Recent geological data collection and preliminary interpretations in support of offshore wind energy decision making on the Scotian Shelf

Net Zero OSW R&D Forum – November 18, 2024

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Geological Survey of Canada – Atlantic

Canada

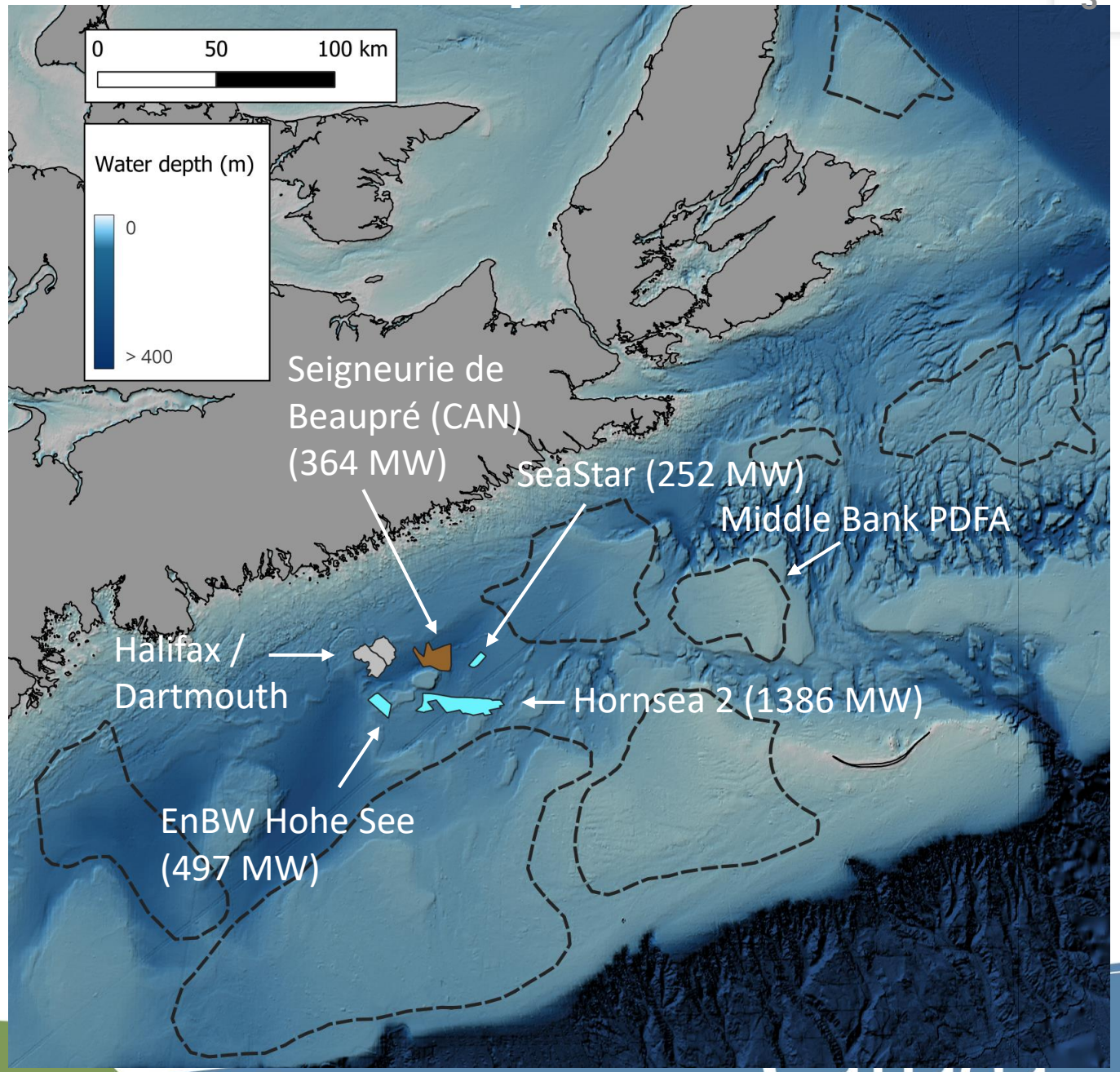
Overview

- Why is geology important in offshore wind energy?
- What knowledge and data gaps exist in Canada?
- What has the Geological Survey of Canada been doing to help with these gaps?

Seigneurie de Beaupré – Canada's largest windfarm (2024) parcseoliensseigneuriedebeaupre.com

Basic numbers (2024)

- Nova Scotia total generating capacity (2839 MW)
- NS offshore wind capacity goal, first round (5000 MW)
- Largest wind farm in Canada (170 km^2) comparable in size to largest offshore wind farm in Europe (202 km^2), but with ¼ the capacity
- Likely minimum size commercial project to be economical in Canada (~500 MW) comparable in size to Dartmouth urban area
- Can fit 7 Hornsea 2's into the Middle Bank PDFA



Hornsea 2 (foreground) evwind.es

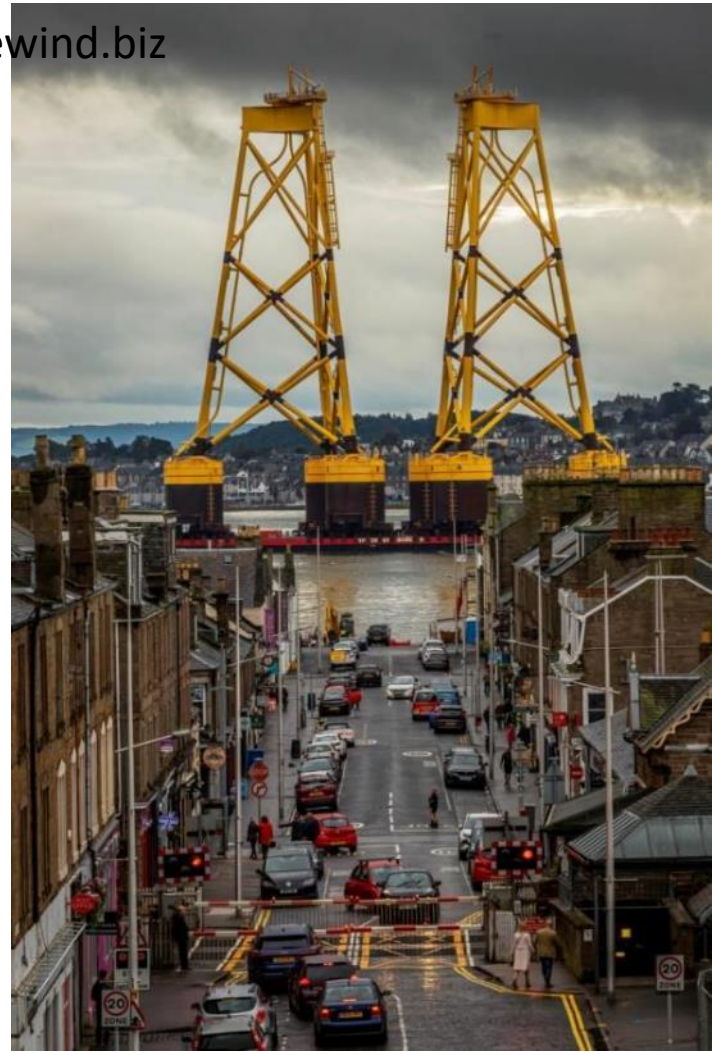
Hornsea 1 - azocleantech.com

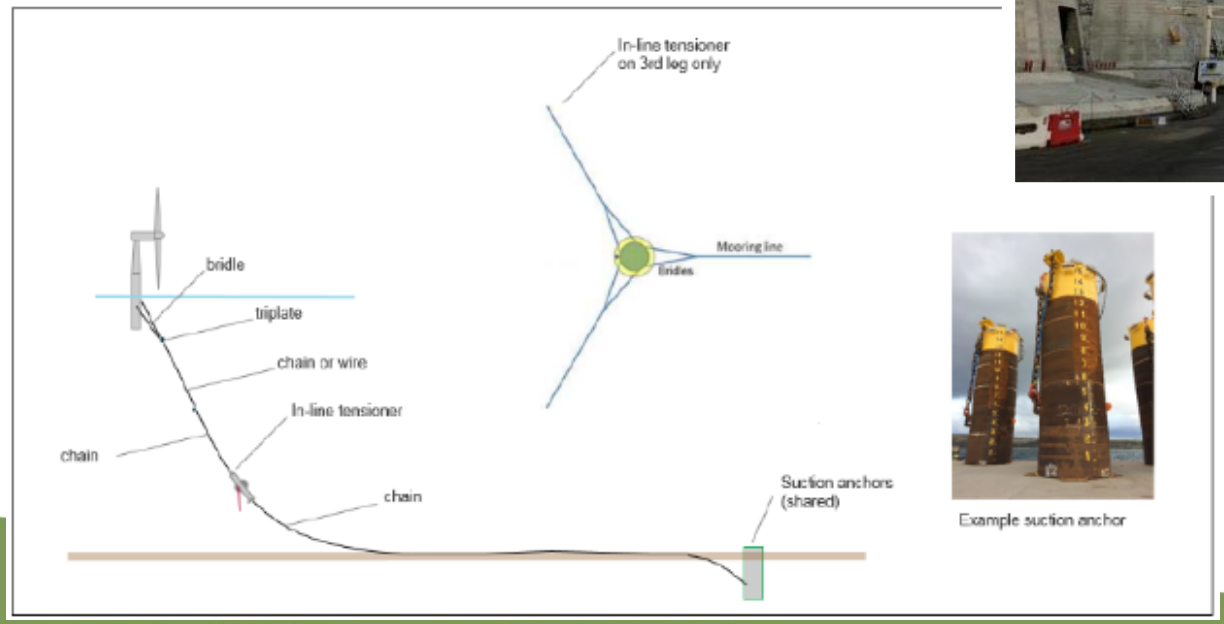

heavyliftnews.com/

Examples of wind turbine foundations

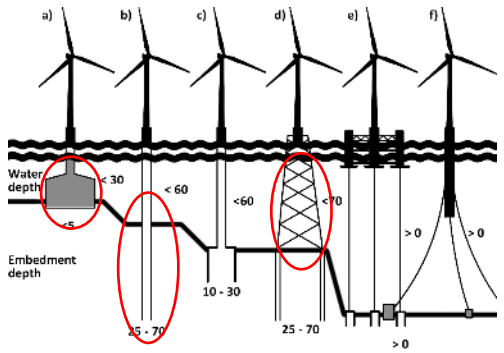
Monopiles in Halifax Harbour – photo Eamer

Offshorewind.biz



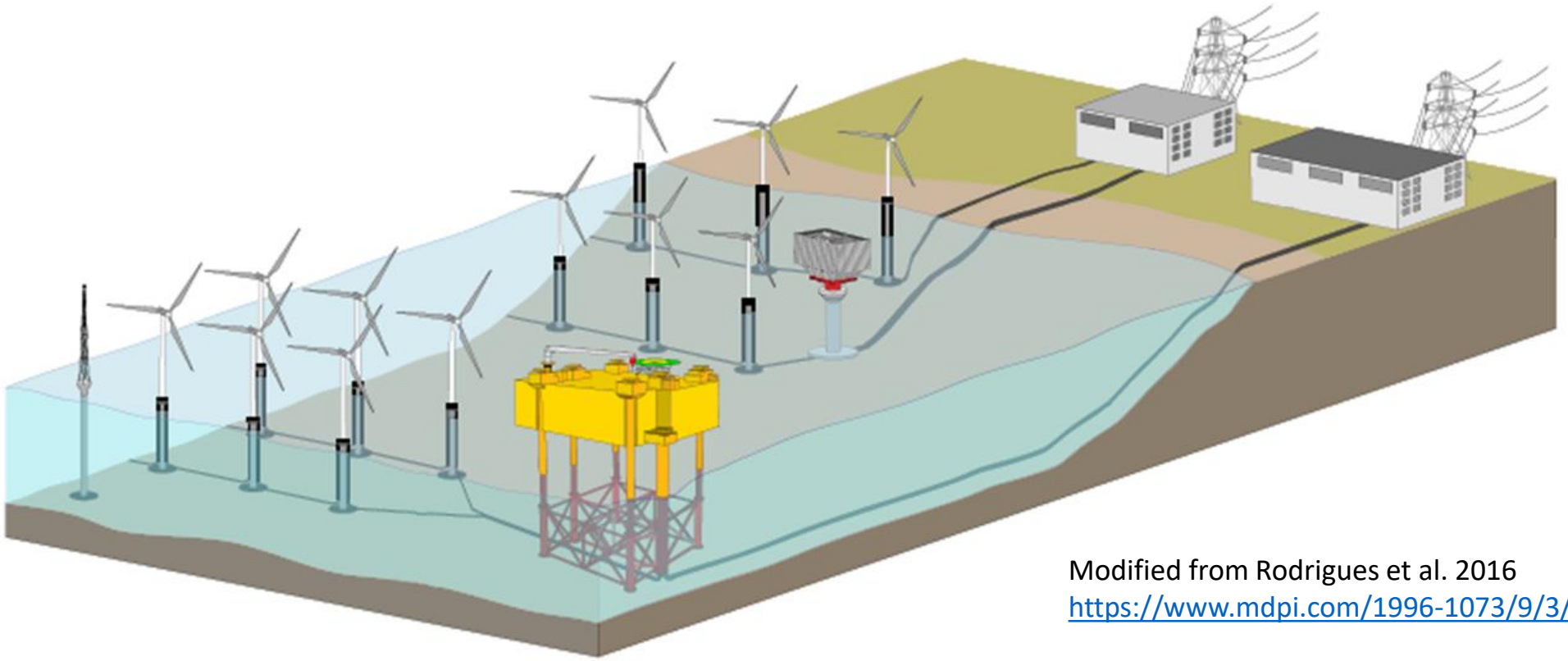


Example suction anchor



https://www.boem.gov/renewable-energy/studies/study-number-deliverable-4-final-report-technical-summary

