

MAREANO seabed mapping – providing knowledge for ecosystem-based ocean management

Terje Thorsnes, Børge Holte and Hanne Hodnesdal



- The MAREANO background
- Mapping strategy
- Methods - video techniques and benthic sampling
- Results – geology, biology, habitats, pollution, bathymetry
- Dissemination - MAREANO web
- Future trends – incl. OLEX and AUVs
- Some highlights





Source: IMR

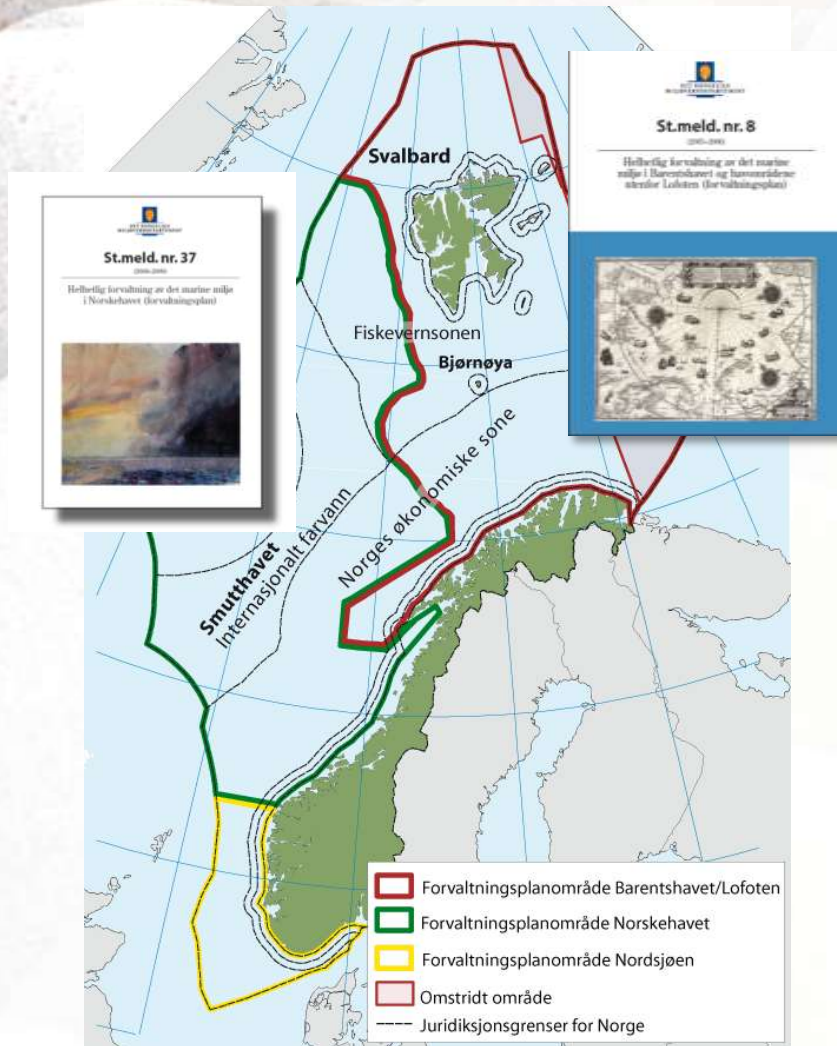
Very large fish resources, vulnerable ecosystems and hydrocarbon resources

Potentially very large hydrocarbon resources (ref. USGS)



Ocean management plans

Government initiative since 2000. First plan in 2006 (Barents Sea), second in 2009 (Norwegian Sea). North Sea next.



Special communities

Umbellula



Vulnerable

- ✓ Rare
- ✓ V. – disturbance vs. Restitution time

Value

- ✓ Maintains high species diversity
- ✓ Important for vulnerable species
- ✓ Important for ecological processes

Bamboo corals



Sponge communities



Coral reefs



Sea pen



Challenge – making the map...



