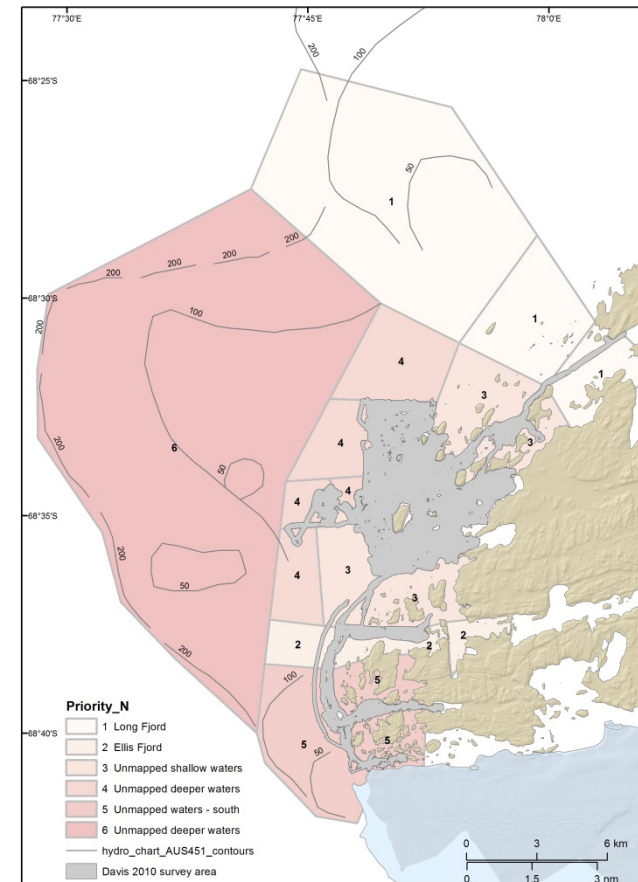
Cape Darnley Glacial Geomorphology



2016/17 Season

Geoscience Australia Activities in Antarctica

1. High-resolution multibeam survey - Davis station
 - Extend coverage from 2010
2. RV Investigator voyage – Totten Glacier
 - Seafloor habitat mapping
3. Absolute gravity survey – Casey station
 - Benchmark ICECAP airborne gravity
4. Geodetic and geophysical monitoring program – Davis station