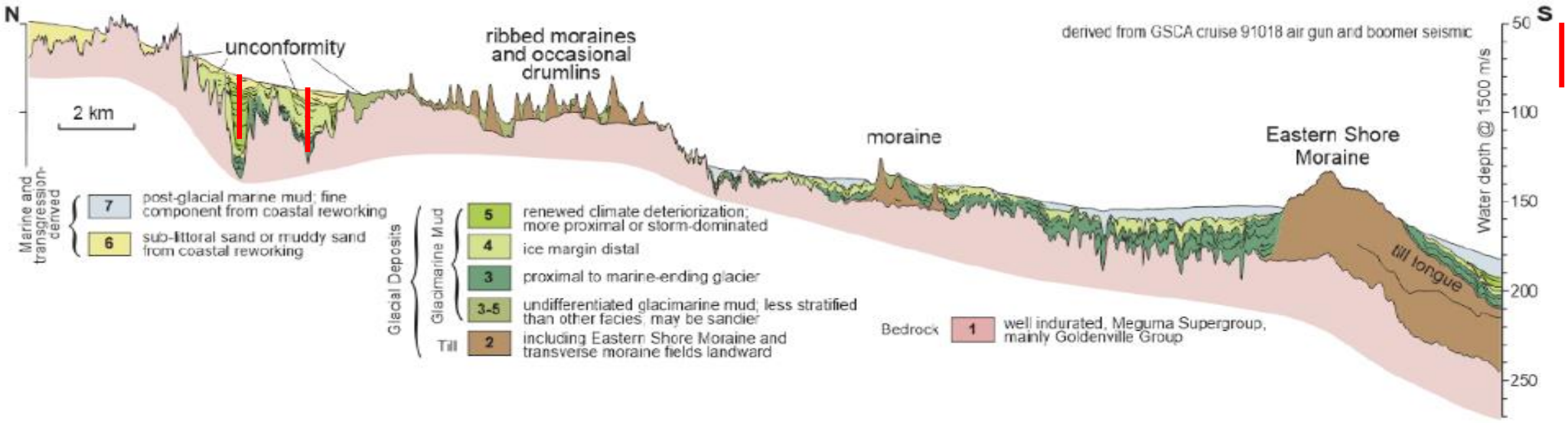
Foundations are just one part of what goes in or on the seabed



Modified from Rodrigues et al. 2016
https://www.mdpi.com/1996-1073/9/3/216#

Important geoscience for offshore wind

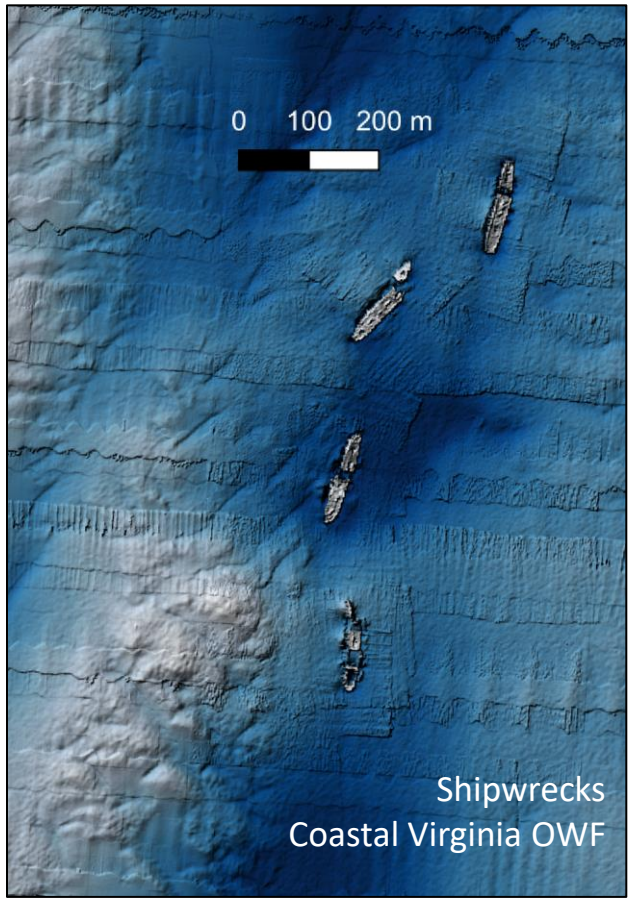
Eastern Shore interpreted geological profile modified from King (2018) - https://doi.org/10.4095/308454



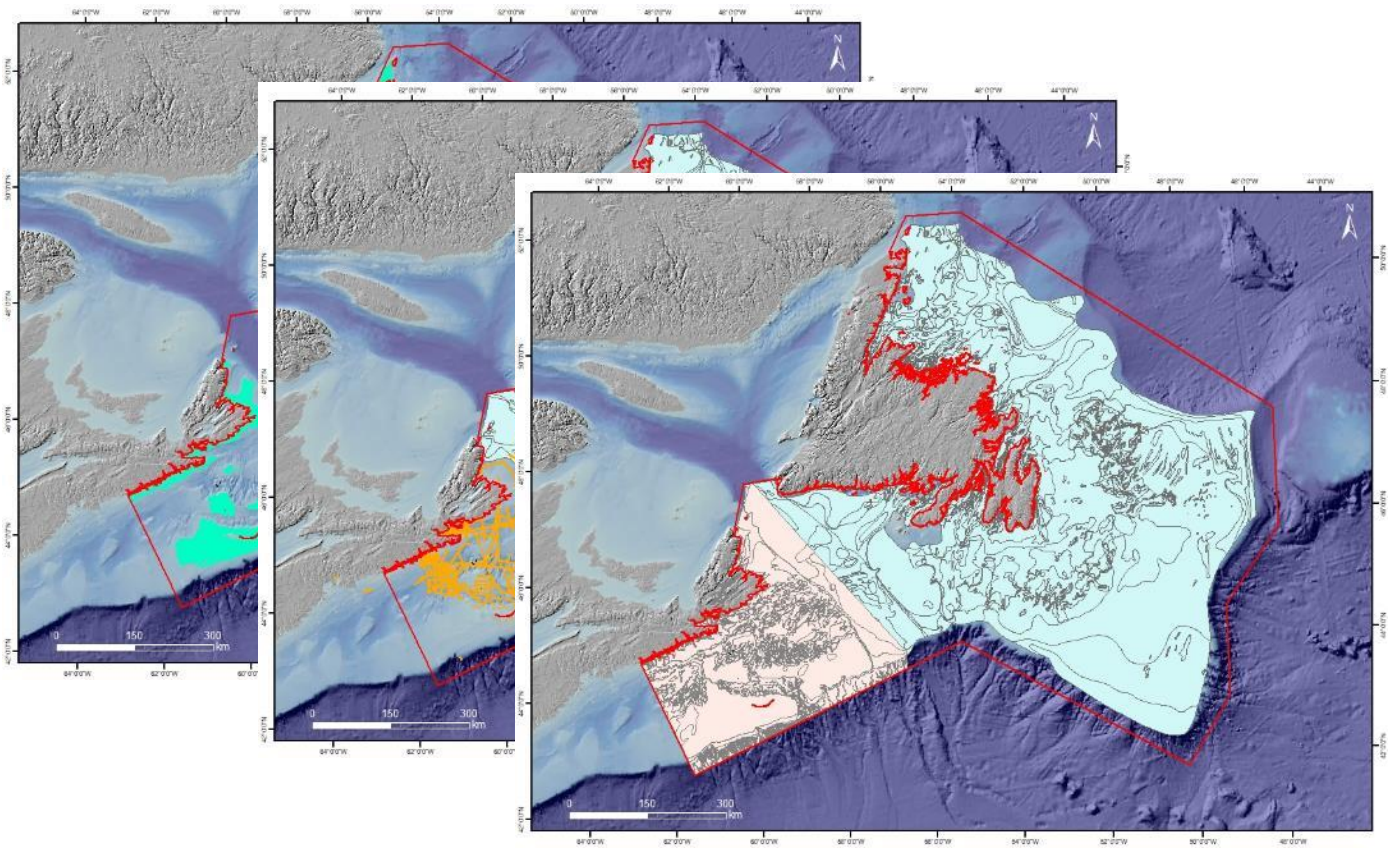
- Water depths
- Seabed sediments
- Sediments below the surface
- Engineering characteristics

Important geoscience for offshore wind

- Mobile sediments
- Hazards (e.g. underwater landslides, gas, salt)
- Anthropogenic features



Model development - Philibert et al. – this session



Parameters included:

- Water depth (GBF, piles, caissons), filtered to minimum OWF size
- Surficial geology (ranked 1-3)
- Sediment thickness (from 2d seismic)
- Slopes (<5°)
- Sediment mobility index
- Salt diapir distribution
- Paleo-lowstand
- Gas charged sediments
- Paleochannels

Parameters <u>not</u> included:

- Any classifications deeper than 70 m
- Geomorphology
- Engineering properties
- Extensive seismic coverage
- Many geohazards (e.g., liquefaction, landslides)