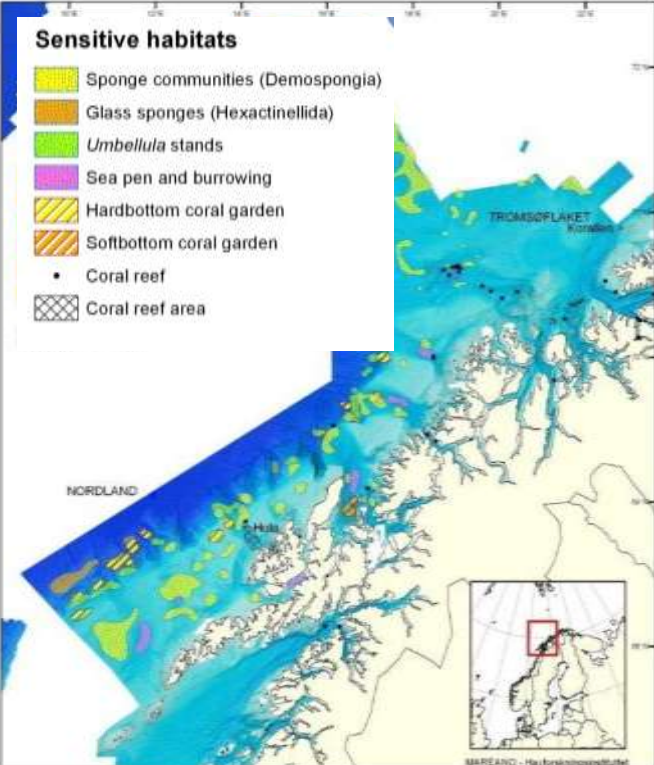
Demospongia



Sea pen communities



Hexactinellida



Hard bottom coral garden



Umbellula
> 700 m

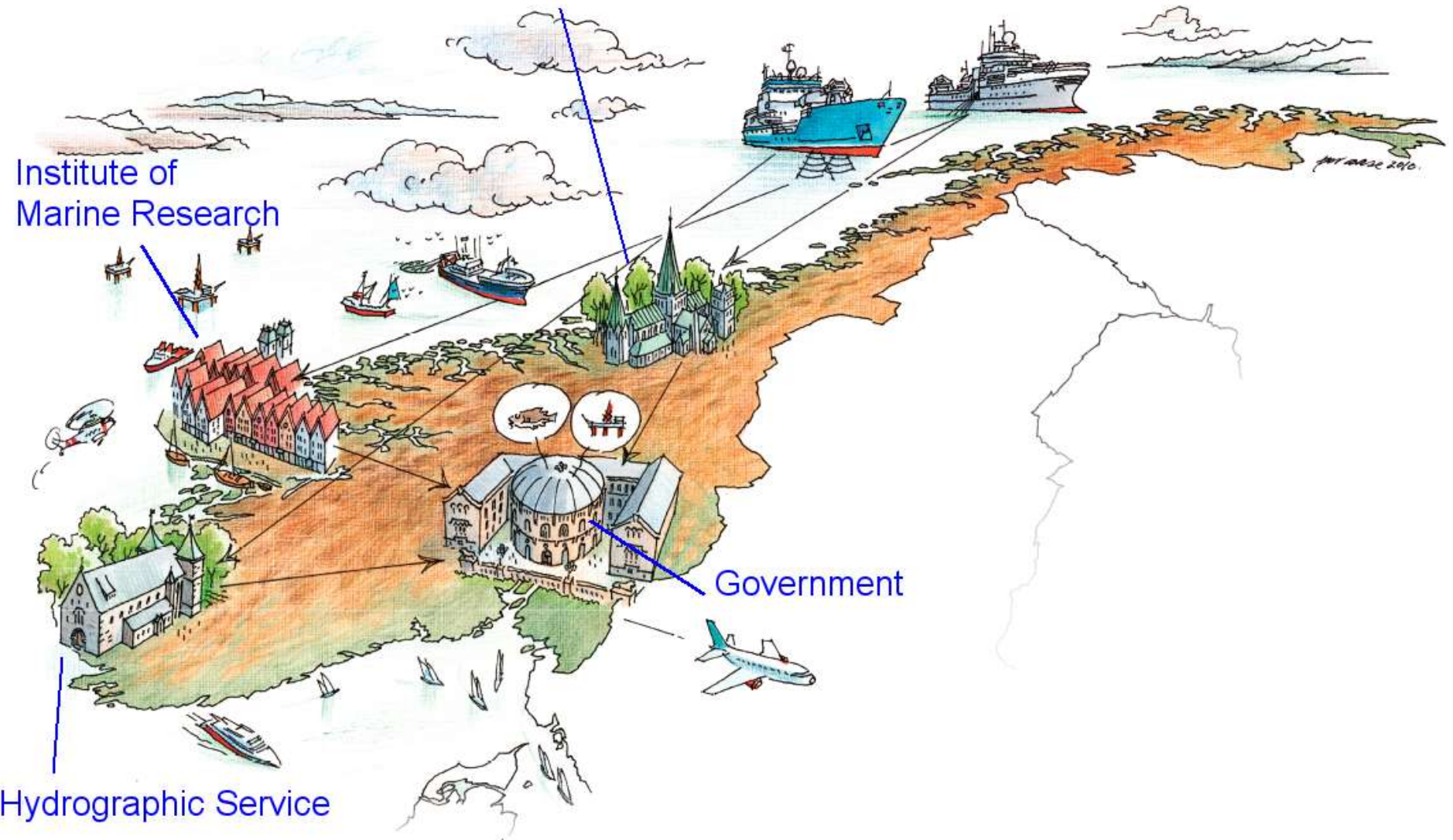


Coral reef

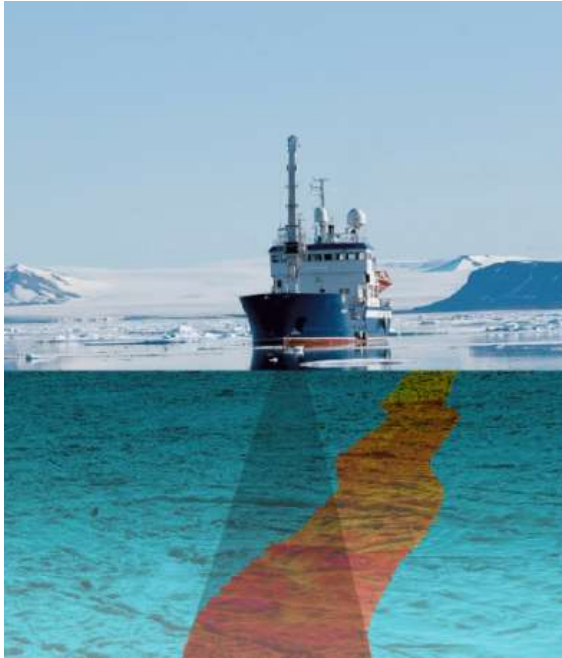


Solution - cross-sectorial cooperation with multidisciplinary approach

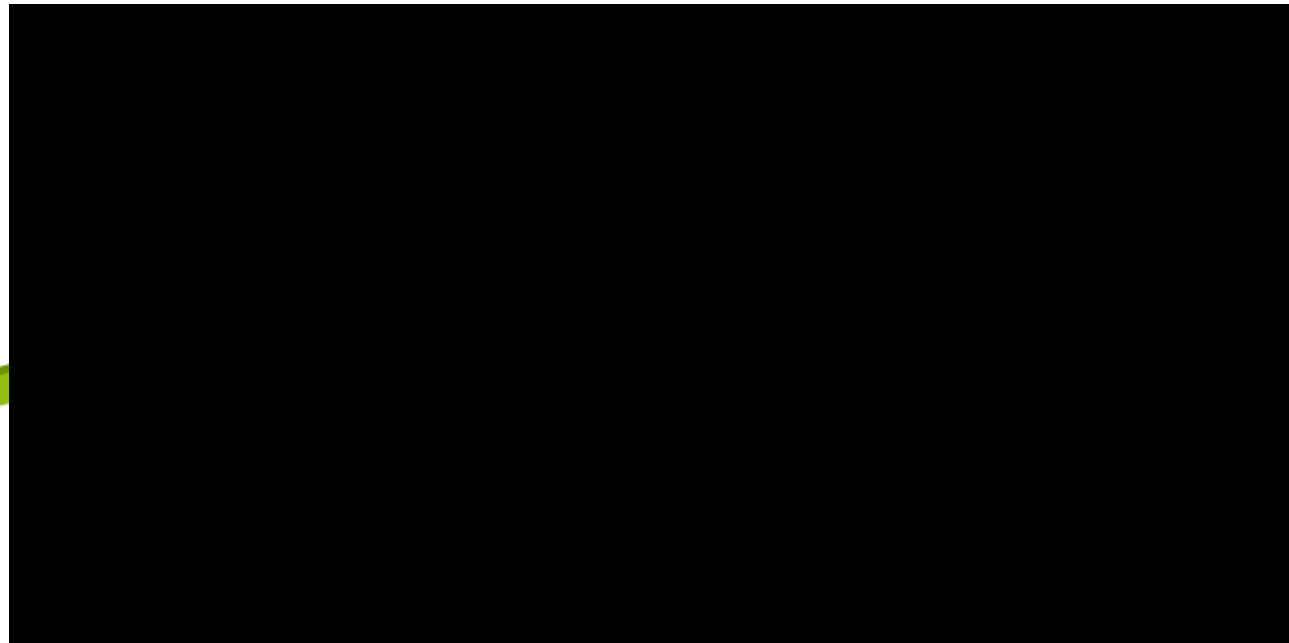
Geological Survey of Norway



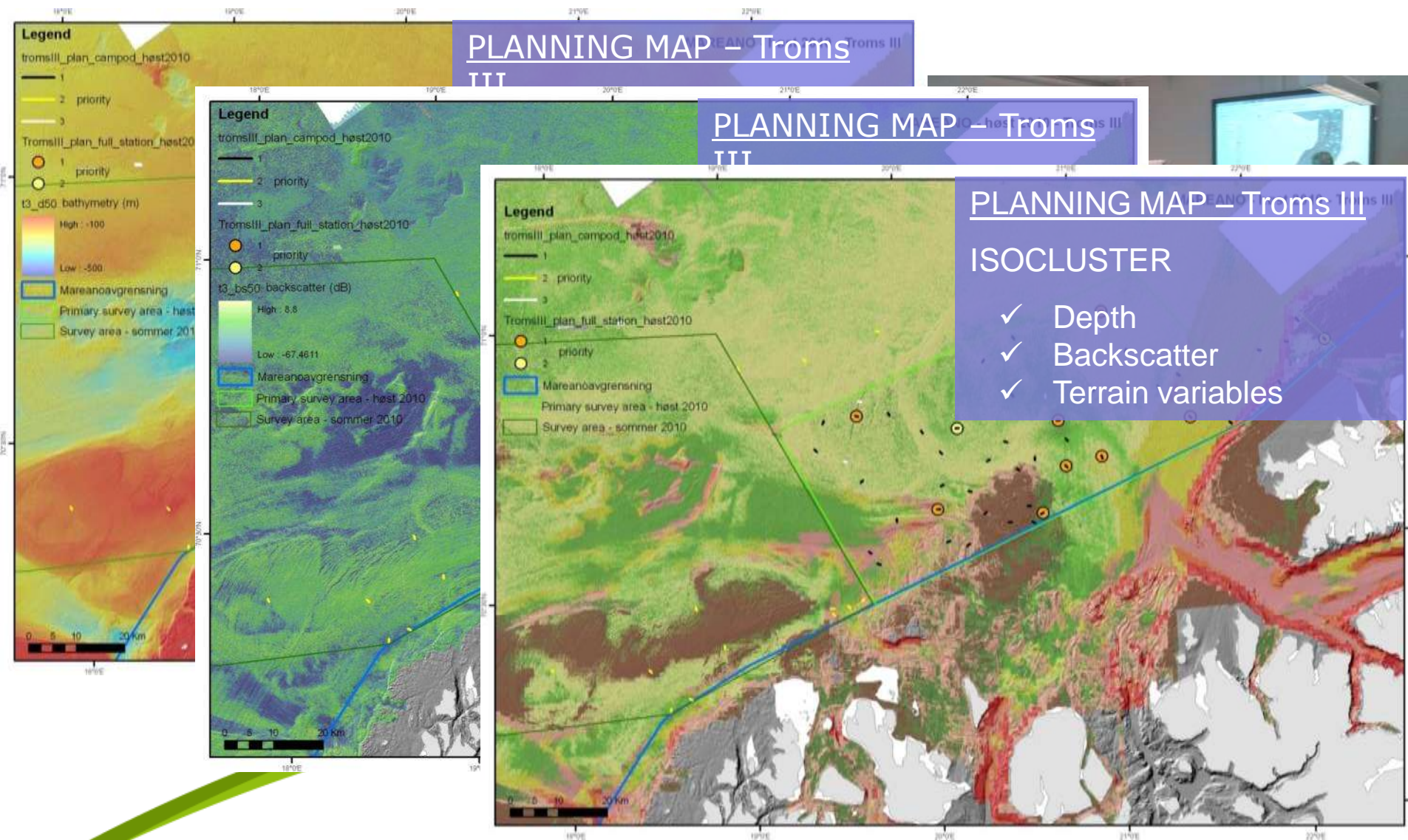
First phase – multibeam bathymetry



Bathymetry, backscatter and water column data



Planning process



Sampling cruise – G.O.Sars



Field sampling

Geological data

- Sediment samples from box corer
- Visual observations of seabed (video)
- Sediment-echosounding (TOPAS etc.)

Biological data

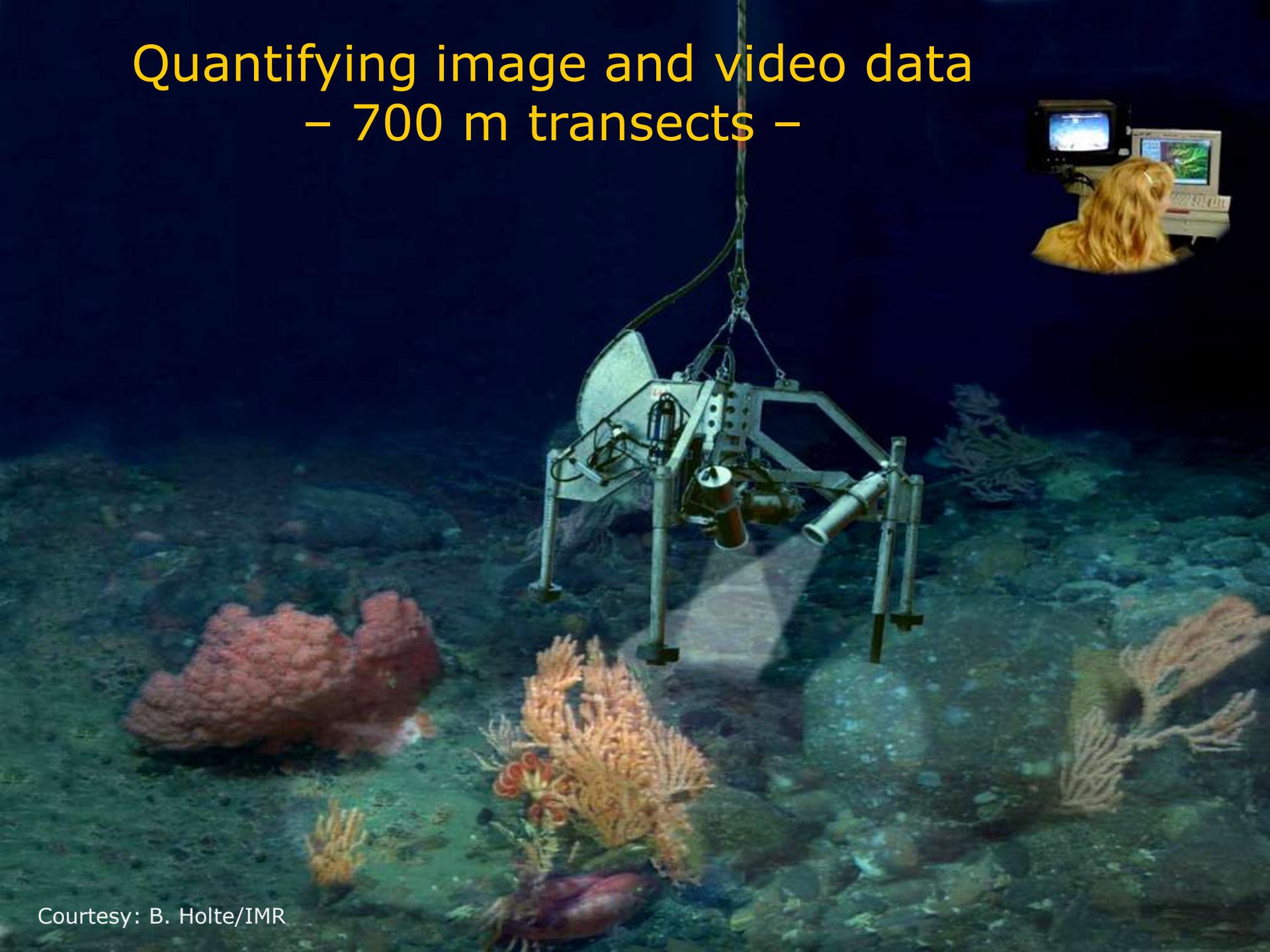
- Grab, sled and beamtrawl sampling
- Sampling of sediments for TOC, grain size, etc.
- Video records
- Video logging

Chemical data

- Sediment samples from box corer
- MultiCorer, 6 parallel samples



Quantifying image and video data – 700 m transects –



The video-rig 'Campod'



parked
(CCD, and

Turbidity

Detailed on board logging program > 30.000 entries (table lines) per cruise

St	DateTime	E	N	Distance	Cumul dist	Depth	Mud	Sand	Sand with shells	Sandy mud	Pebble	Cobble	Boulder	Bedrock	Species	Value	Laserbeam	Field width	Comments	
R100VL116	11.04.07:11:11:47	840669.5	7807508.4		0.0	0	316	5	85	0	0	10	0	0	0		2.4	198.8		
R100VL116	11.04.07:11:11:47	840669.5	7807508.4		0.0	0	316	5	85	0	0	10	0	0	0	Stichopus	1	2.4	198.8	
R100VL116	11.04.07:11:11:47	840669.5	7807508.4		0.8	0.7901093	316	5	85	0	0	10	0	0	0	Cerianthidae	1	2.4	198.8	
R100VL116	11.04.07:11:11:56	840669.5	7807507.6		0.0	0.7901093	317	5	85	0	0	10	0	0	0	Stichopus	1	2.4	198.8	
R100VL116	11.04.07:11:11:56	840669.5	7807507.6		1.2	1.9698279	317	5	85	0	0	10	0	0	0	Teleostei	1	2.4	198.8	
R100VL116	11.04.07:11:12:08	840669.4	7807506.4		0.0	1.9698279	317	5	85	0	0	10	0	0	0	Cerianthidae	1	2.4	198.8	
R100VL116	11.04.07:11:12:08	840669.4	7807506.4		0.0	1.9698279	317	5	85	0	0	10	0	0	0	Stichopus	1	2.4	198.8	
R100VL116	11.04.07:11:12:12	840669.4	7807506.4		0.0	1.9698279	317	5	85	0	0	10	0	0	0	Unidentified	1	2.4	198.8	
R100VL116	11.04.07:11:12:12	840669.4	7807506.4		0.4	2.3594394	321	5	85	0	0	10	0	0	0	Unidentified	1	2.4	198.8	
R100VL116	11.04.07:11:12:16	840669.3	7807506.0		0.8	3.1495477	318	5	90	0	0	5	0	0	0		1.4	340.7		
R100VL116	11.04.07:11:12:23	840669.3	7807505.2		0.0	3.1495477	318	5	90	0	0	5	0	0	0	Teleostei	1	1.4	340.7	
R100VL116	11.04.07:11:12:23	840669.3	7807505.2		0.0	3.1495477	318	5	90	0	0	5	0	0	0	Stichopus	1	1.4	340.7	
R100VL116	11.04.07:11:12:23	840669.3	7807505.2		0.4	3.5391593	318	5	90	0	0	5	0	0	0	Stichopus	1	1.4	340.7	
R100VL116	11.04.07:11:12:32	840669.3	7807504.9		1.3	4.8720789	319	5	90	0	0	5	0	0	0				muddy sand with lots of tubes	
R100VL116	11.04.07:11:12:45	840669.1	7807503.5		3.0	7.8738224	319	10	90	0	0	0	0	0	0		2.4	198.8		
R100VL116	11.04.07:11:13:47	840670.7	7807501.0		0.4	8.2351037	318	10	90	0	0	0	0	0	0		2	238.5	whole last section: no sightsediment turbulences	
R100VL116	11.04.07:11:13:53	840671.1	7807501.1		2.0	10.233926	317	10	90	0	0	0	0	0	0	Stichopus	2			
R100VL116	11.04.07:11:14:47	840672.8	7807502.0		7.9	18.137544	318	10	90	0	0	0	0	0	0		7	68.1	camera zoomed inwhole last section sediment turbulences	
R100VL116	11.04.07:11:15:48	840673.0	7807509.9		3.7	21.832473	319	15	85	0	0	0	0	0	0				no light sediment disturbance	
R100VL116	11.04.07:11:16:05	840672.2	7807513.5		0.0	21.832473	318	15	85	0	0	0	0	0	0		4	119.3	camera zoomed in	
R100VL116	11.04.07:11:16:05	840672.2	7807513.5		0.9	22.747098	318	15	85	0	0	0	0	0	0	Unidentified	2	4	119.3	camera zoomed in
R100VL116	11.04.07:11:16:09	840672.0	7807514.4		3.5	26.223316	318	15	85	0	0	0	0	0	0	Unidentified	1			
R100VL116	11.04.07:11:16:25	840672.1	7807517.9		1.9	28.098207	318	15	85	0	0	0	0	0	0	Unidentified	2			
R100VL116	11.04.07:11:16:34	840672.6	7807519.7		0.0	28.098207	318	15	85	0	0	0	0	0	0				camera zoomed in during the whole transect	
R100VL116	11.04.07:11:16:34	840672.6	7807519.7		1.1	29.208444	318	15	85	0	0	0	0	0	0	Kophobelemnon	1			
R100VL116	11.04.07:11:16:38	840672.7	7807520.8		1.7	30.884585	318	15	85	0	0	0	0	0	0	Unidentified	1			
R100VL116	11.04.07:11:16:44	840672.9	7807522.5		1.1	31.994822	318	15	85	0	0	0	0	0	0	Unidentified	1			
R100VL116	11.04.07:11:16:47	840673.0	7807523.6		0.6	32.549939	318	15	85	0	0	0	0	0	0		6	79.5		