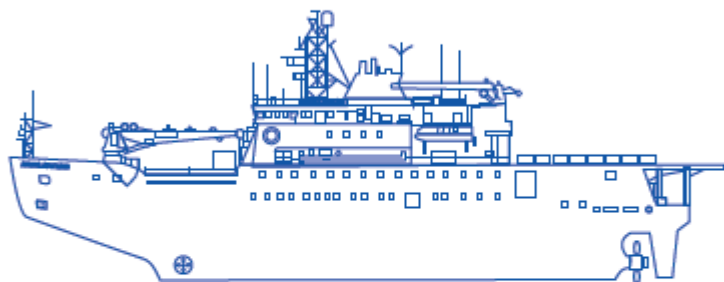
Future Directions

Replacement Icebreaker

- Due in 2020
- 30 year life
- Full ocean depth multibeam capabilities

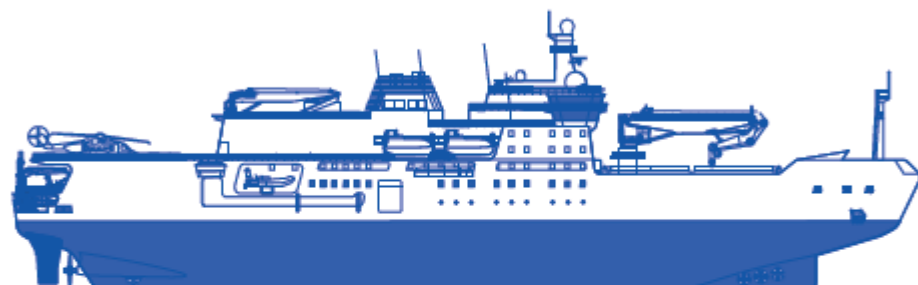


RSV Aurora Australis

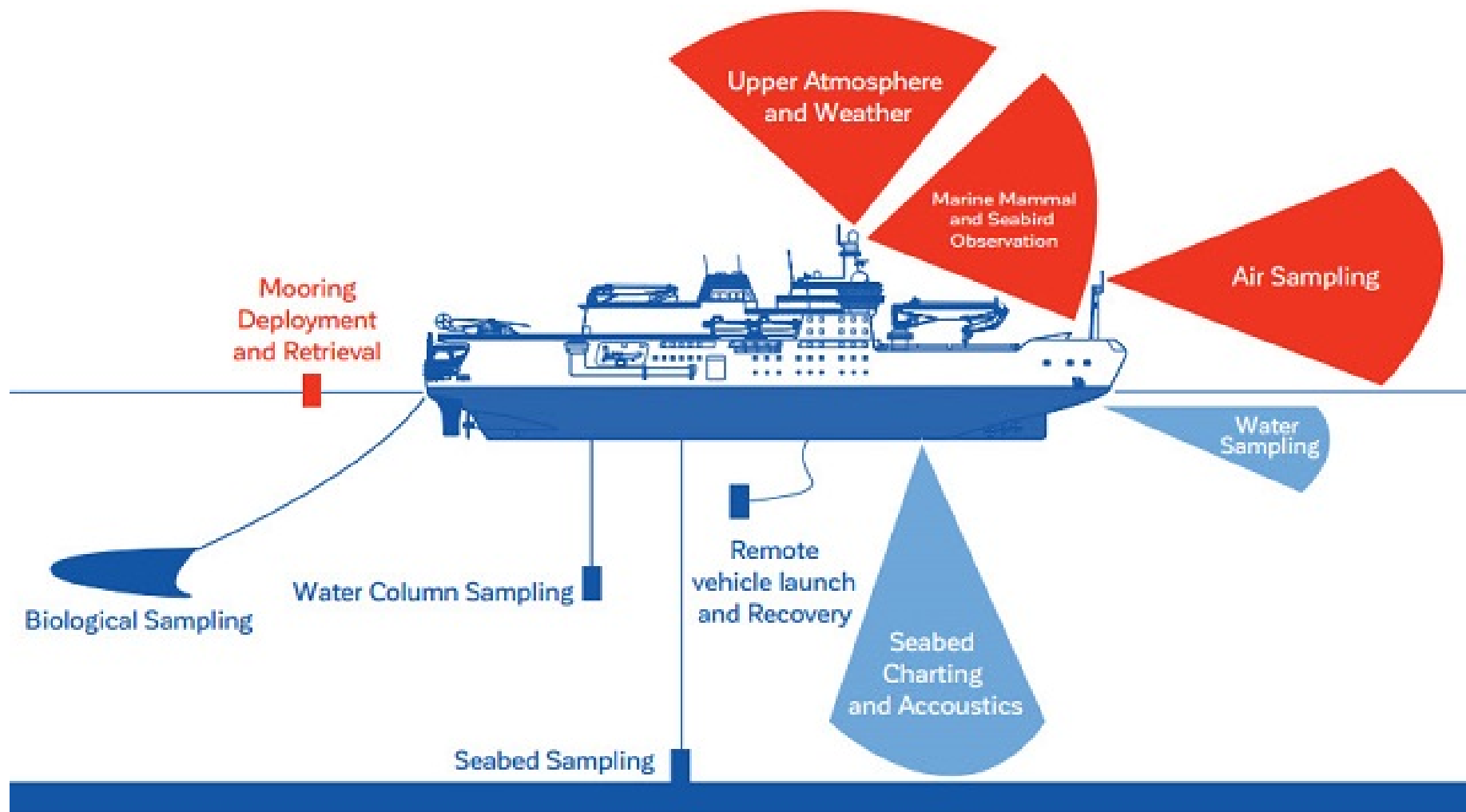


Commissioned	1990
Length overall	94.91 metres
Maximum beam	20.3 metres
Maximum draught	7.8 metres
Displacement	8,158 tonnes
Icebreaking	1.23 metres at 2.5 knots
Speed	11 knots economical, 16+ knots max
Cargo Fuel Capacity	1,100,000 litres / 968 tonnes
Container Capacity	34
Cargo weight	800 tonnes
Passengers	116

NEW ICEBREAKER



Length overall	156.0 metres
Maximum beam	25.6 metres
Maximum draught	9.6 metres
Icebreaking	1.65 metres at 3 knots
Speed	12 knots economical, 16+ knots max
Range	> 16,000 nautical miles
Endurance	90 days
Cargo Fuel Capacity	1,900,000 litres / 1671 tonnes
Container Capacity	96 TUE
Cargo weight	1200 tonnes
Passengers	116



ありがとうございます Arigatou gozaimasu

- Thanks to Chris Carson and Alix Post (Geoscience Australia)
- Thanks for Nogi-san for inviting me to Japan and providing the Cape Darnley data
- Thanks to Miura-san for helping with the Cape Darnley interpretations

Questions?