Offshore wind science questions in Atlantic Canada

1. How thick are sediments under the banks?
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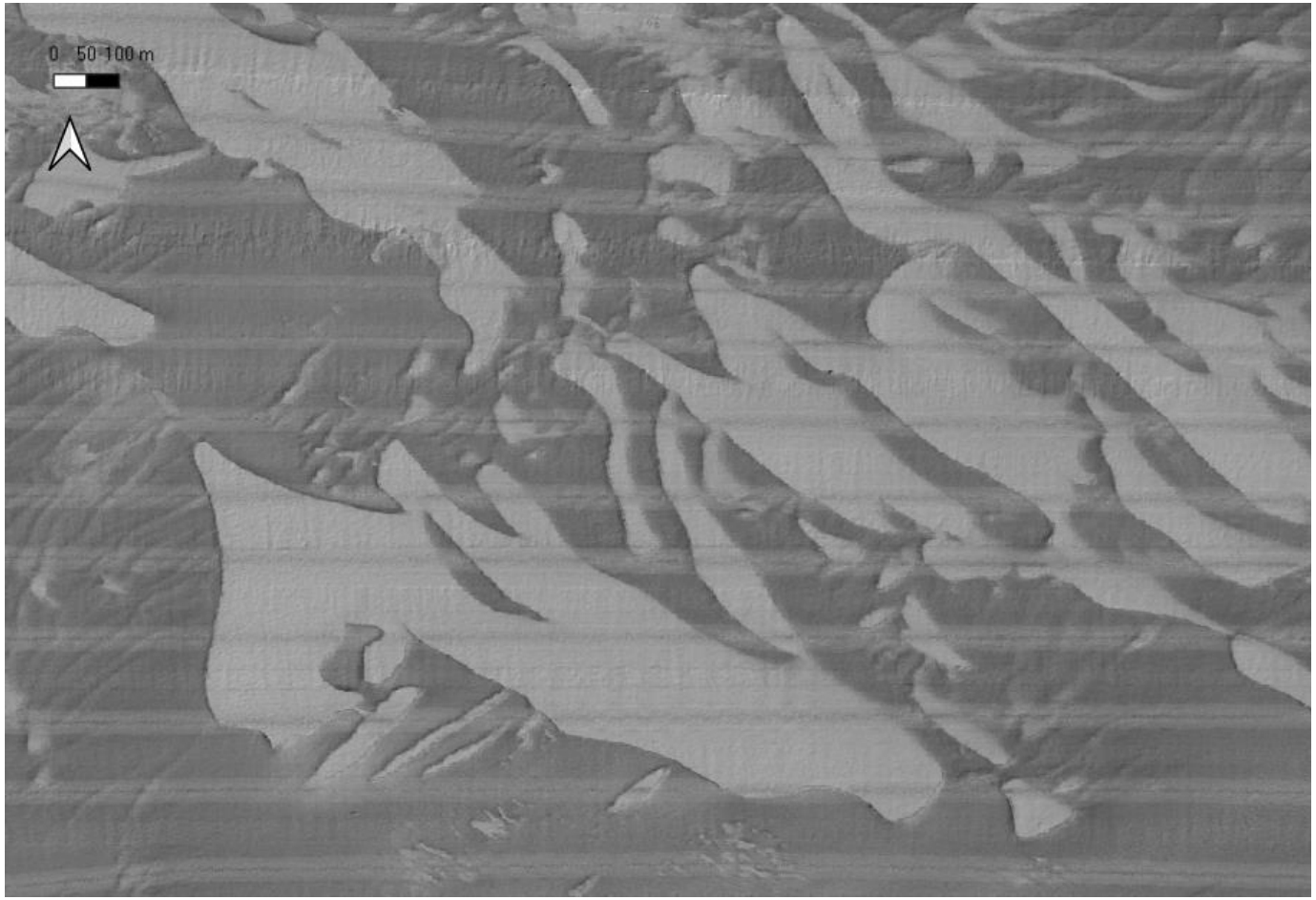
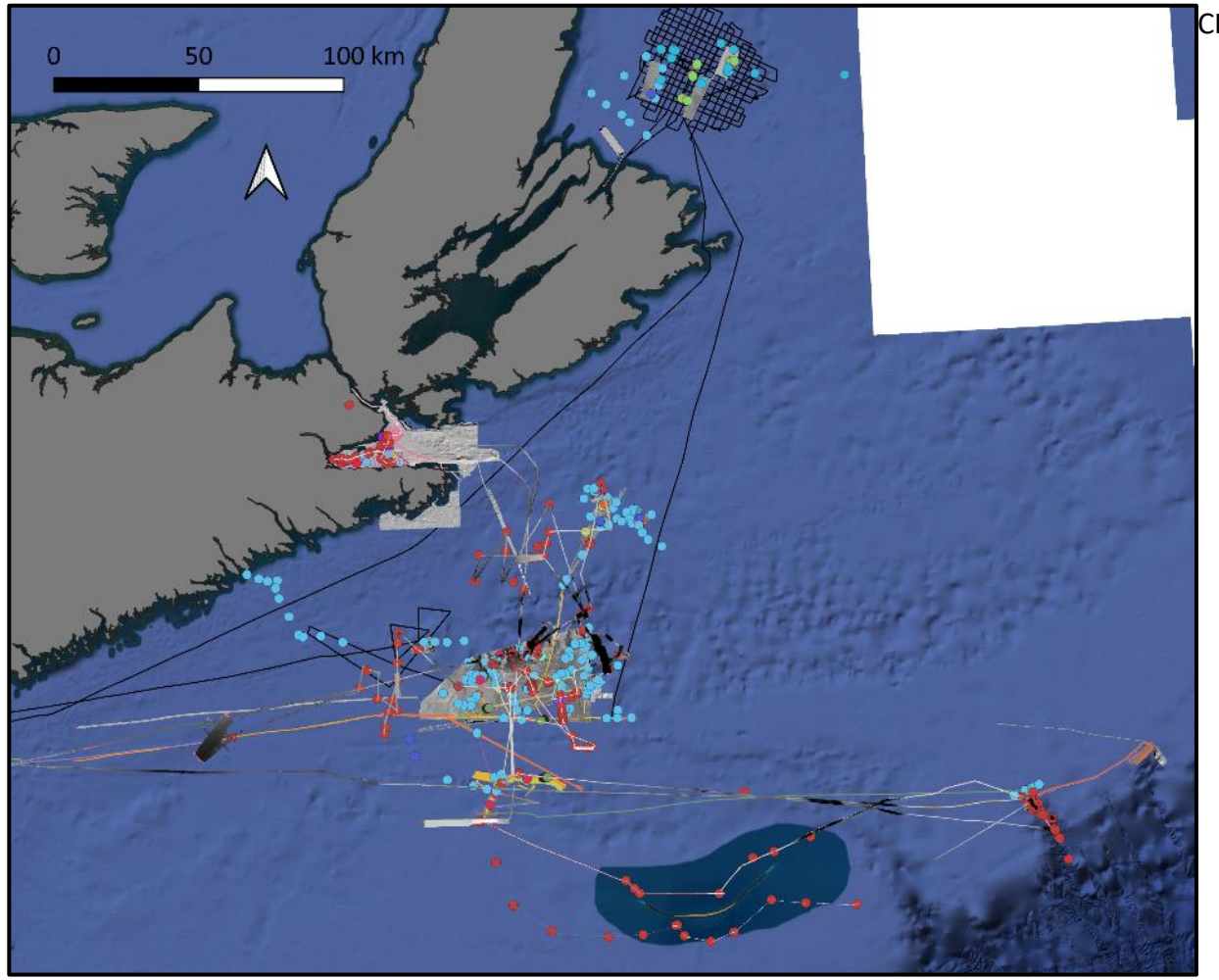
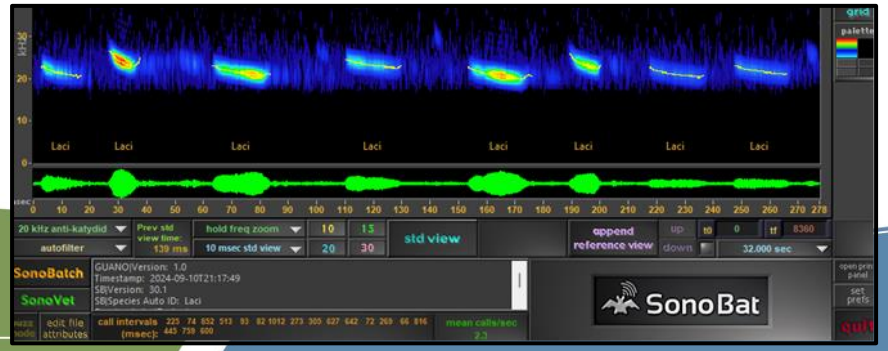


Backscatter mapping data from Middle Bank, Scotian Shelf (2024001)

Active data collection

- 7 expeditions since mid-2023
- Hundreds of stations (samples, photos, moorings, etc)
- Hundreds of thousands of km of subbottom data
- Hundreds of thousands of hectares of new mapping
- Also - Observations of bats, birds, and marine mammals





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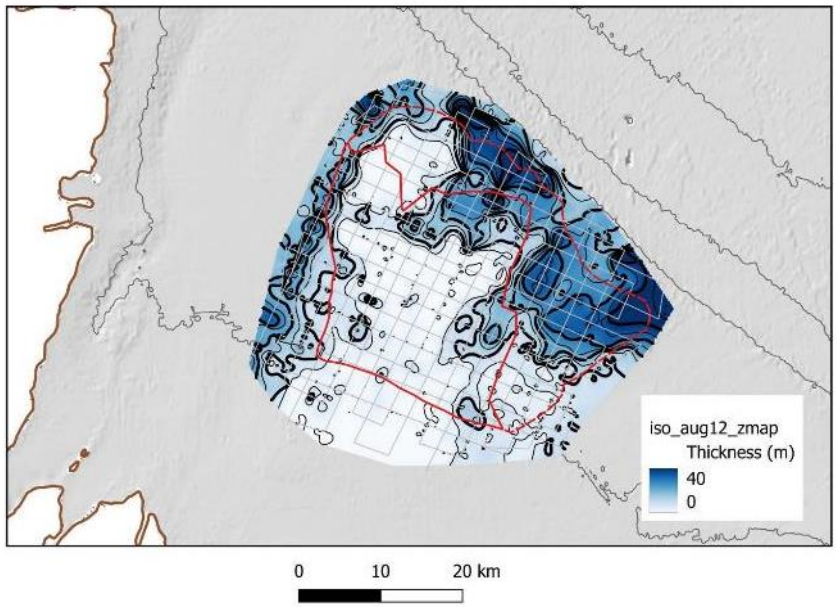
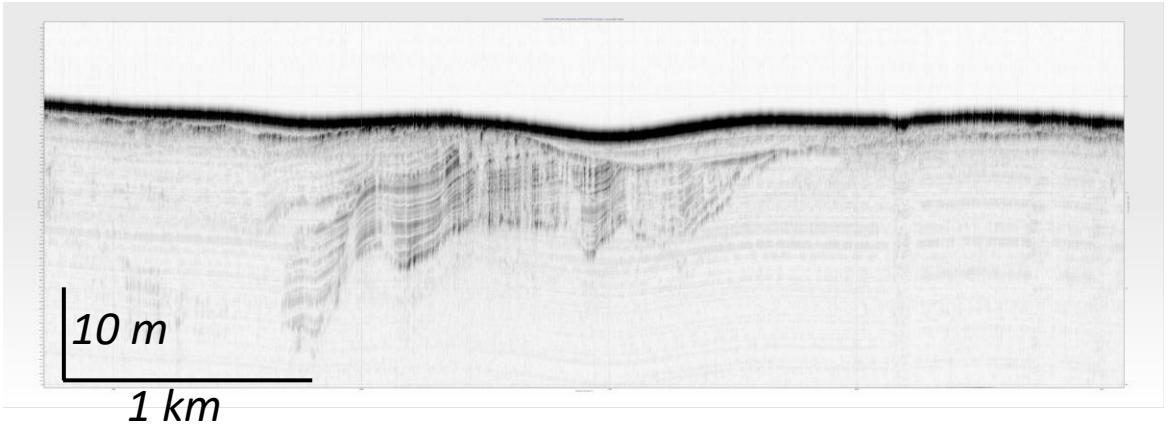
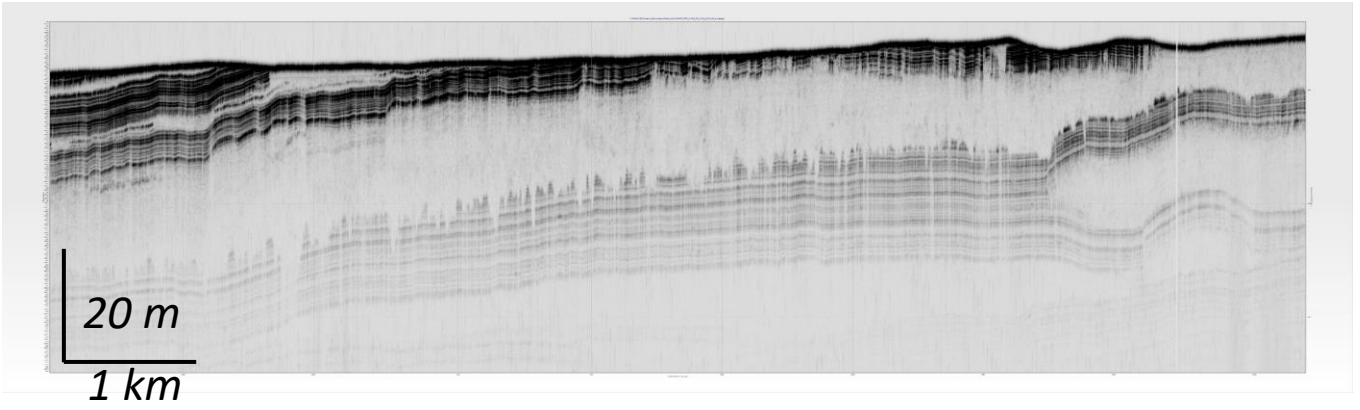


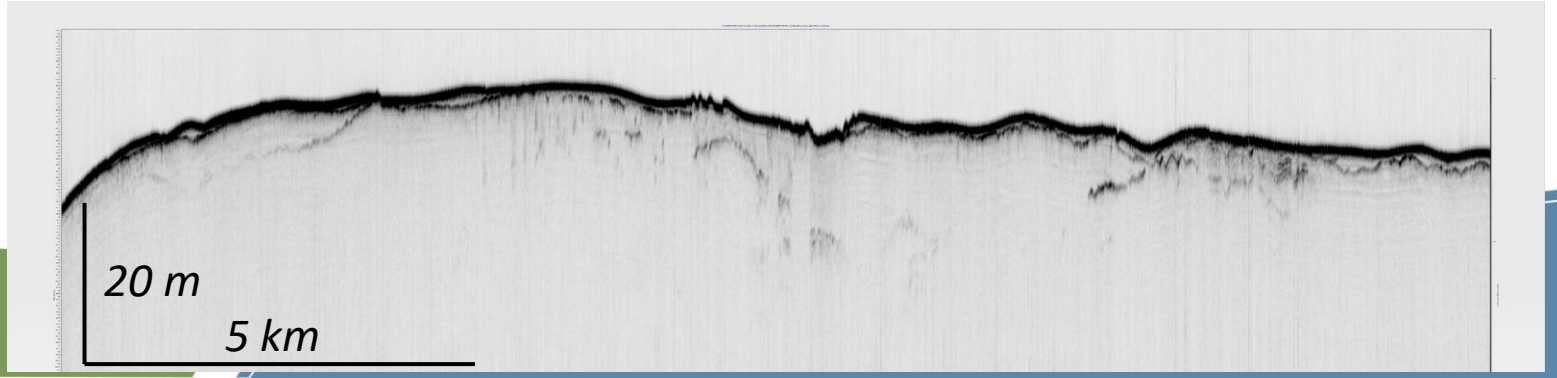
Draft sediment thickness map

- Depth converted using 1700 m/s
- 5 m contours (10 m bold)
- *Courtesy DC Campbell, 2024003 data*

2024004 data from Canso, French, and Middle Banks (top to bottom)