Sampling of sediments and organisms

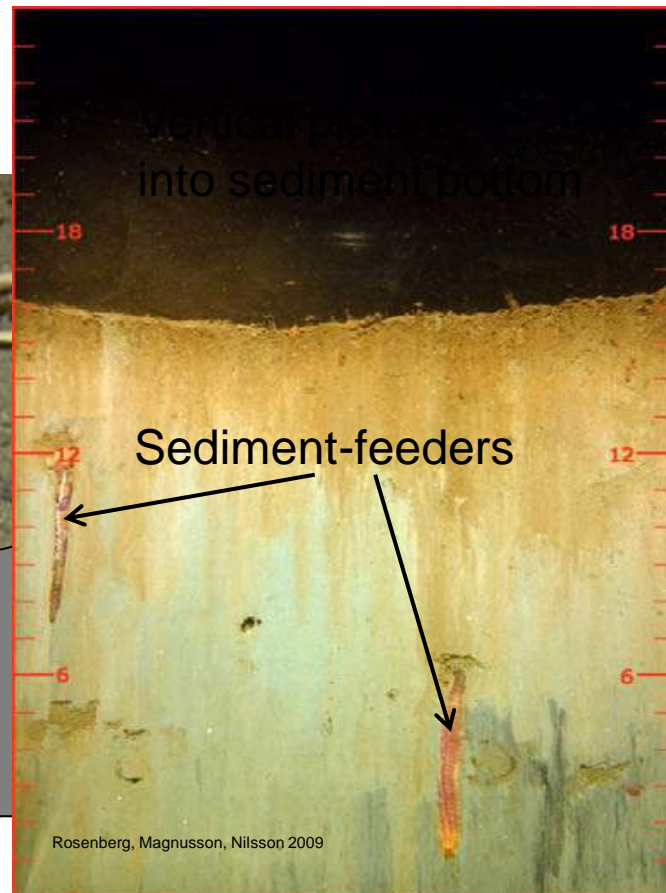
Sled



Beam-trawl

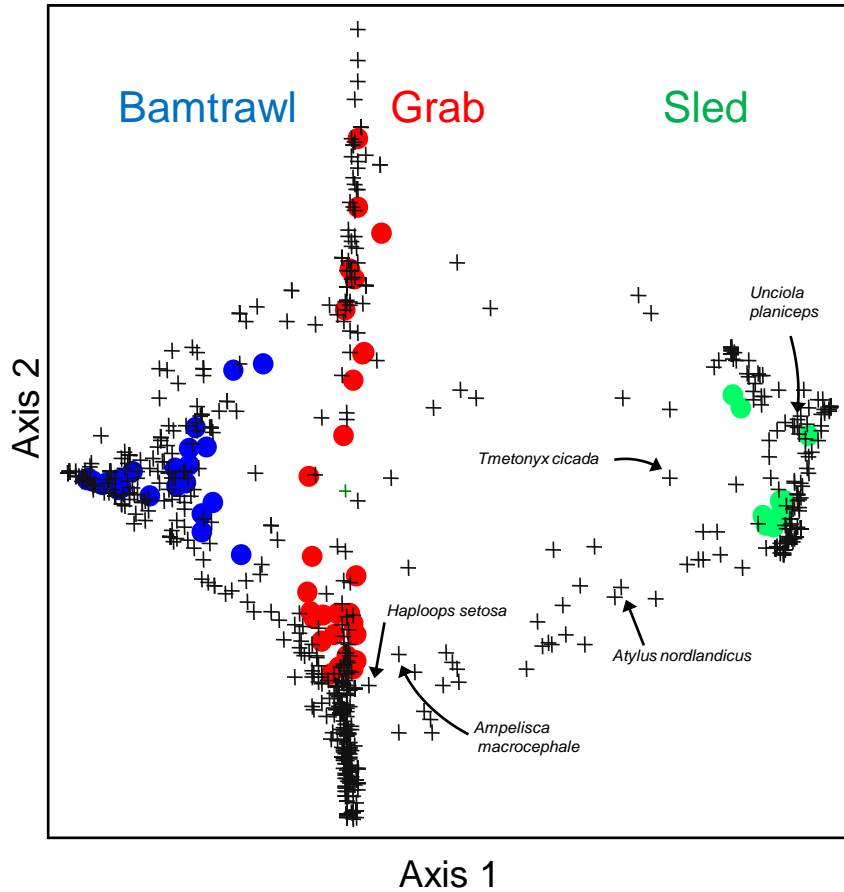


Grab



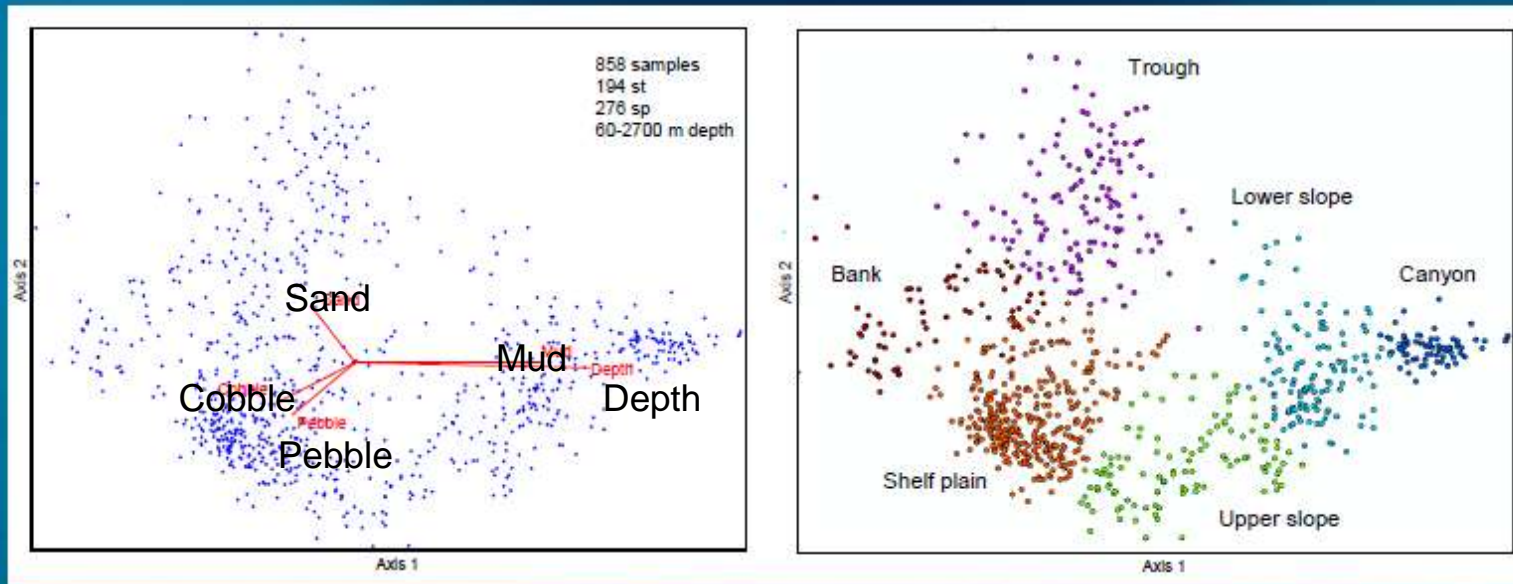
Complementary sampling gear – not much species overlap

DCA-analysis



Sled: Decanted >0,5 mm Crustacea
 Grab: Macrofauna, >1 mm
 BT: >5mm fauna

Detrended Correspondence Analysis of video results



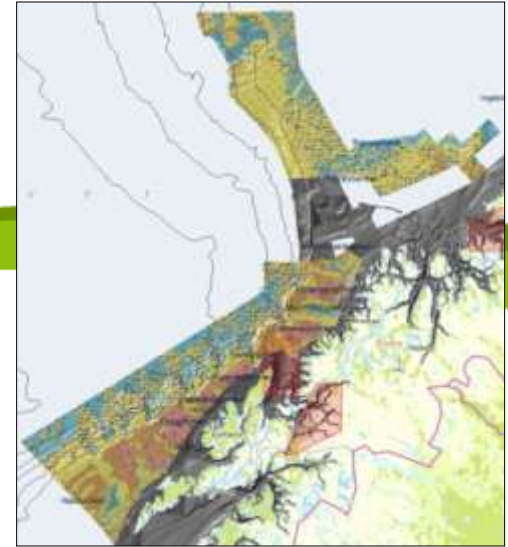
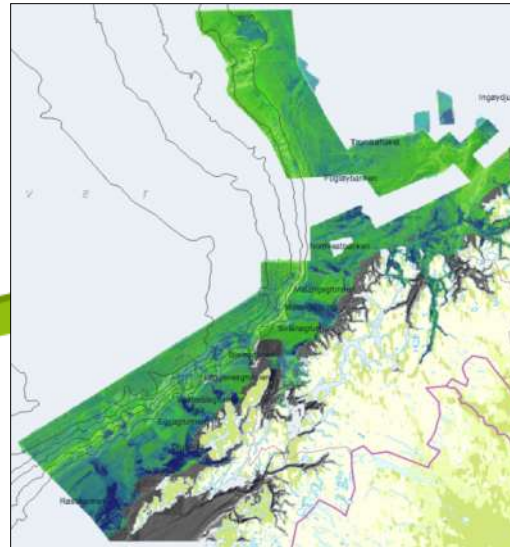
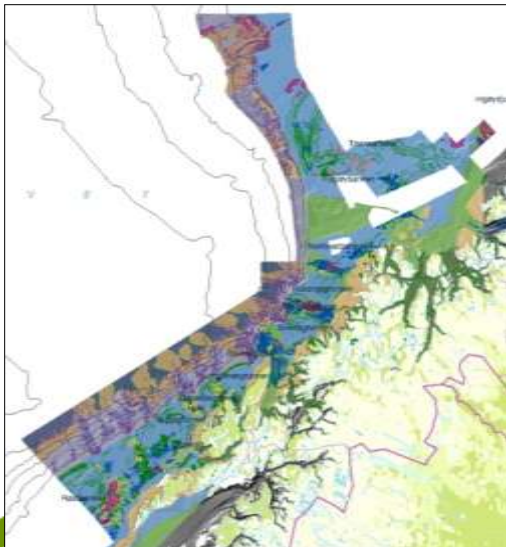
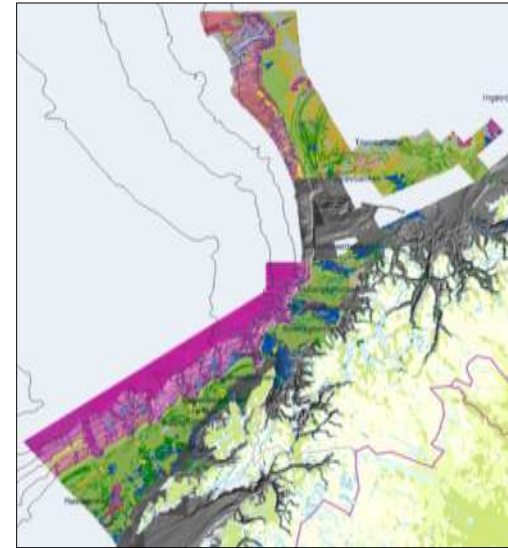
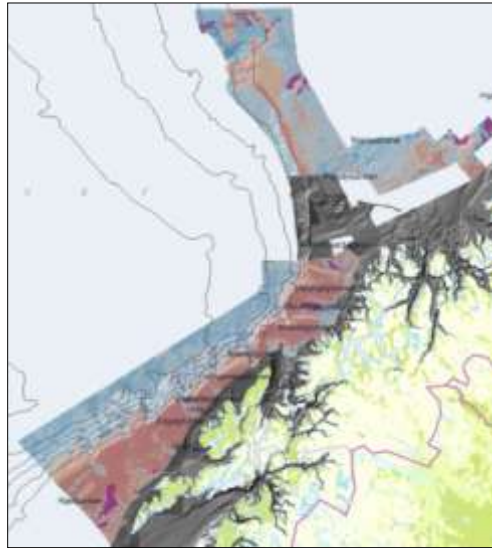
Canyon	Lower slope	Upper slope	Shelf plain	Bank	Trough
Cerianthidae violet	Nephtheidae	<i>Crossaster</i>	<i>Henricia</i> Porifera	<i>Sebastes</i>	<i>Stichopus</i>
<i>Lycodes</i>	<i>Hymenaster</i>	<i>Polymastia</i>	encrusting	<i>Lithothamnion</i>	<i>Kophobelemnon</i>
<i>Ophiopleura</i>	<i>Rhizocrinus</i>	<i>Drifa</i>	<i>Hippasteria</i>	<i>Gadus</i>	<i>Ditrupa</i>
<i>Stylocordyla</i>	<i>Lycodes frigidus</i>	Antedonacea	<i>Phakellia</i>	<i>Tethya</i>	<i>Flabellum</i>
<i>Bythocaris</i>	<i>Caulophacus</i>	<i>Gorgonocephalus</i>	Echiuridae	Galatheidae	<i>Raja</i>

Nearly 50% of the habitats listed in the Habitats Directive are geomorphic features, or can be identified by geomorphic analysis (Dolan et al. in prep.)