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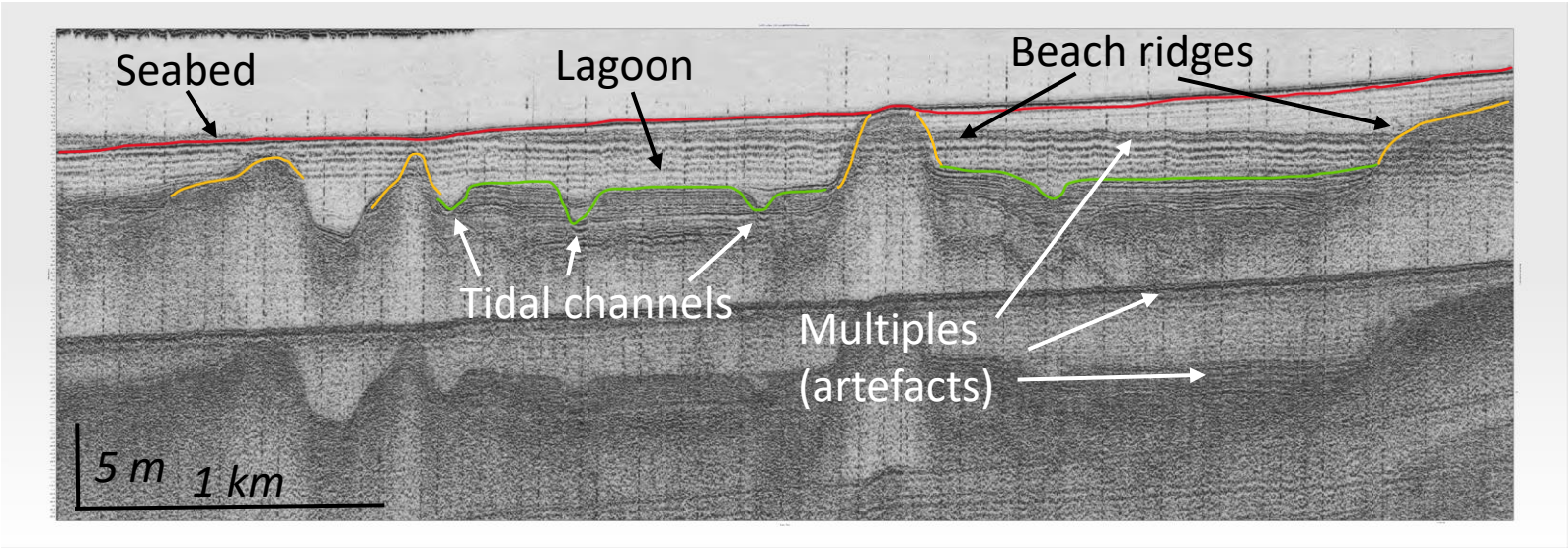
2. Where are drowned coastal landscapes located and preserved?

Outcropping organic horizon, Sable Island, 2019 (photo – Eamer)



Seismic profile showing possible lagoonal sediments in Chedabucto Bay, NS – 90028 Huntec 305 1442

Offshore wind science questions in Atlantic Canada

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Possible outcropping organic beds under ~30 m of water , Sable Island Bank (Photos – Eamer, 2024)

Fossil grasses found below 35 m of water and 3 m of sediment (Photo – Eamer, 2024)

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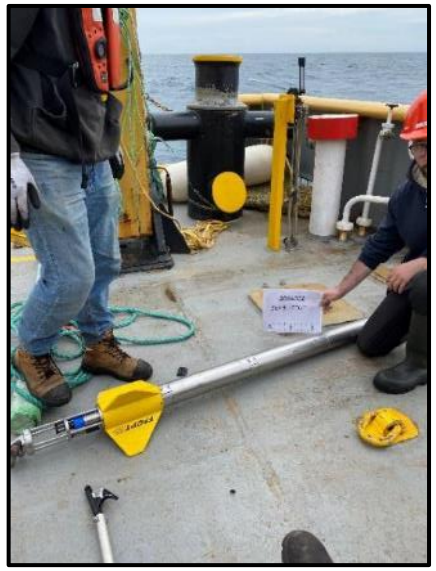
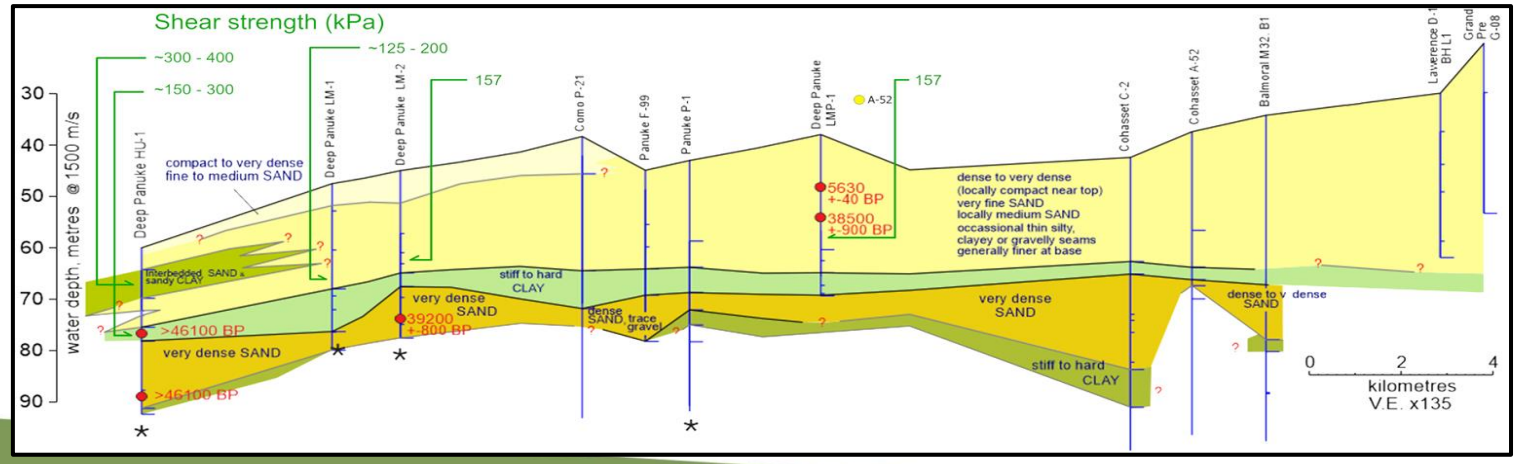
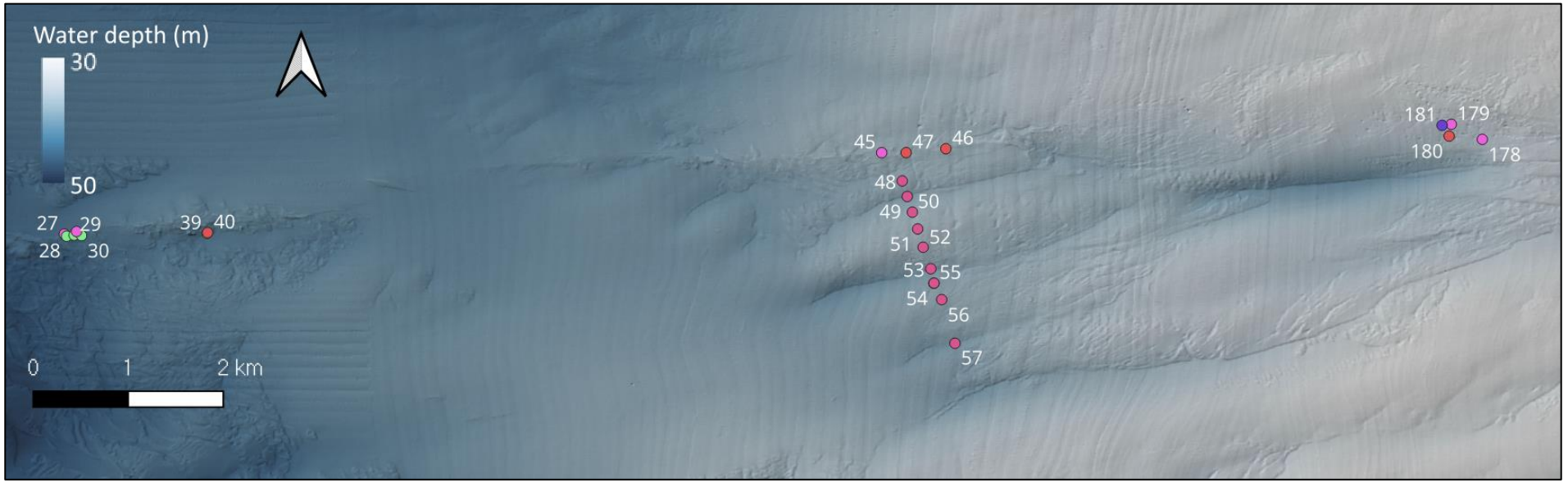
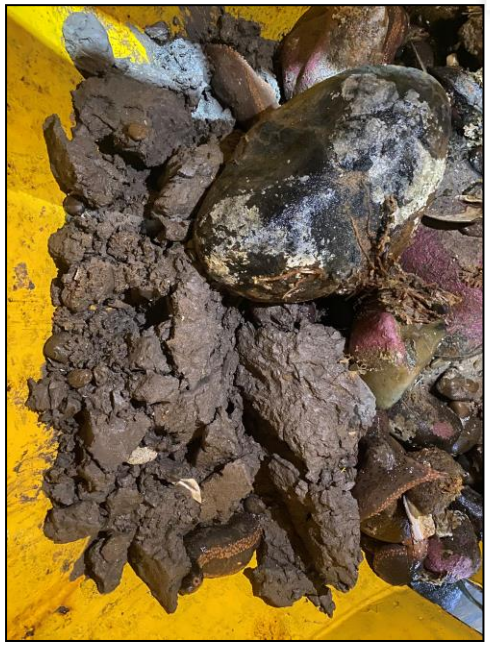


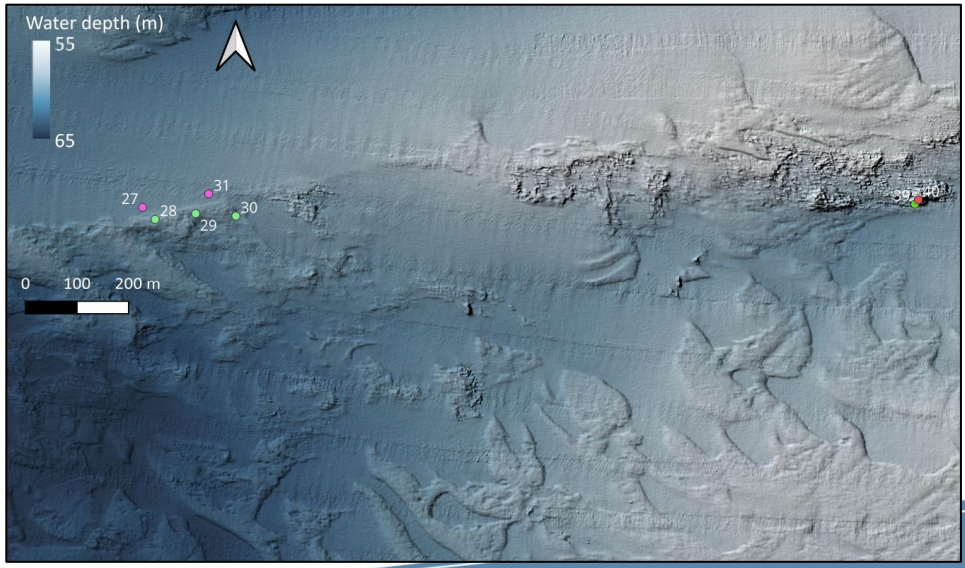


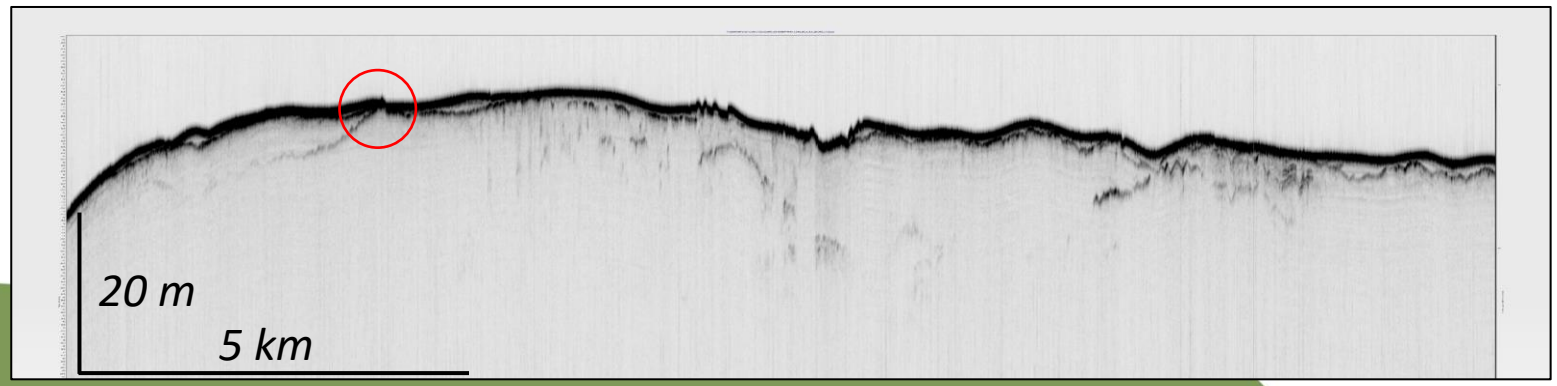
Clockwise from top left: Free-fall cone penetrometer - Photo: L. Campbell 2024; Seabed photo of outcropping over-consolidated muds – Middle Bank, 2024; Borehole correlation with shear strengths, Sable Bank. Modified from King (unpublished) and Eamer et al. (2021)





Middle Bank. Clockwise from top left: Shaded relief map data from 2024001, 2024004 stations overlain; photo from 2024004 station 47; shaded relief zoom of boulder/clay region in 2024001 data; sub-bottom profile from 2024004 showing subsurface bed outcropping at sample location





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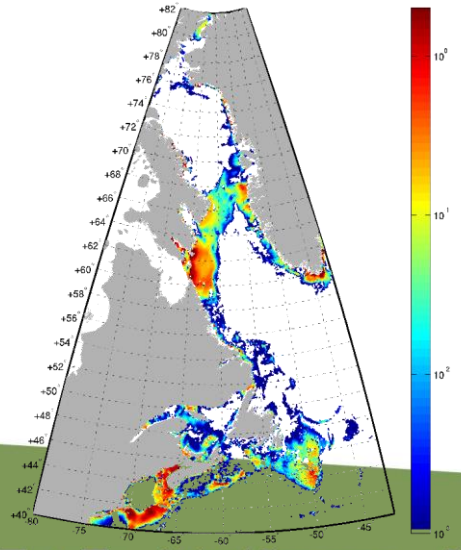
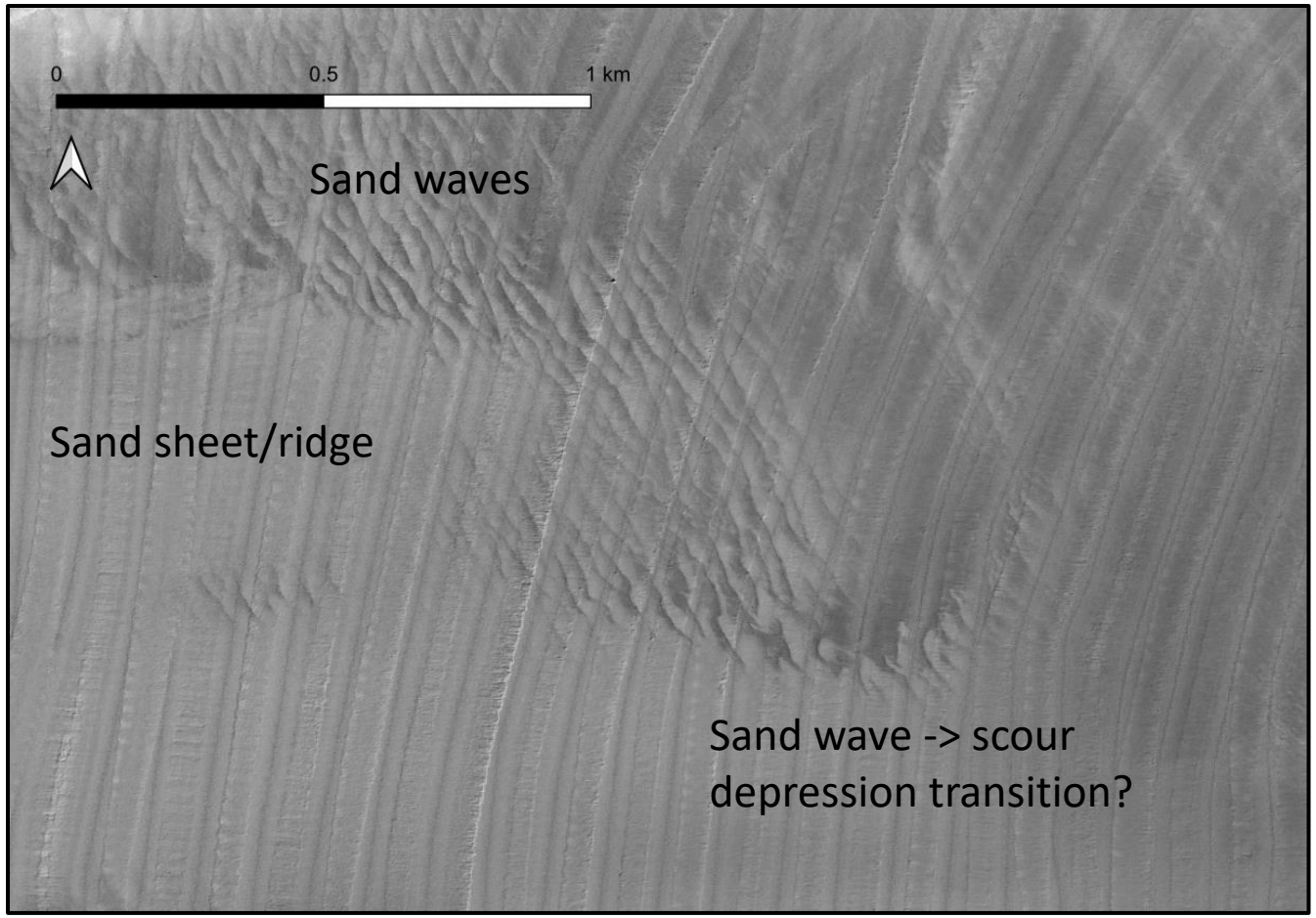


Backscatter mapping data of Middle Bank (2024001)

Seabed backscatter mapping data of Middle Bank – from 2024001 (Broom et al., in press)



Seabed Mobility Index from Li et al. (2021) https://doi.org/10.4095/328363 , with future work to characterize wave and current processes, bed shear stresses, sediment transport, and regional assessment of sediments and bedform mobility in offshore wind study areas

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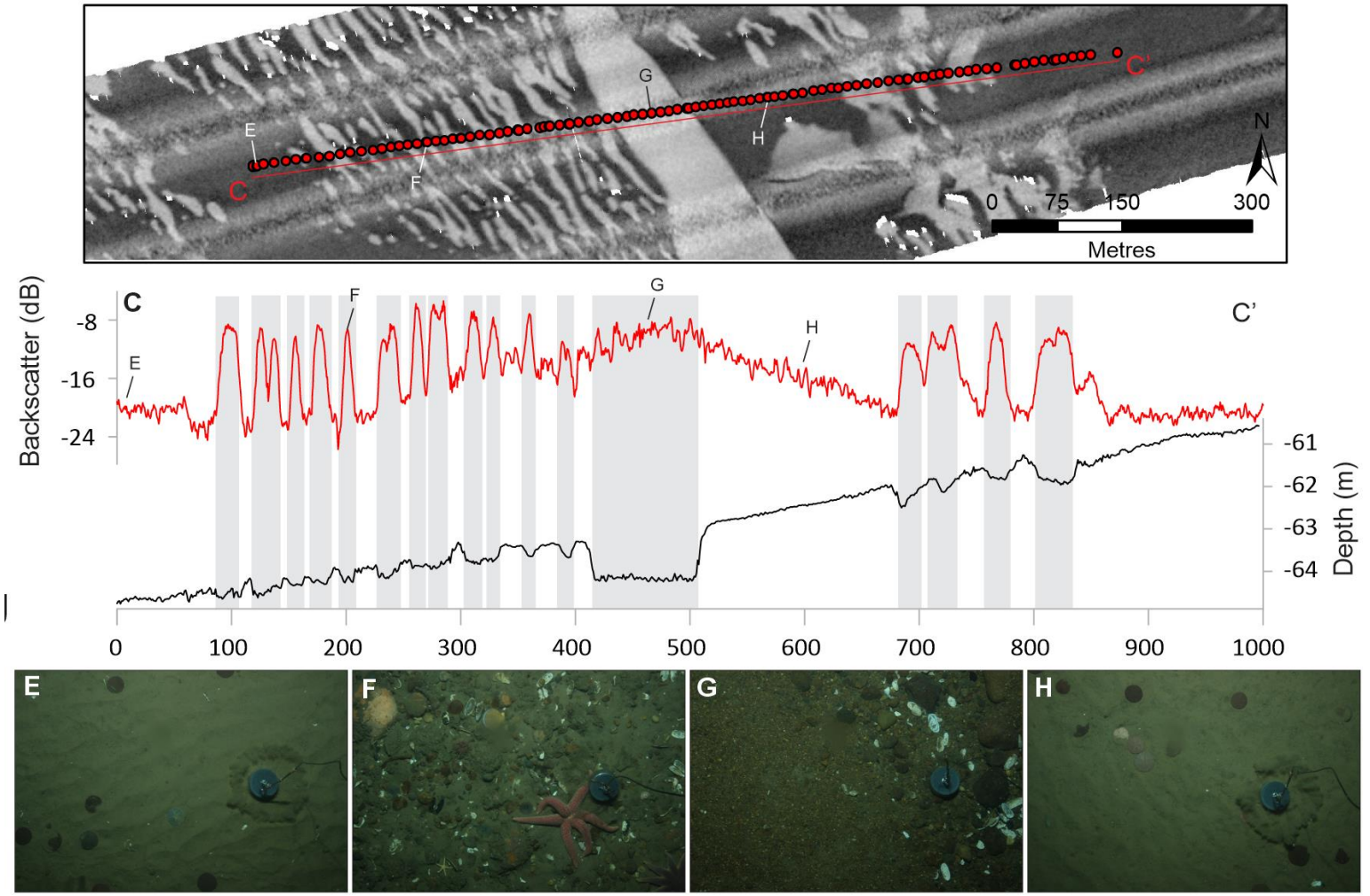

Backscatter map (top), data (middle), and seabed photos (bottom), 2023003 data from Campbell et al., (in press); Eamer et al., 2024

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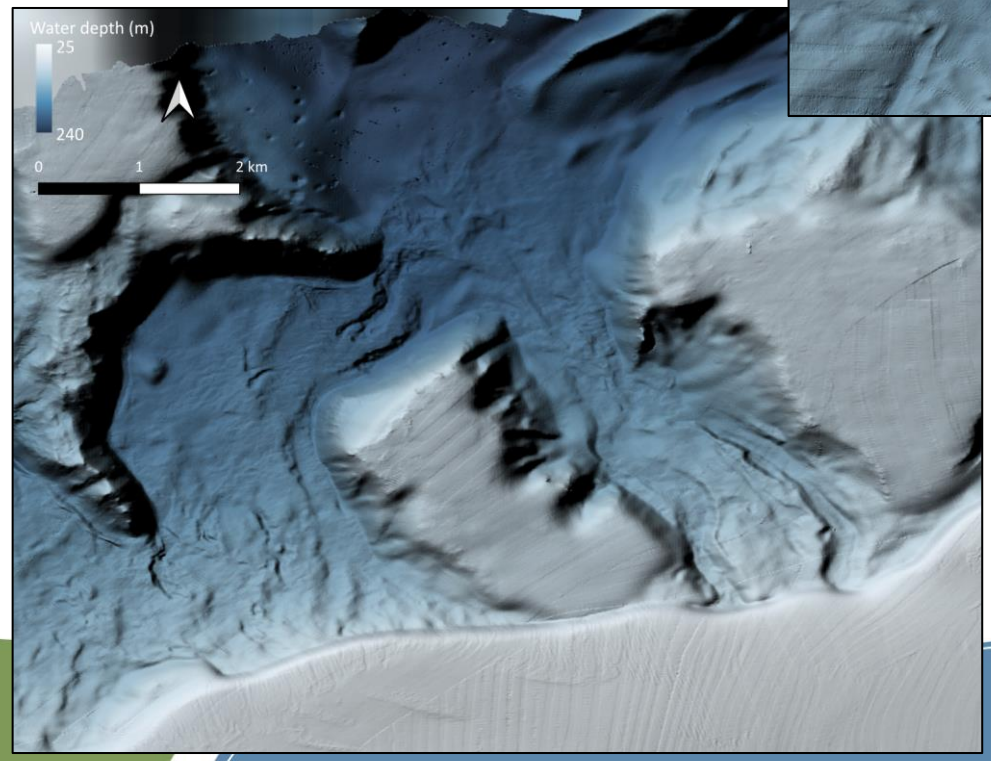
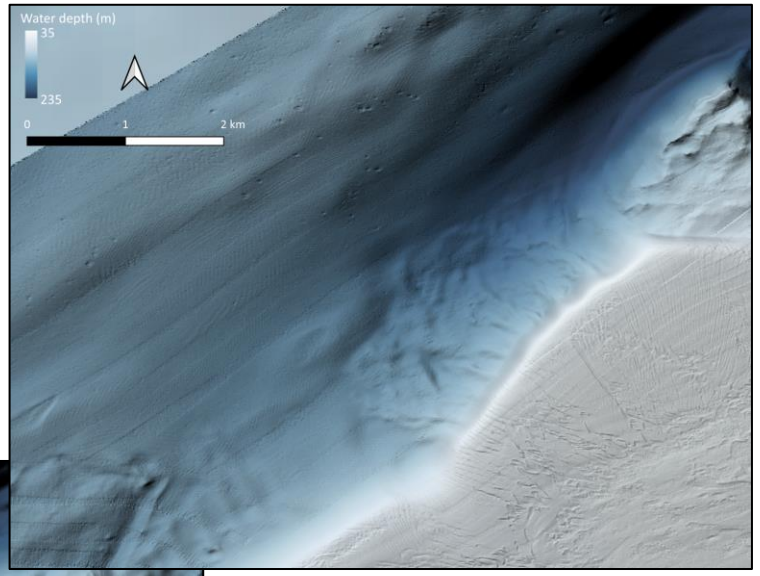
Shaded relief mapping data from northern Middle Bank showing (likely) very old landslides (top) and (likely) former littoral landscape (bottom) – from 2024001 (Broom et al., in press)