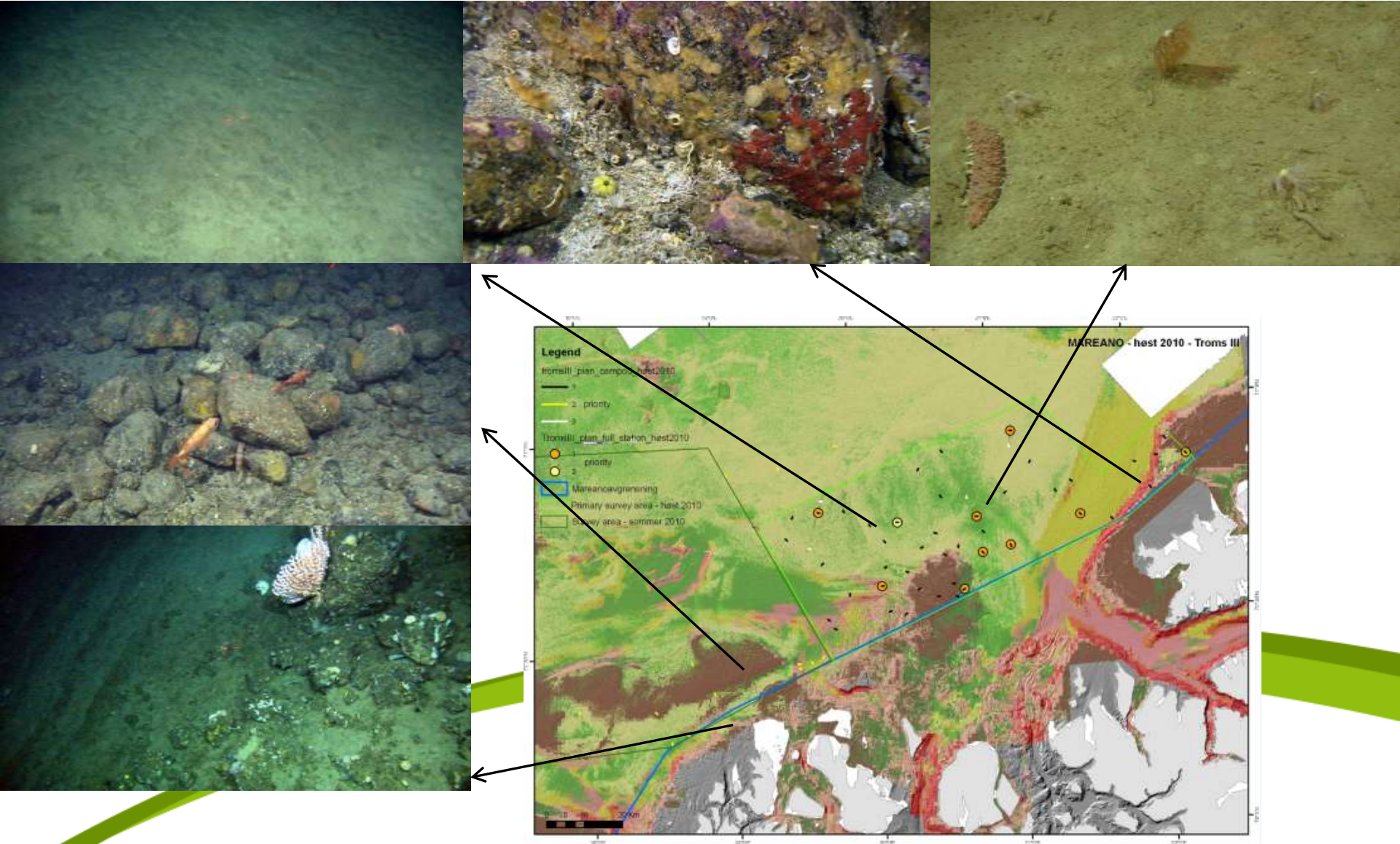
Geological seabed maps

- Sediment processes
- Genesis (Quaternary)
- Landscape with land forms
- Acoustic hardness
- Grain size

All available on
mareano.no



Benthic organisms are selective...

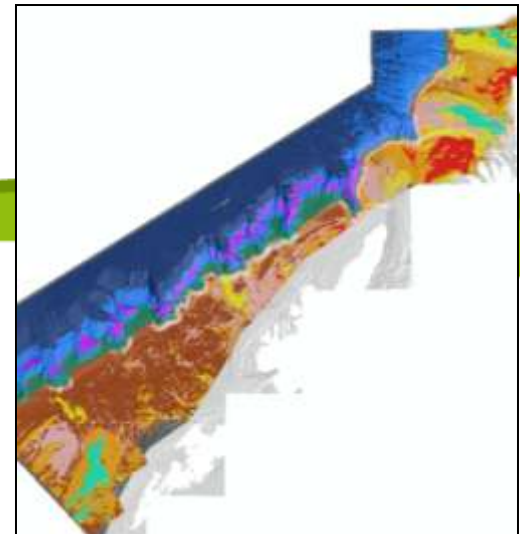
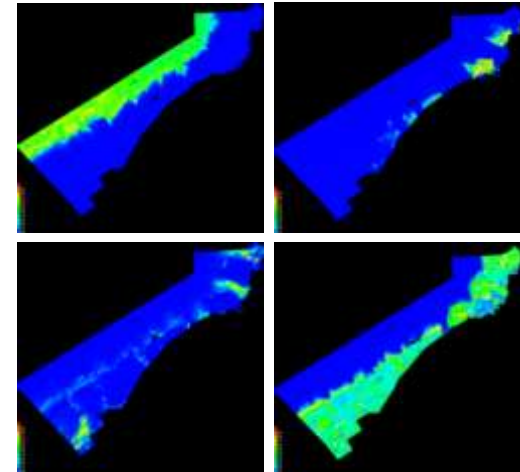
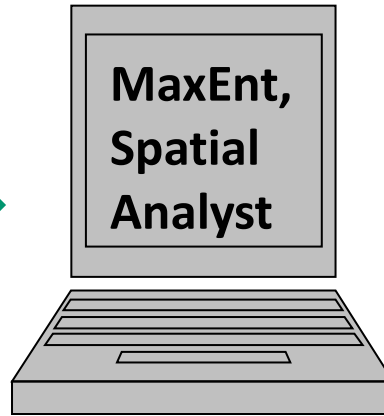
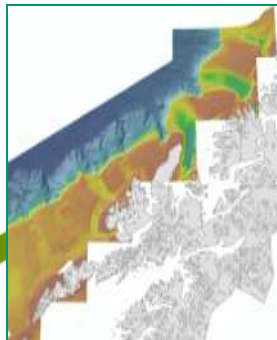


Differing environments – differing faunas

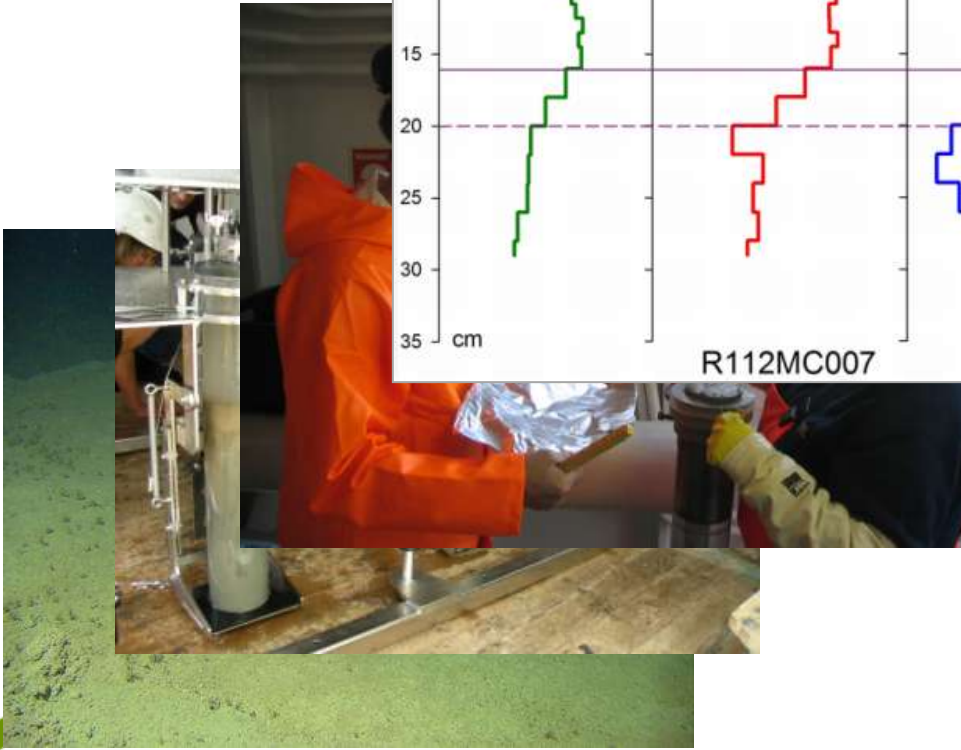
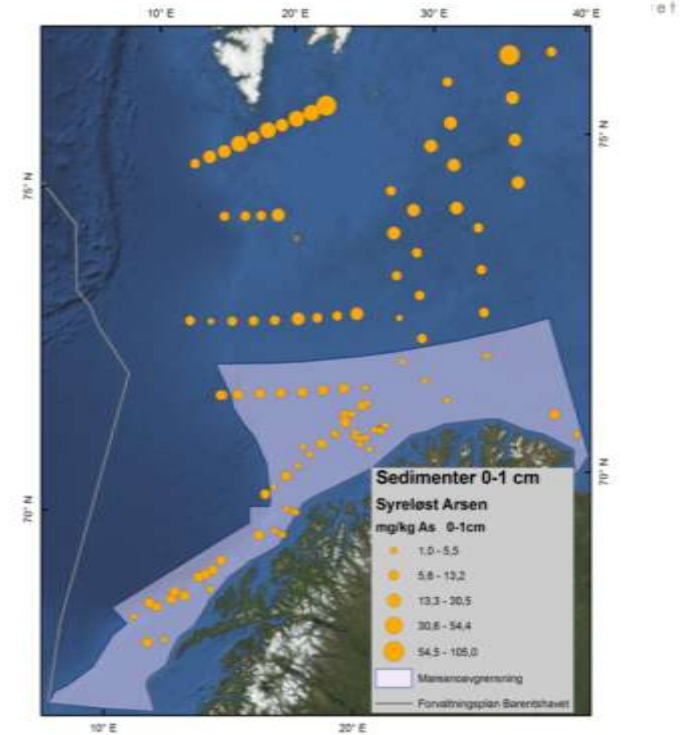
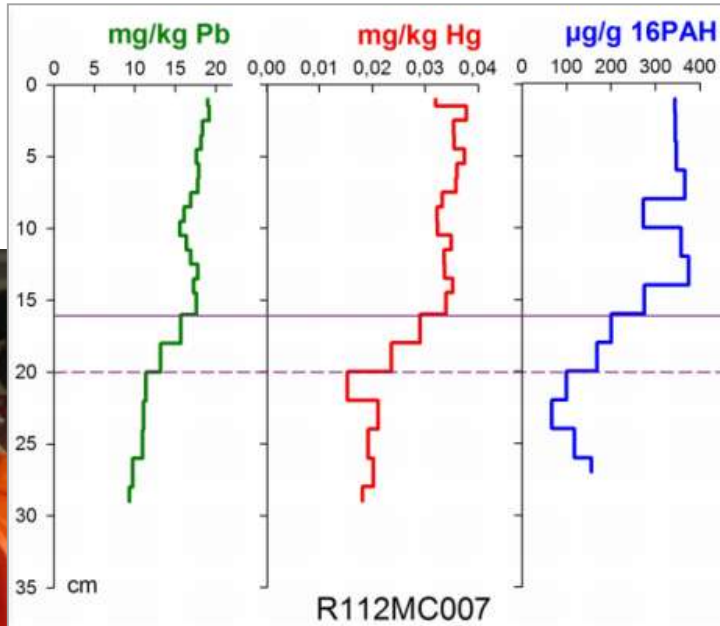
Habitat maps - process

DPTMN (depth)
Backscatter
SLP49MN (slope)
UTMNMN (latitude)
MNCRV49MN (rugosity)
BPI49MN (relative position)

Categorical variables:
SEDKORN (grain size)
LANDSKP (landscape)