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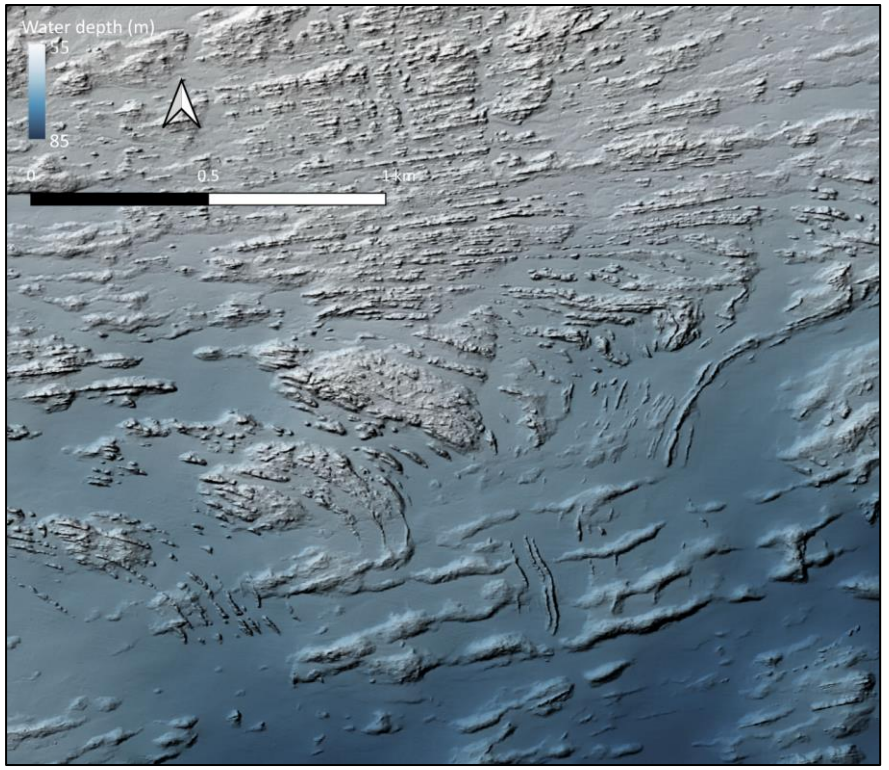

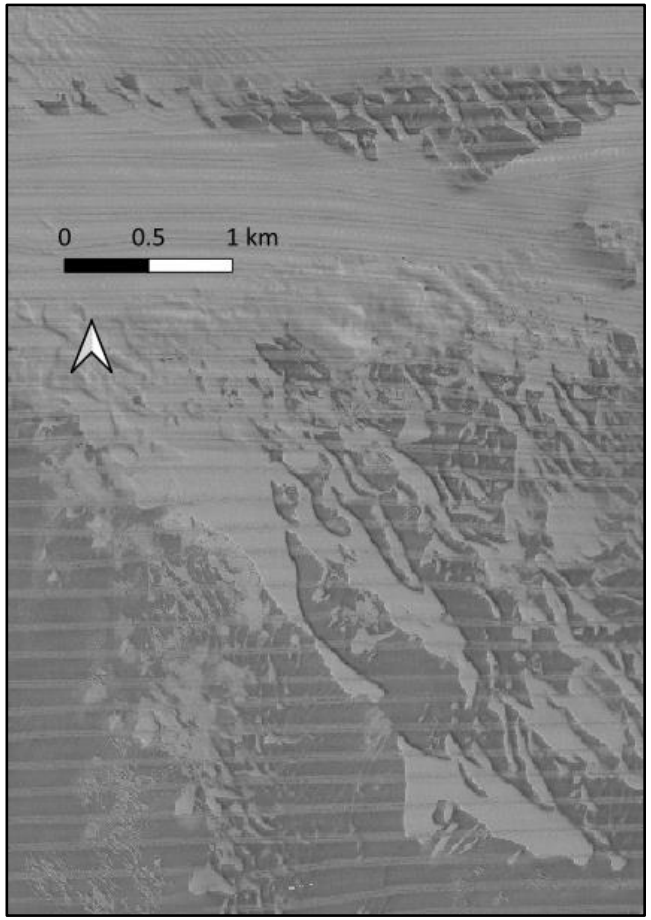

Shaded relief mapping data from Novus 2024 showing outcropping bedrock and glacial moraines (left) and backscatter mapping data from 2024001 highlighting rippled scour depressions (right)

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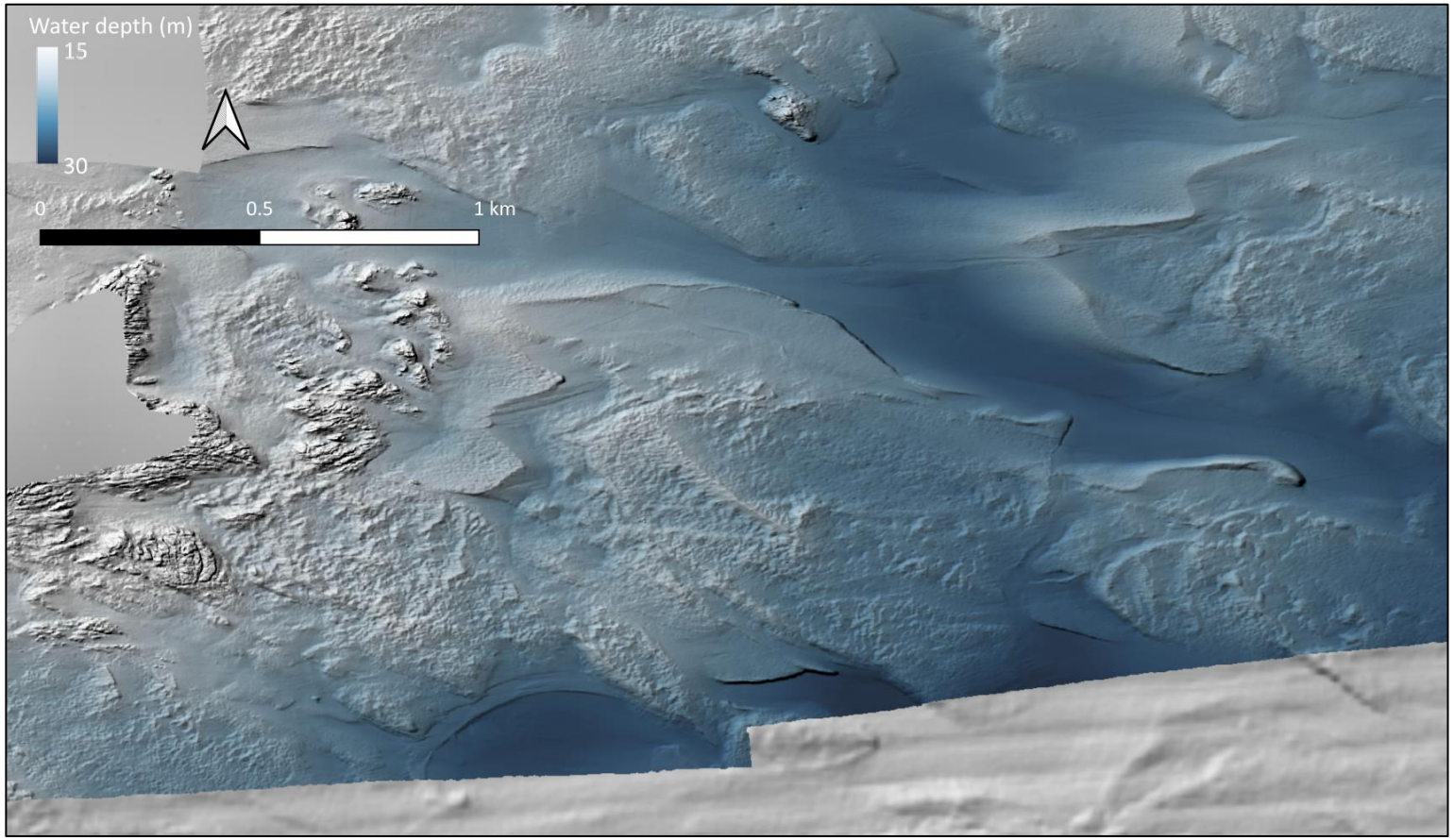

Shaded relief mapping data from Novus 2024 showing drowned coastal environments

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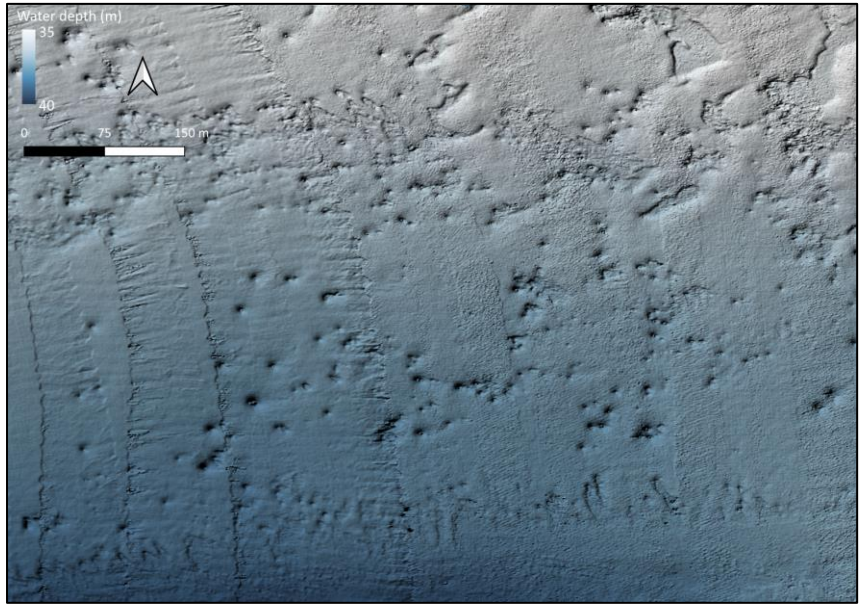

Shaded relief mapping data of Middle bank from 2024001 highlighting circular depressions that frequently host boulders (top) or are flat bottomed and become elongate toward the southeast (bottom)

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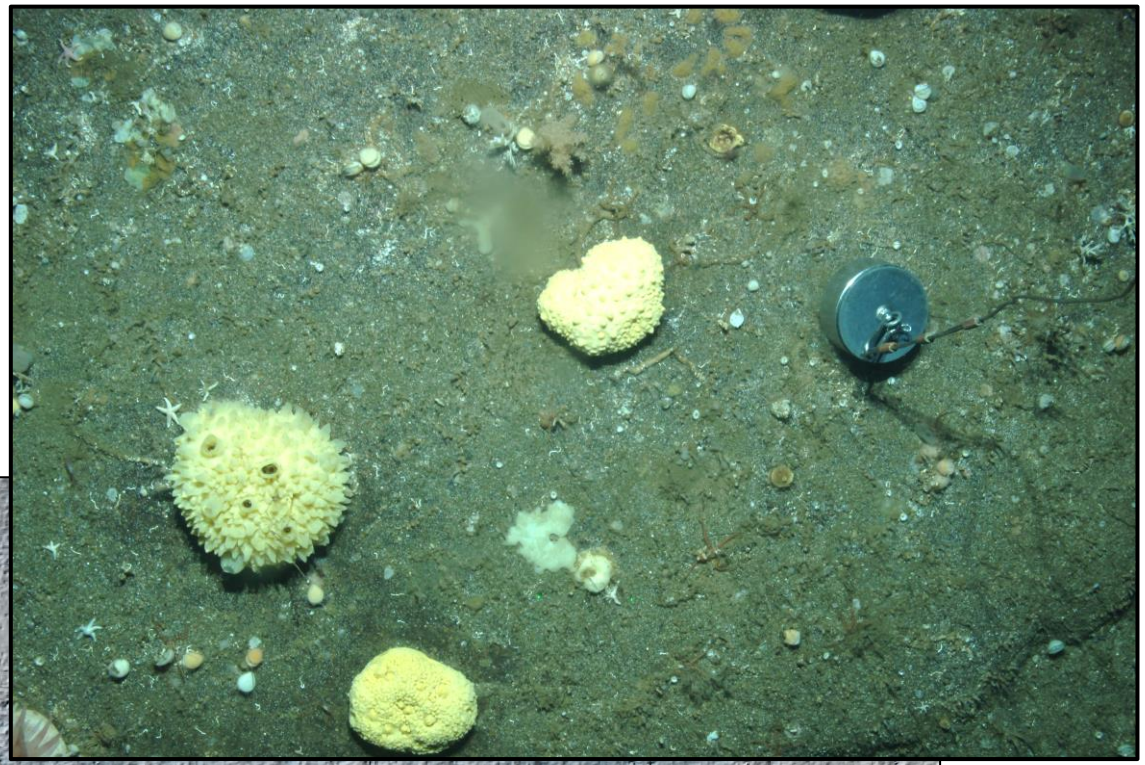
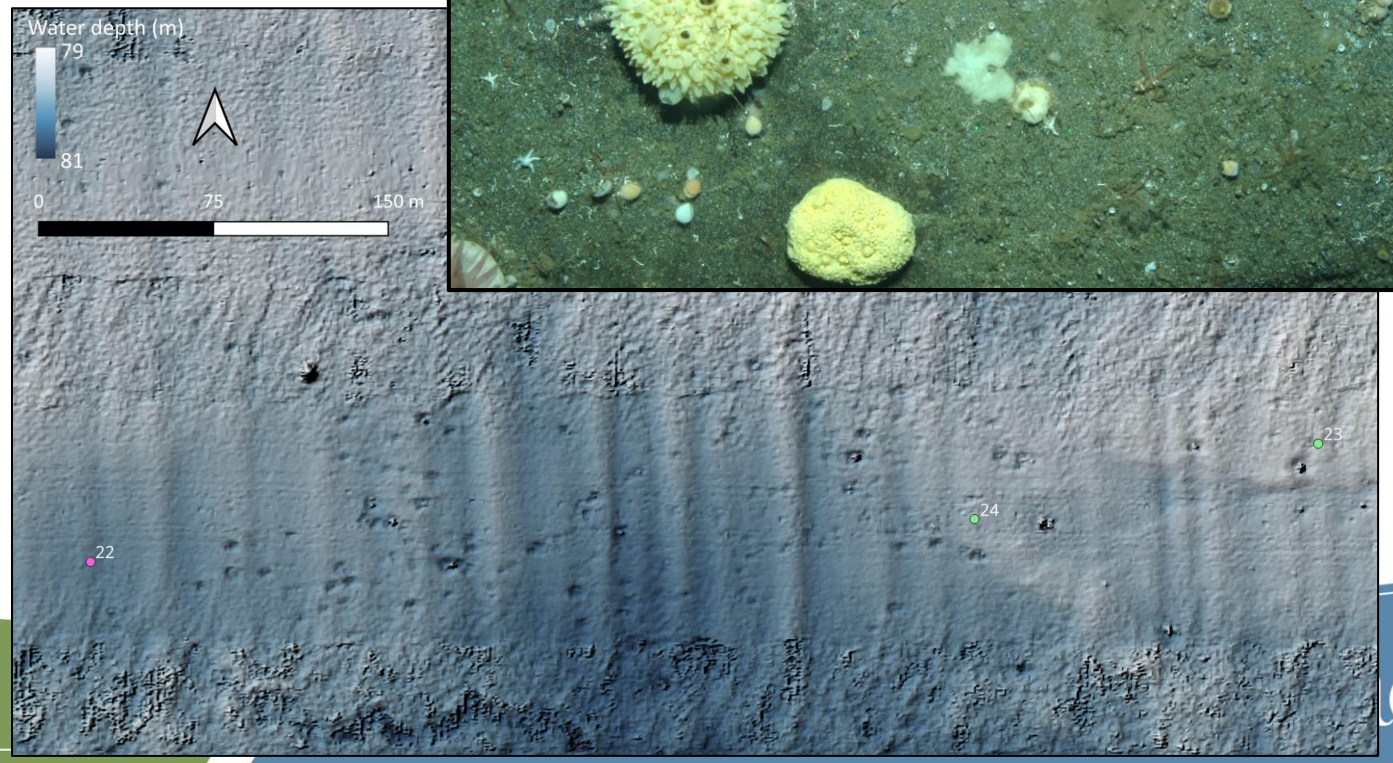
Shaded relief map data of French Bank from 2024002 highlighting more depressions, 2024004 photo from the base of a depression





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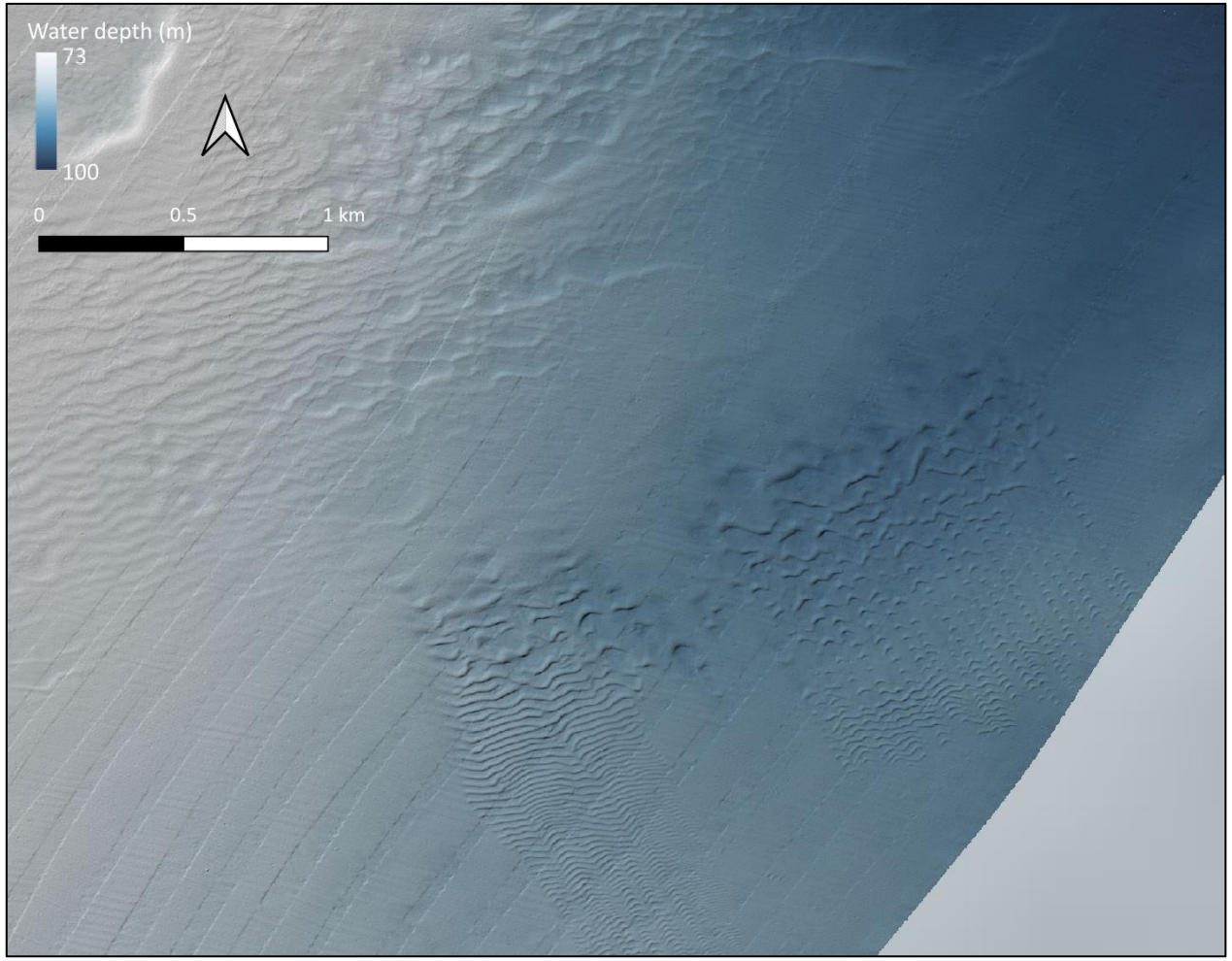
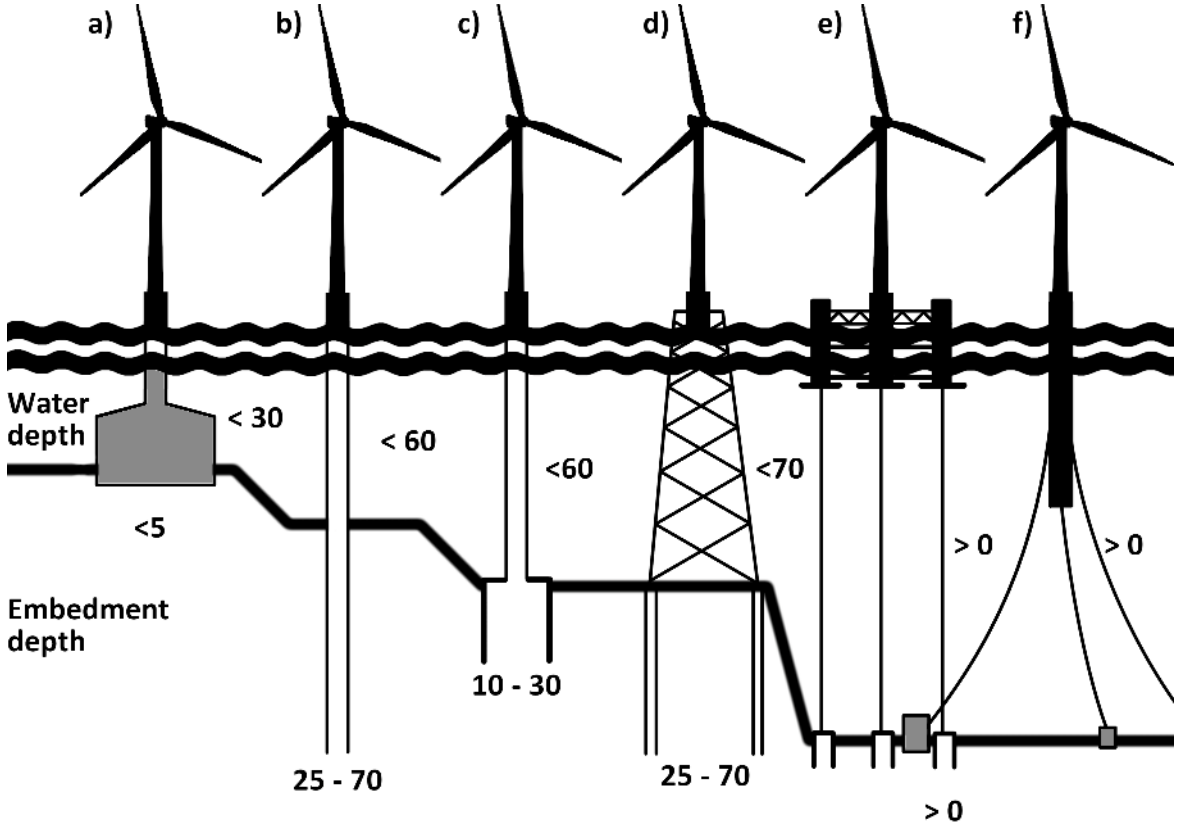
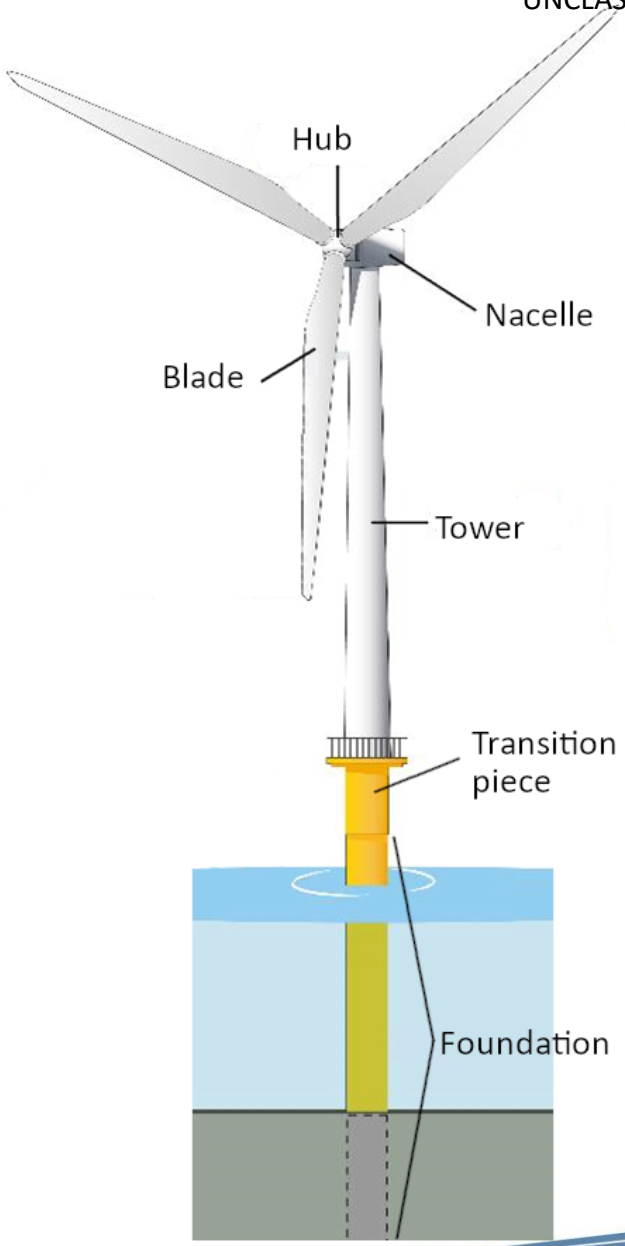