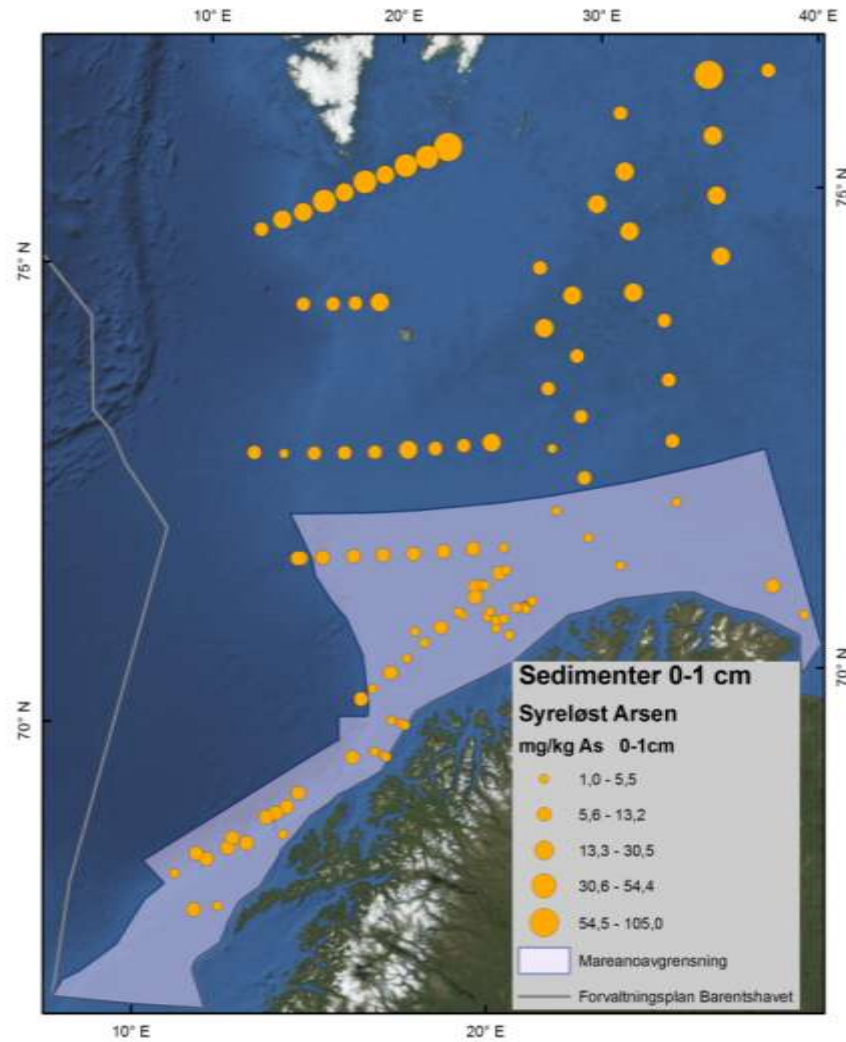
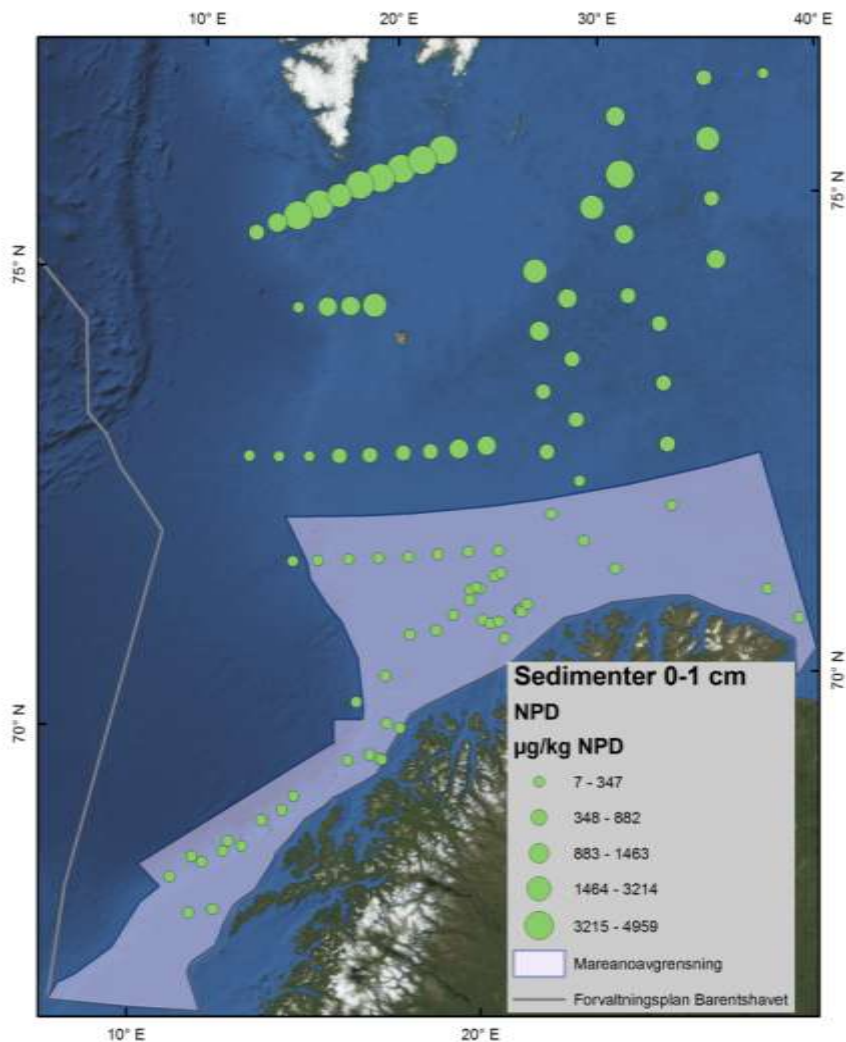


Contamination – surface and historical



Light aromatic hydrocarbons (NPD) in surface sediments

Arsenic in surface sediments



Elevated levels of NPD and As are probably due to natural variations in the background levels - not human pollution

Knowledge dissemination



www.mareano.no – map services and description



Downloadable data sets – shape files, WMS, "digital paper maps", QC'ed analytical data and Norway Digital

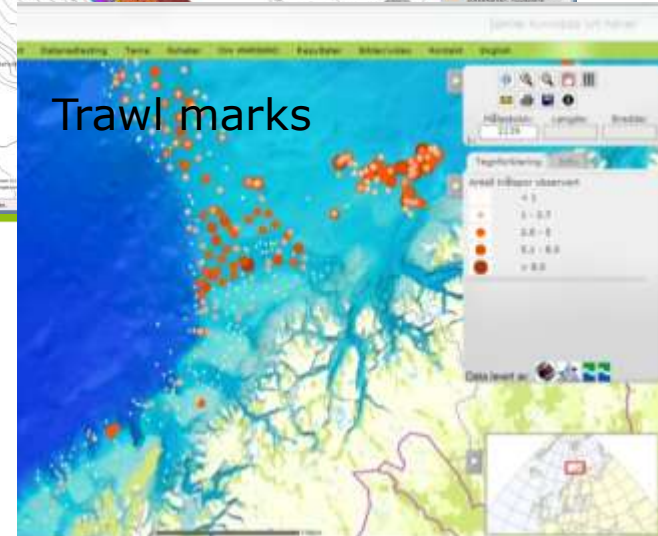
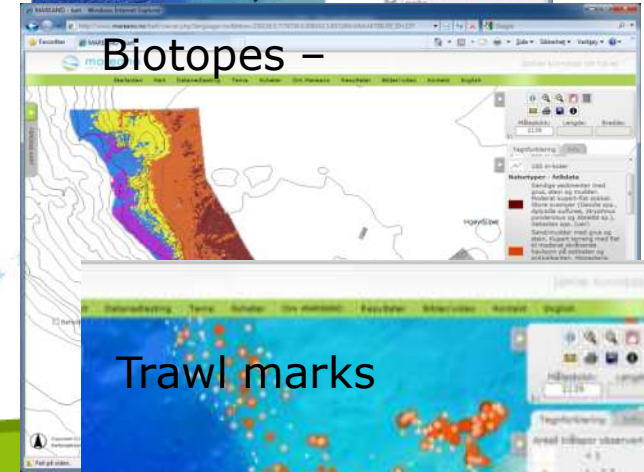
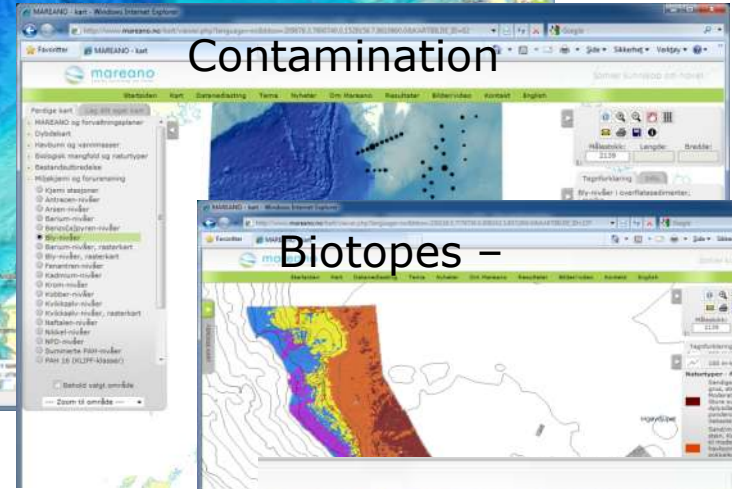
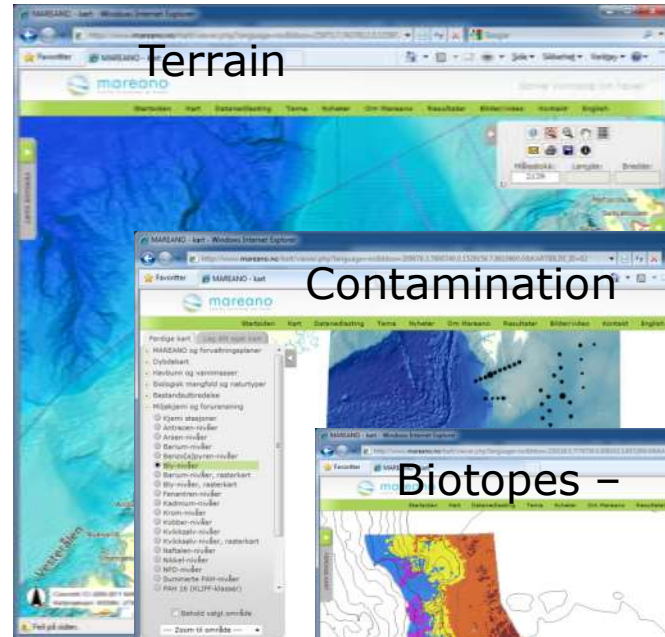
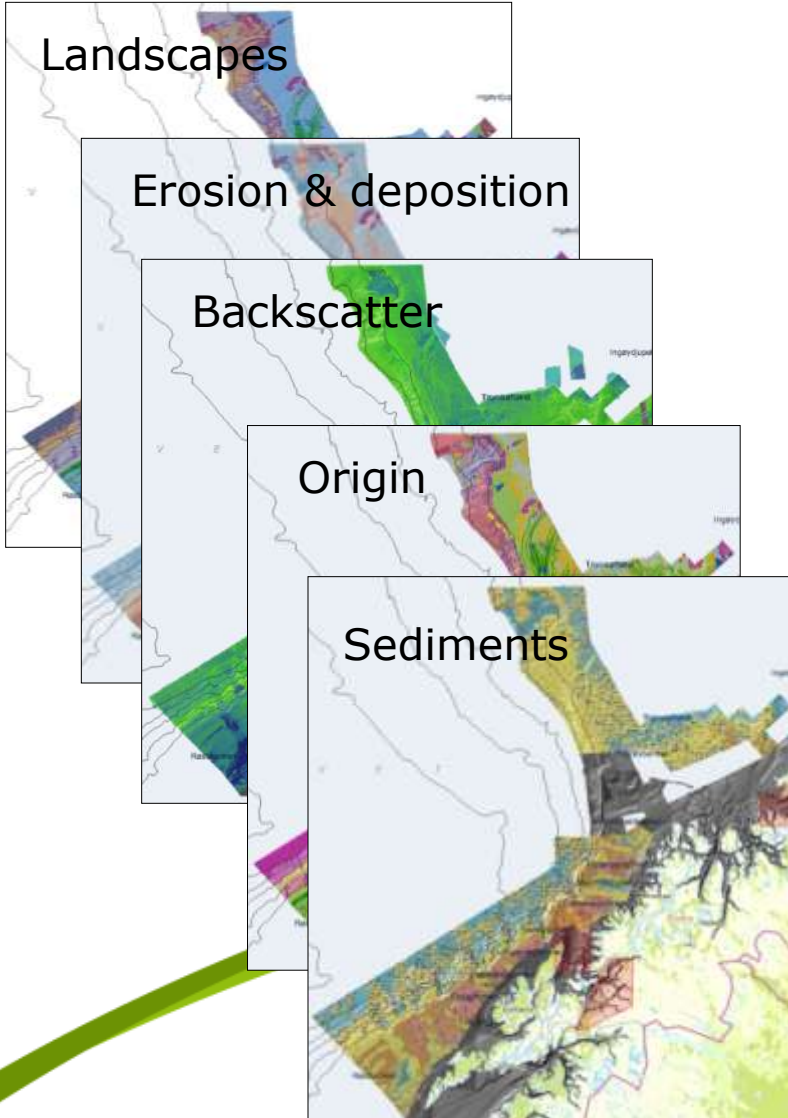


Book, booklets, scientific papers



3D visualization online – ArcGisExplorer
www.ngu.no/havbunn/3D

Maps – www.mareano.no



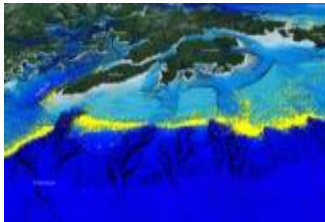
Using the knowledge



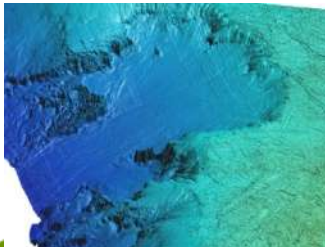
Decision support for ecosystem based management



Environmental status sediments



Fisheries – reduced fuel consumption, reduced damage on seabed and gear, reduced emissions

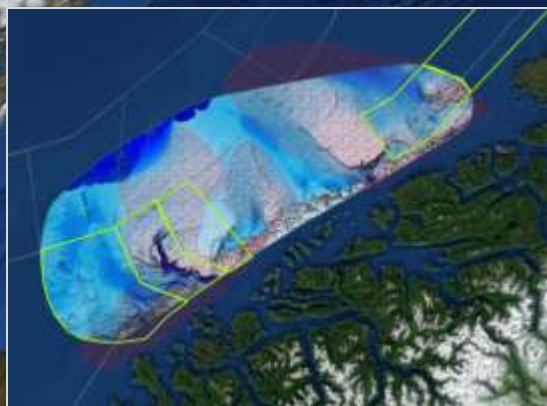


Stability assessments for subsea constructions

Future trends...

Previously disputed areas

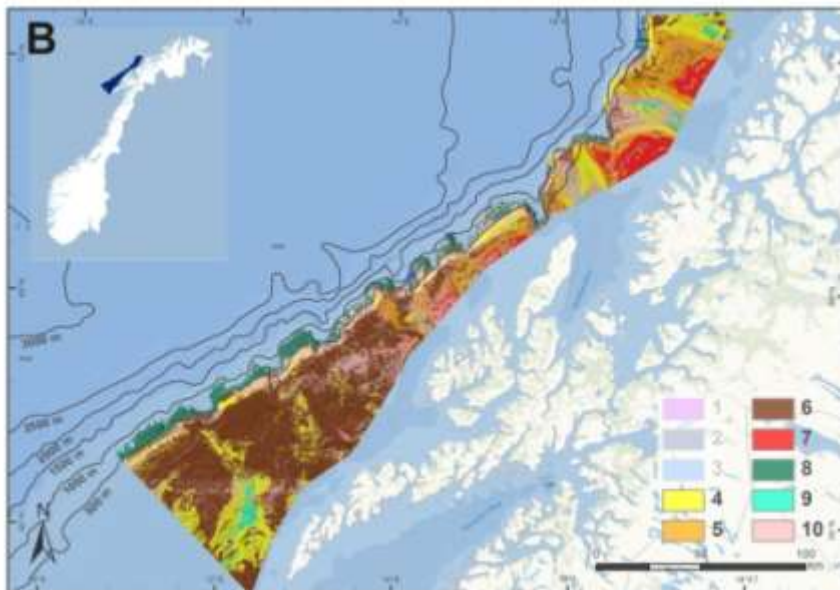
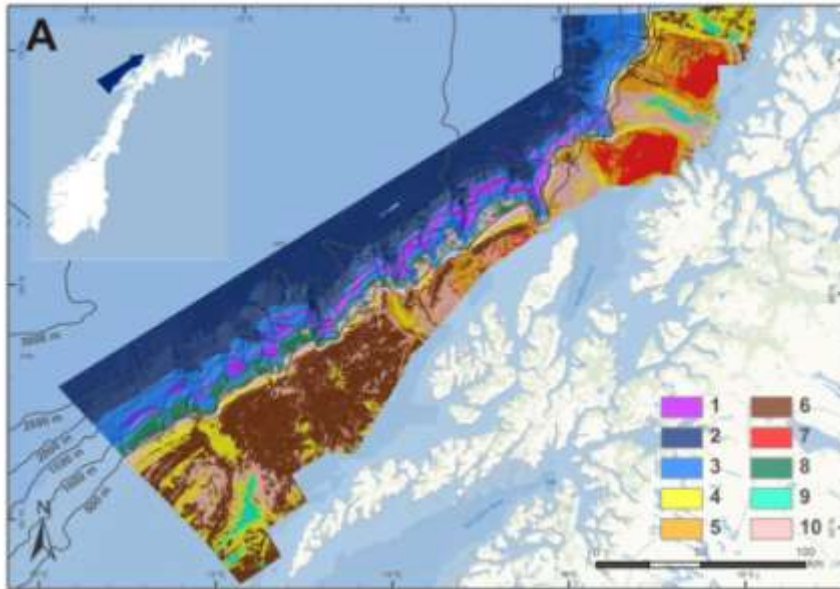
Norwegian Sea



Methods:

- OLEX ++
- AUV's?

Alternative sources for bathymetry



Possible new platforms and instruments – AUV equipped with Synthetic Aperture Sonar, Photo, Methane sniffer +++



Hull-mounted multibeam vs. AUV-mounted Synthetic Aperture Sonar (SAS)

Data courtesy: Neotectonics and Fluid Flow Processes in the Southwestern Barents Sea – Phase II

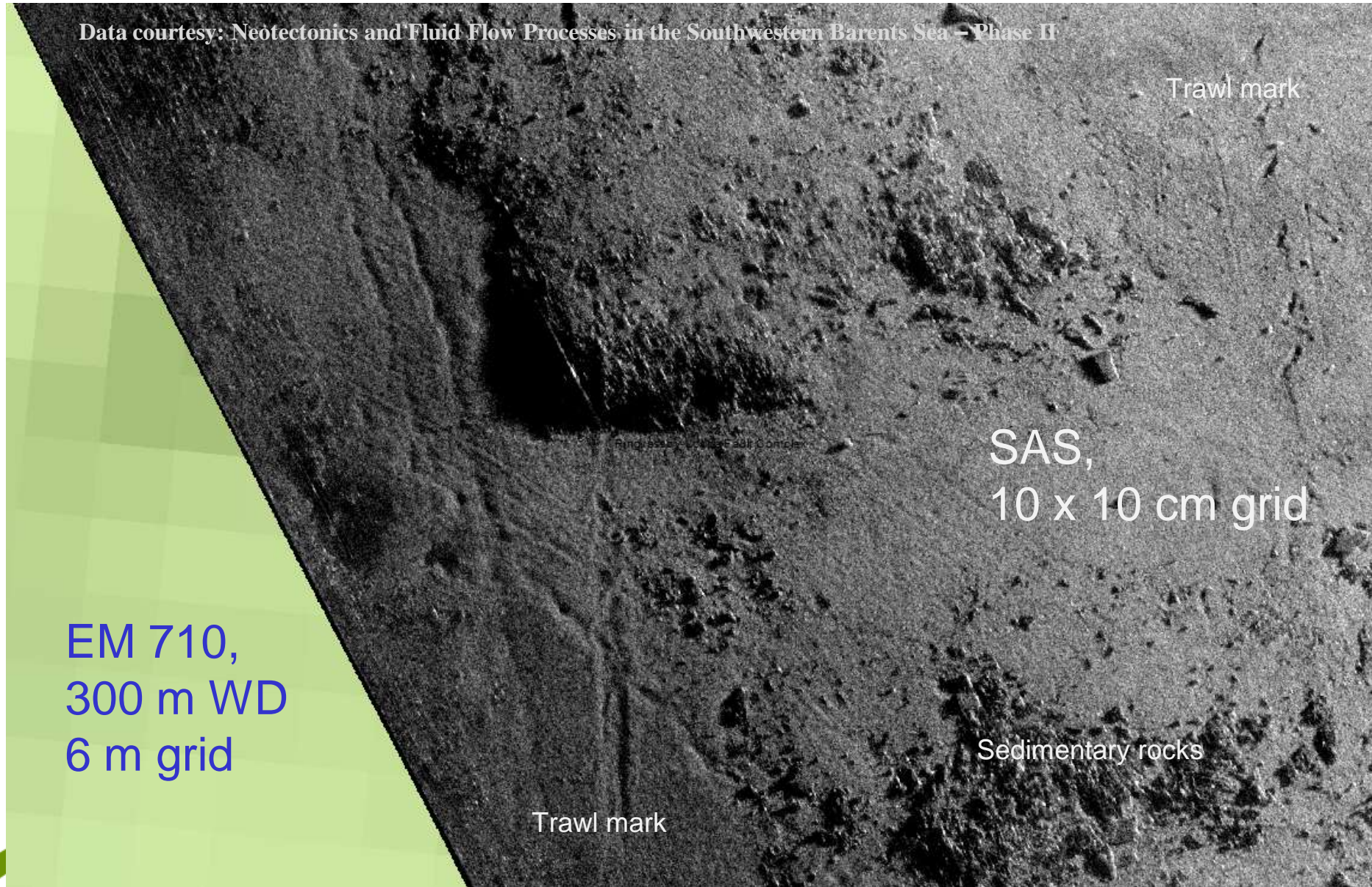
Trawl mark

SAS,
10 x 10 cm grid

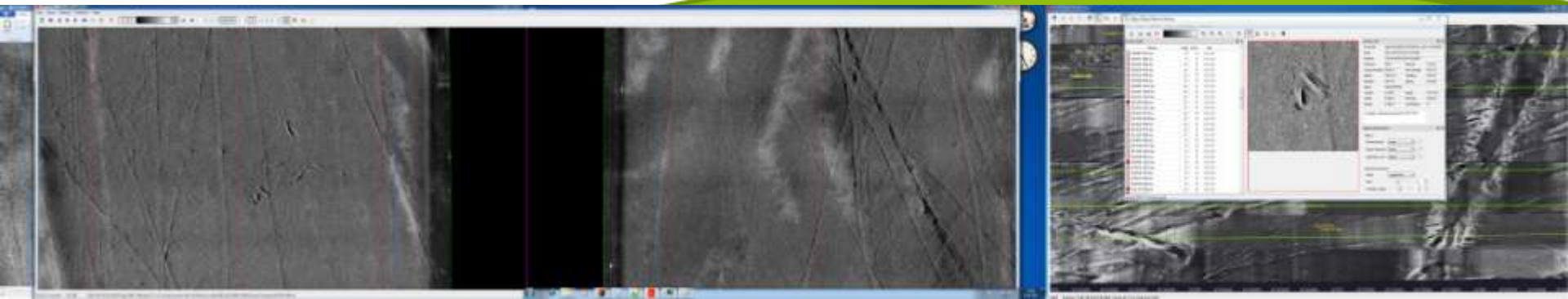
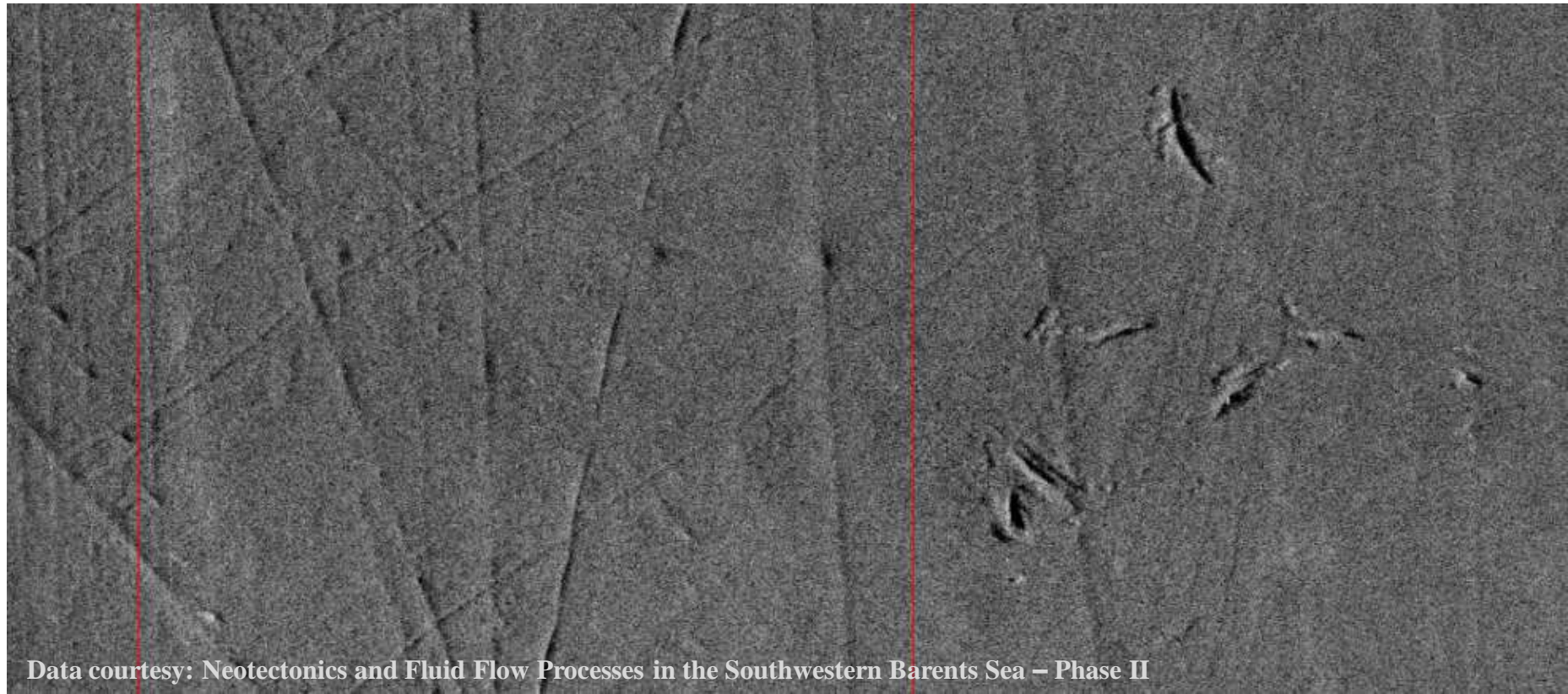
EM 710,
300 m WD
6 m grid