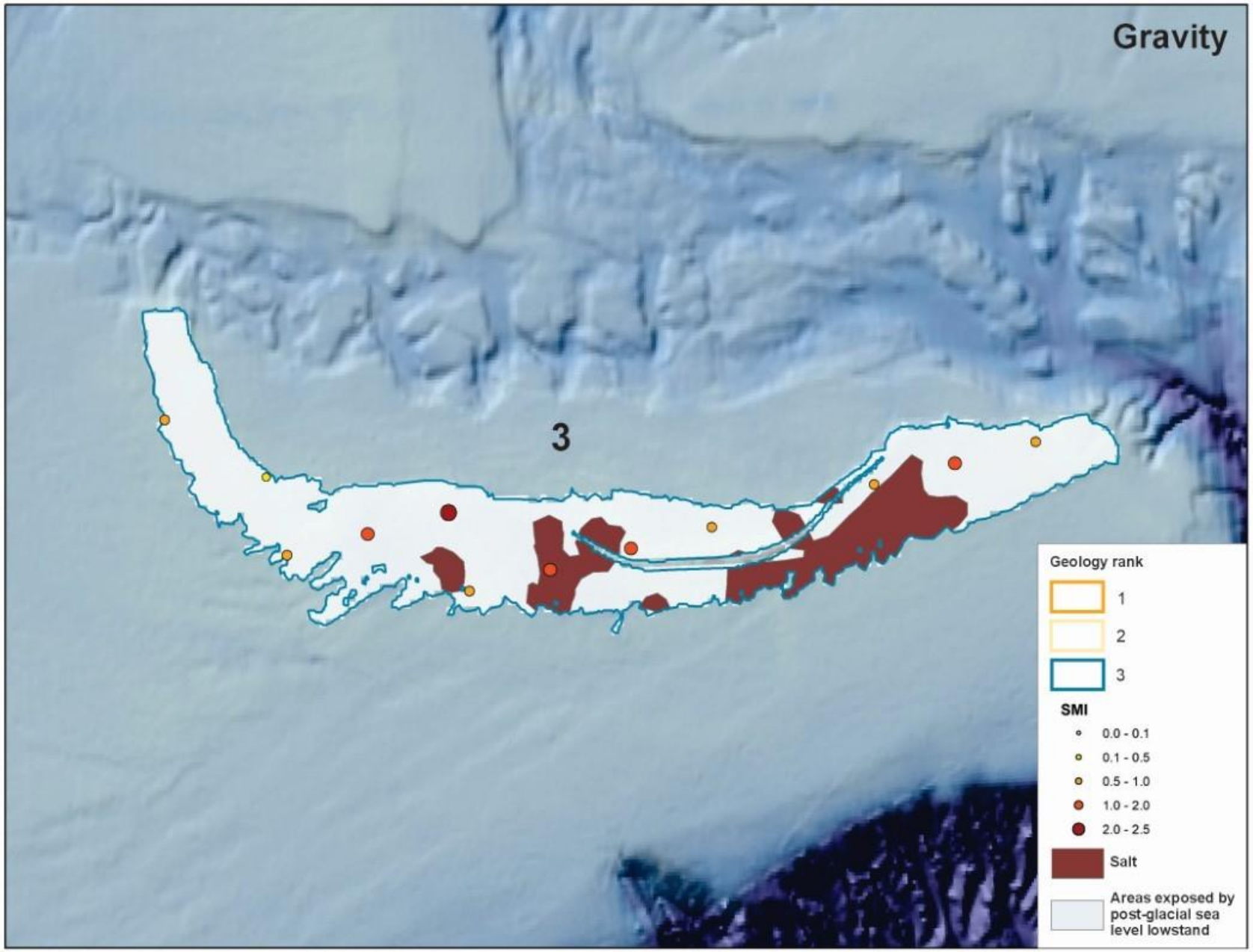
Shaded relief map data of Sydney Bight showing transverse and barchanoid dunes, from 2024003

Thank you – jordan.eamer@nrcan-rncan.gc.ca

Components of offshore wind turbines

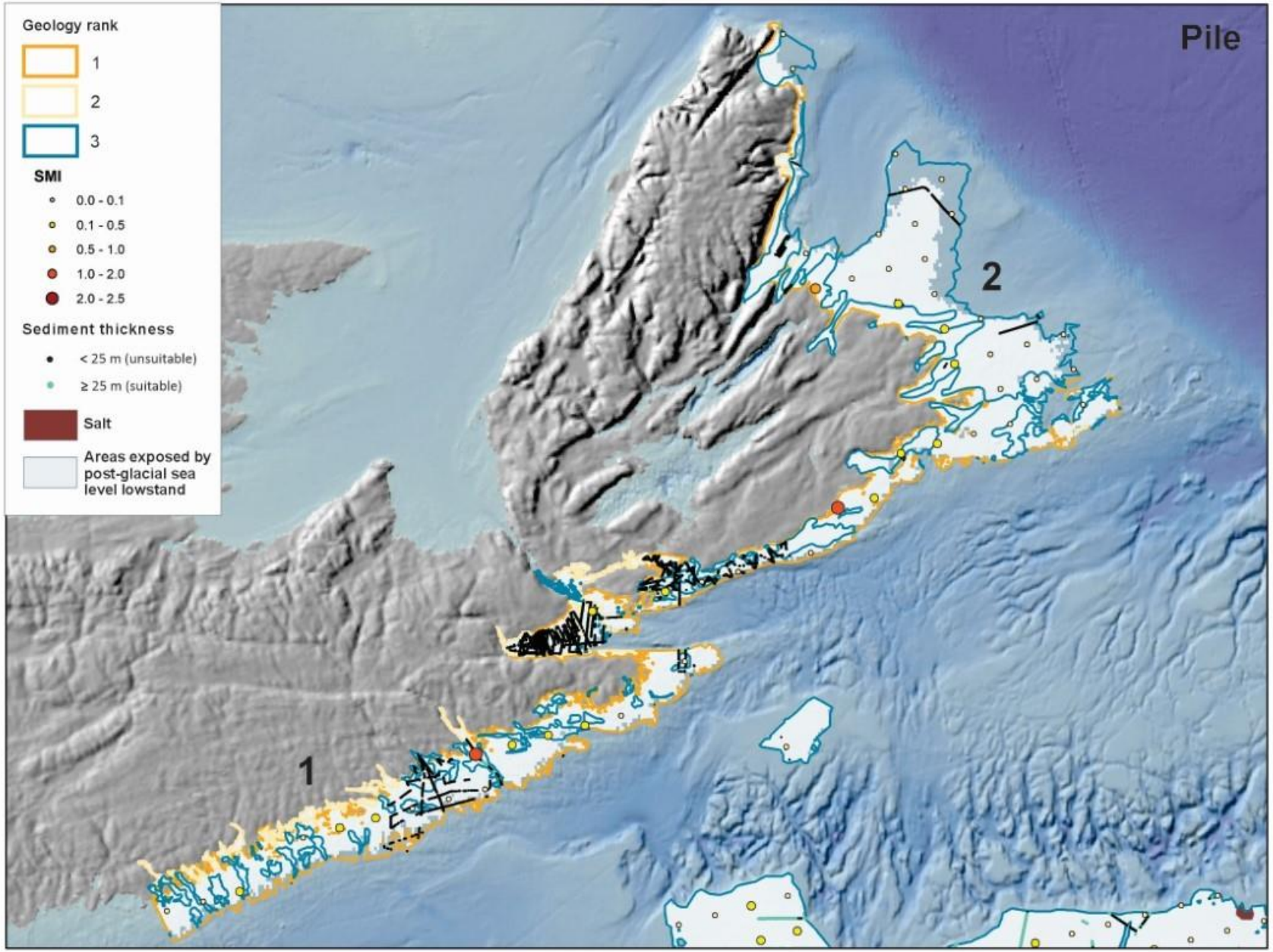






3. Sable Island Bank

Area within suitable depth range (0 - 30 m) : 1700 km²
Surface Geology : Post-glacial sand and gravel
Surface Geology Rank : 3 (100%)
Sediment thickness: Does not impact gravity base foundation
SMI : Moderate to very high
Slopes : Suitable
Areas exposed by post-glacial sea level : 100 %
Salt : 20 %

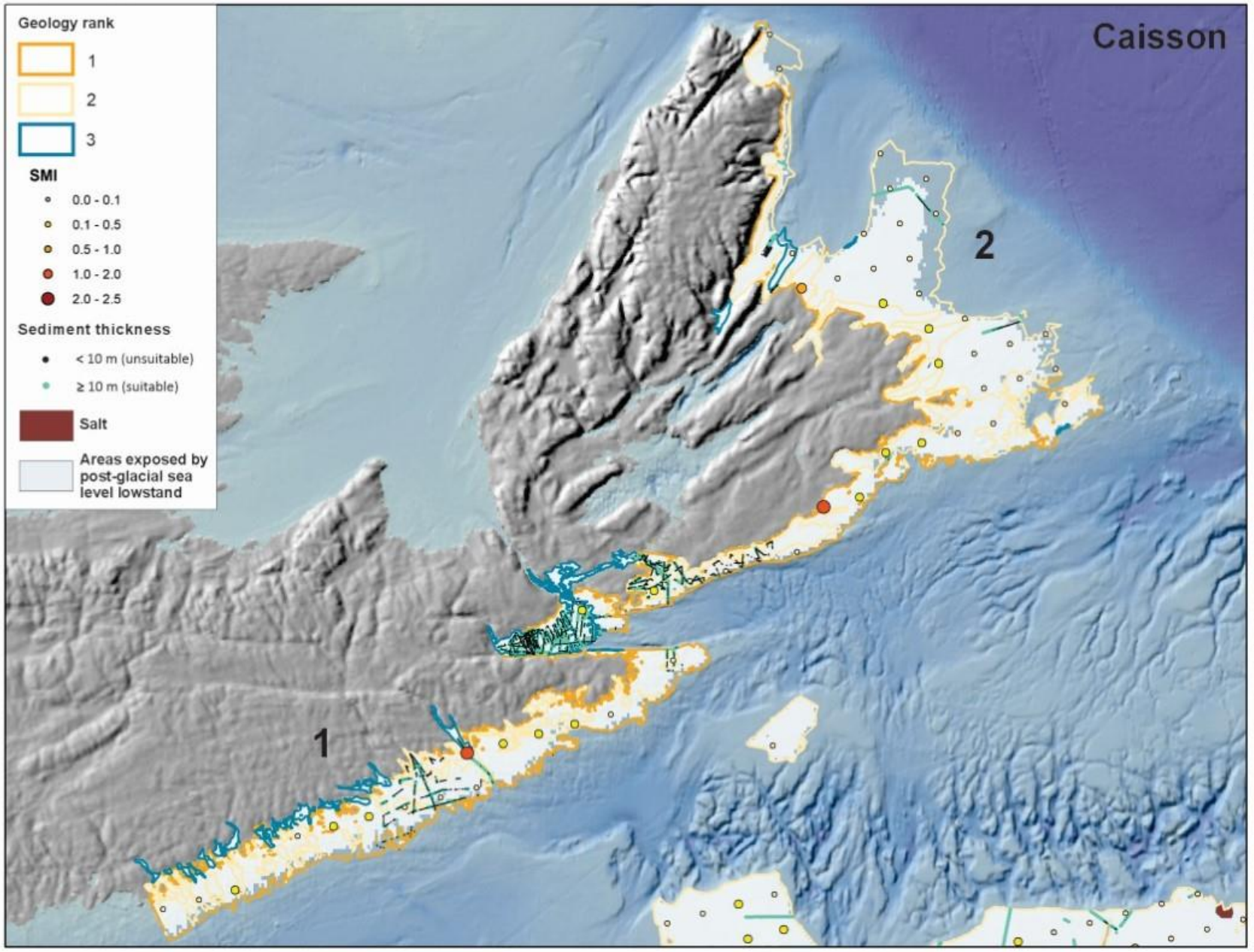


1. Eastern Shore of Nova Scotia

Area within suitable depth range (0 - 70 m) : 3000 km²
Surface Geology : Bedrock, post-glacial sand and gravel and post-glacial marine mud
Surface Geology Rank : 1 (70%), 2 (15%), 3 (15%).
Sediment thickness data range : 0 to 85 m
Sediment thickness data coverage : Insufficient
SMI : Low to high
Slopes : Suitable
Areas exposed by post-glacial sea level lowstand : 95%
Salt : NA

2. Cape Breton Island

Area within suitable depth range (0 - 70 m) : 5000 km²
Surface Geology : Bedrock and post-glacial sand and gravel
Surface Geology Rank : 1 (38%), 2 (2%), 3 (60%).
Sediment thickness data range : 0 to 50 m
Sediment thickness data coverage : Insufficient
SMI : Low to high
Slopes : Suitable
Areas exposed by post-glacial sea level lowstand : 90%
Salt : NA



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