Sedimentary rocks

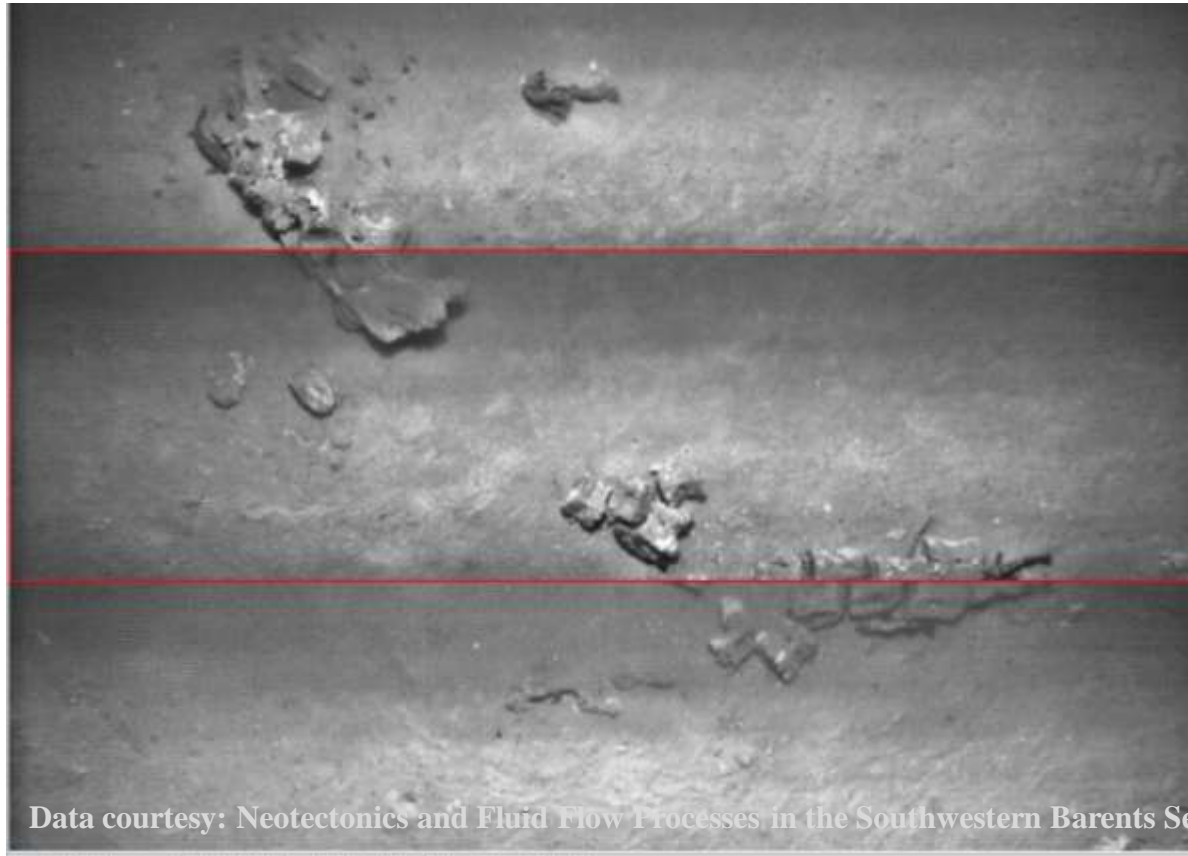
Trawl mark



Whale marks and trawl marks



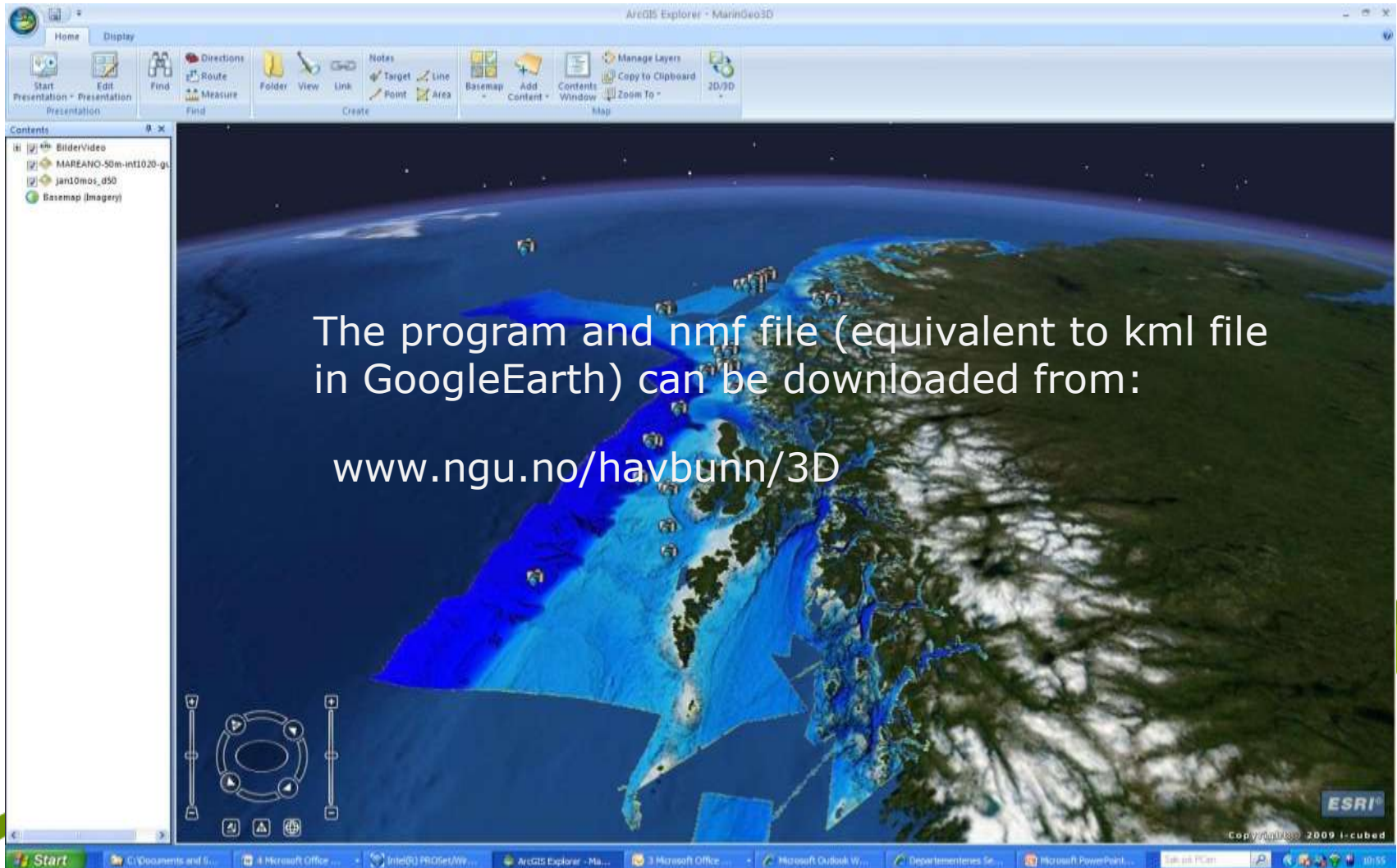
Whale skeleton

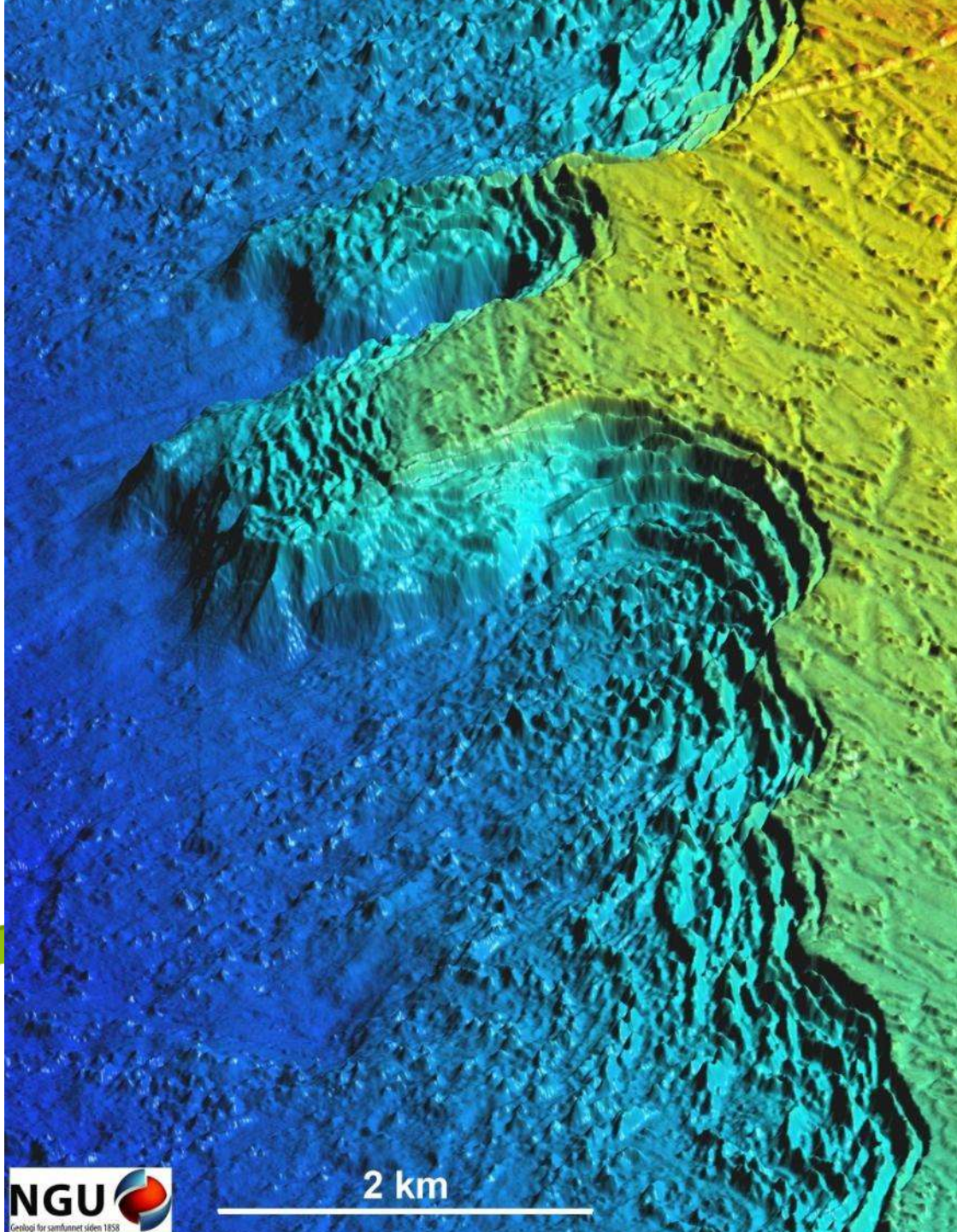
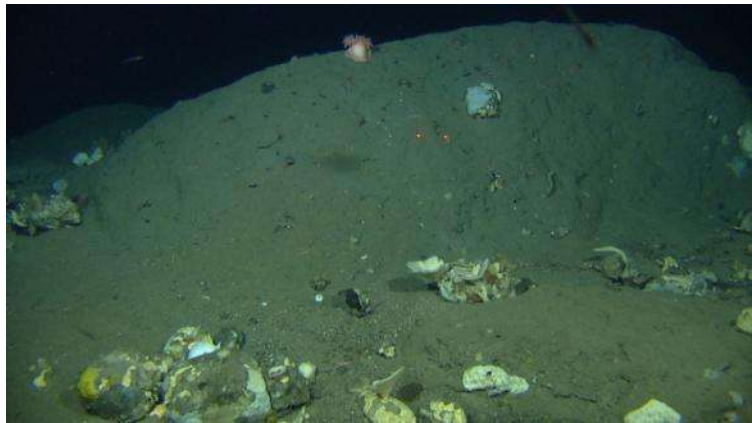


Data courtesy: Neotectonics and Fluid Flow Processes in the Southwestern Barents Sea – Phase II



Some highlights - flying from Lofoten to Bear Island



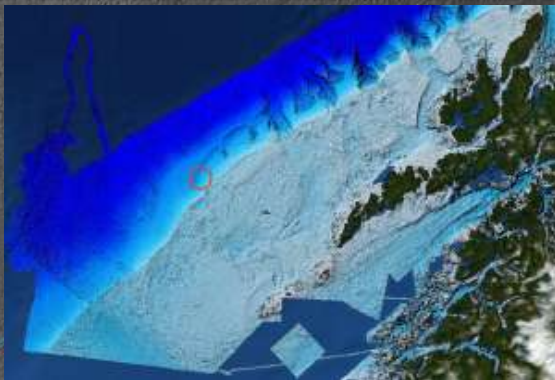


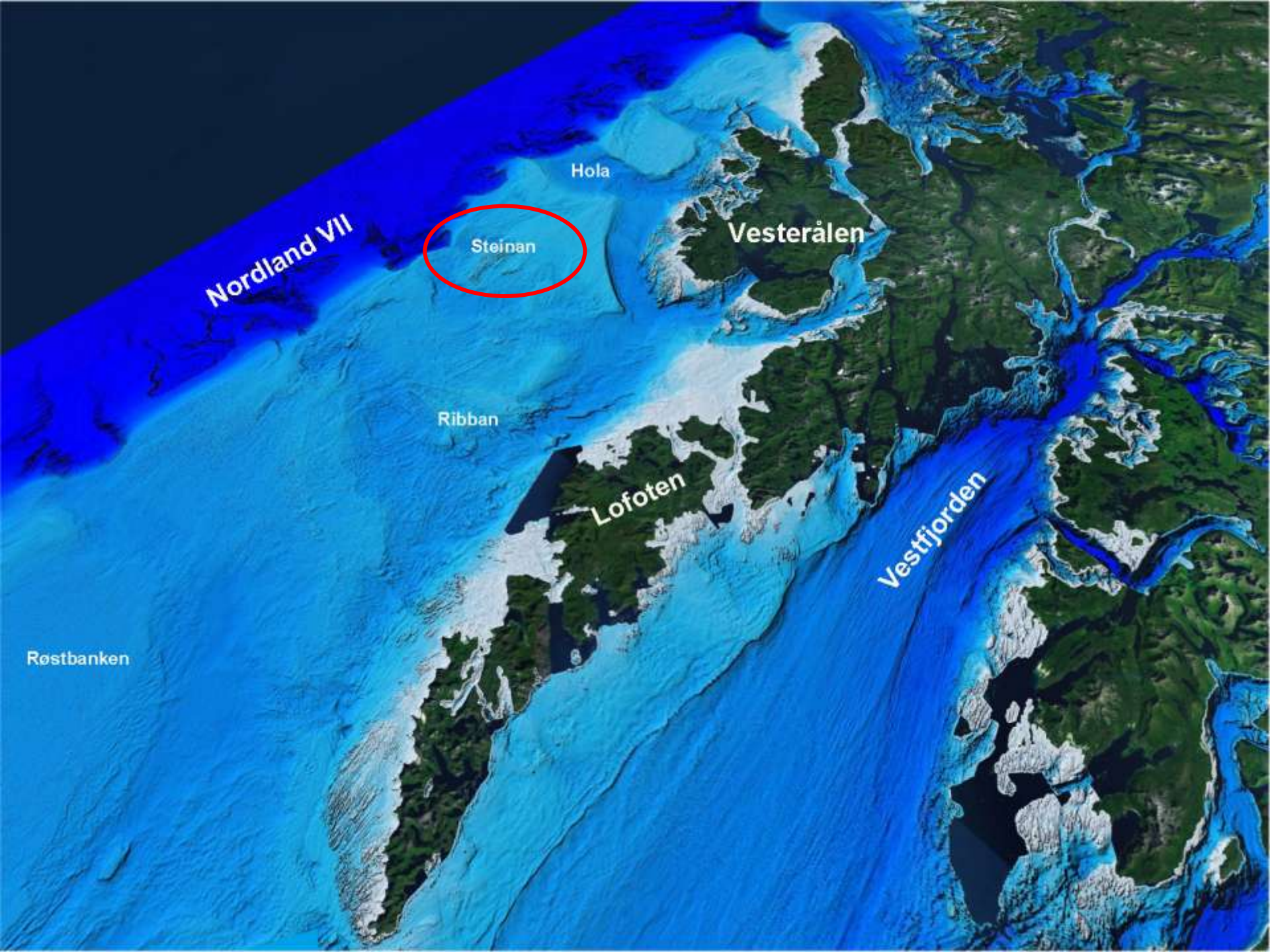
Canyons with seep related faunas?



Canyons

High density of beard worms / Siboglinidae, which receive energy from bacteria exploiting methane / H₂S (ref. PBM/BH - IMR)





Nordland VII

Holo

Steinan

Vesterålen

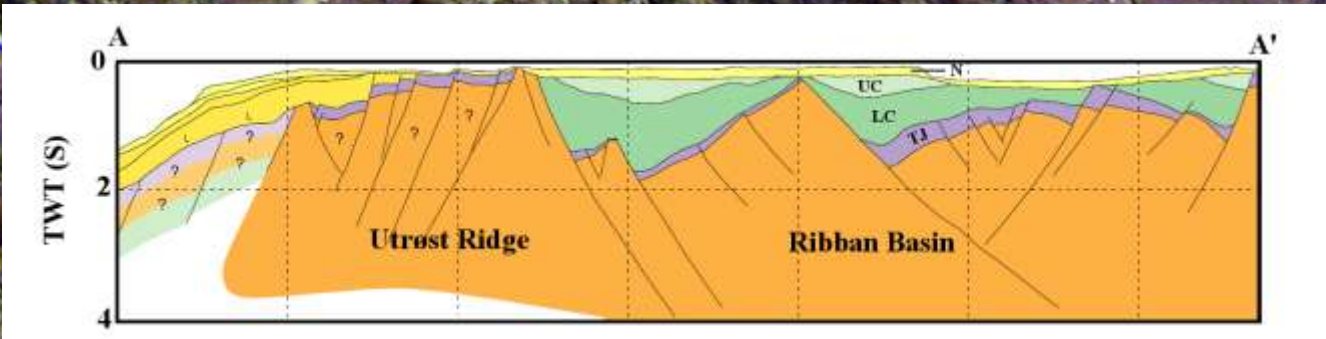
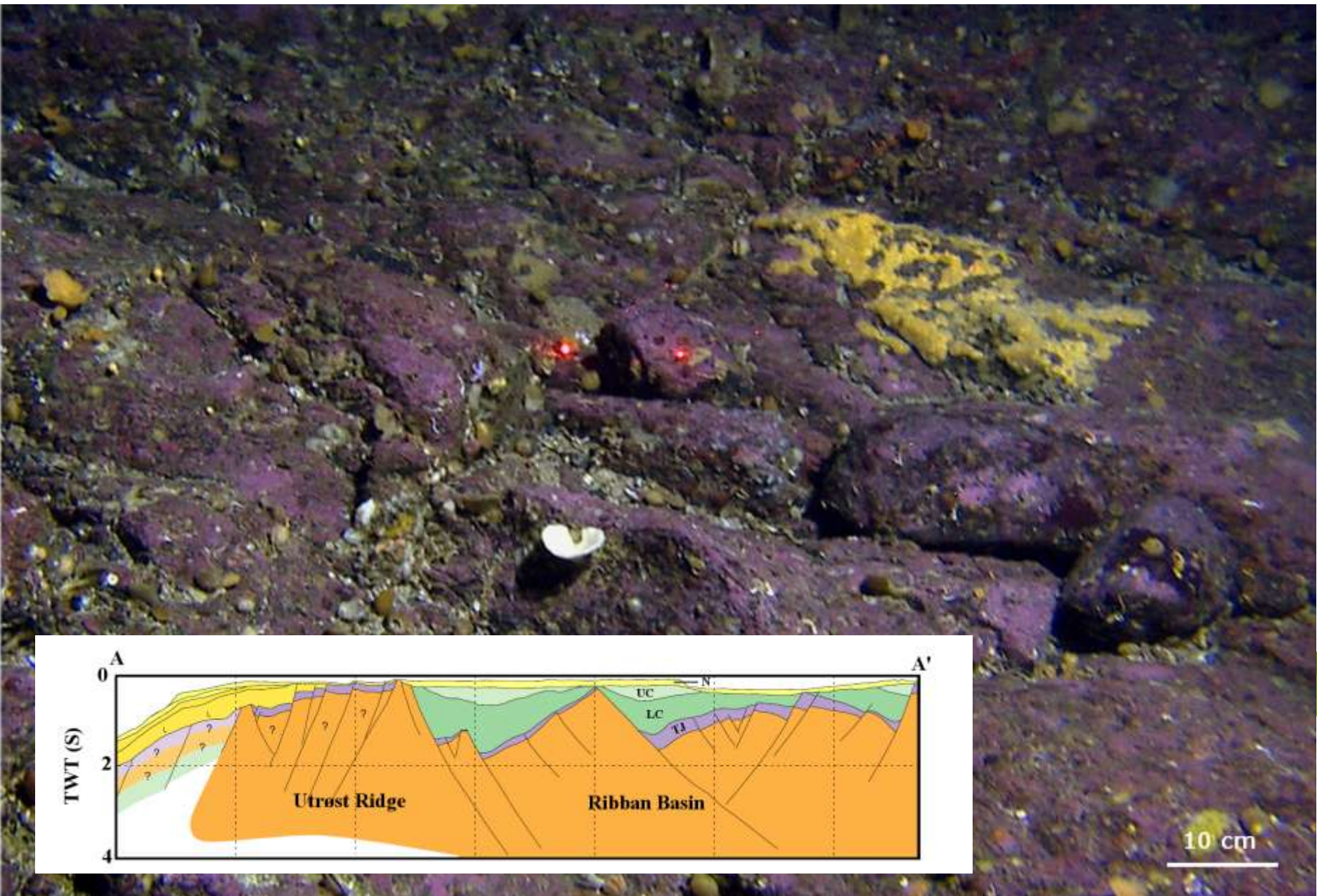
Ribban

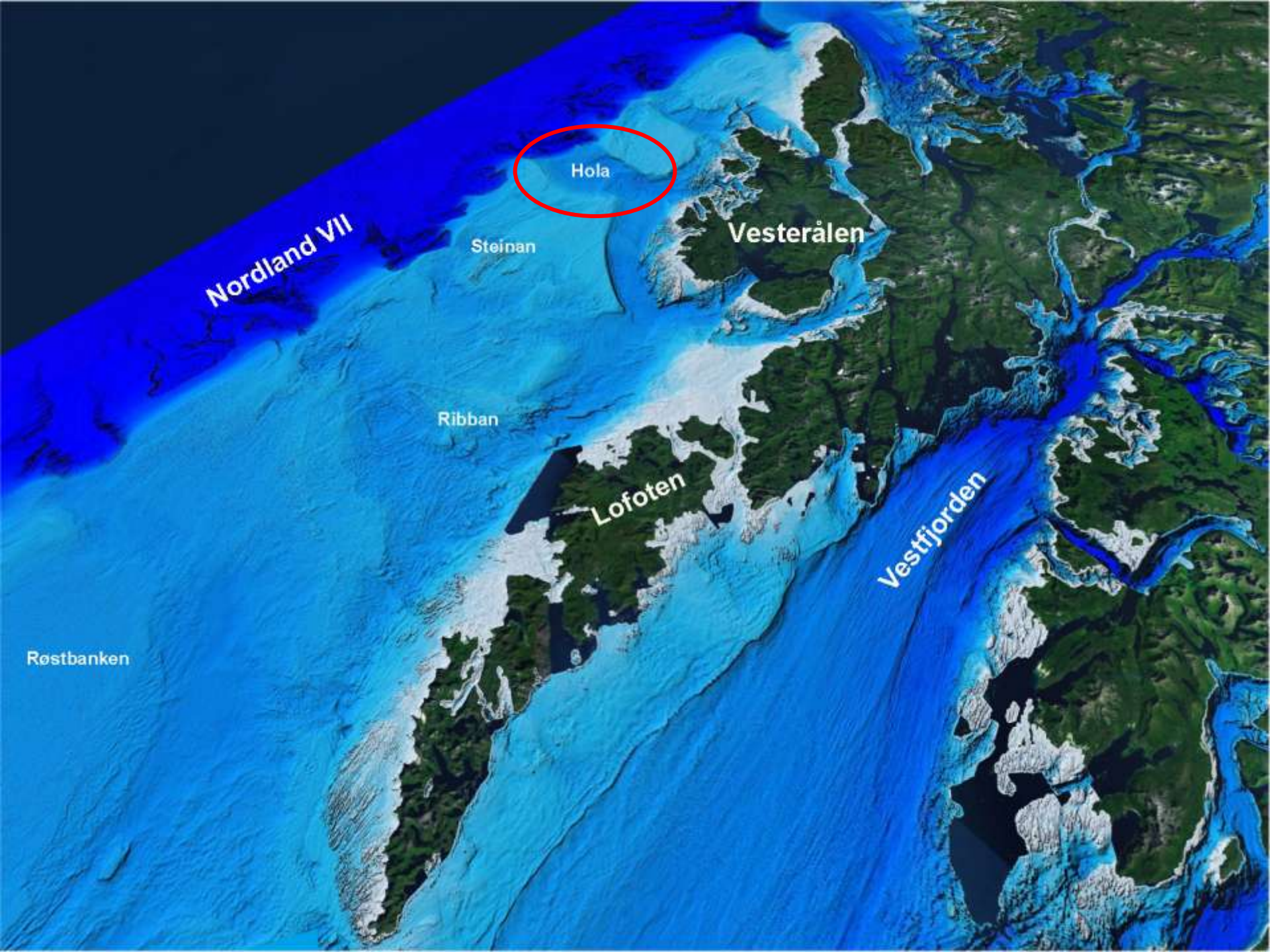
Lofoten

Vestfjorden

Røstbanken

Fauna on hard rock, Steinan





HOLA

Nordland VII

Steinan

Vesterålen

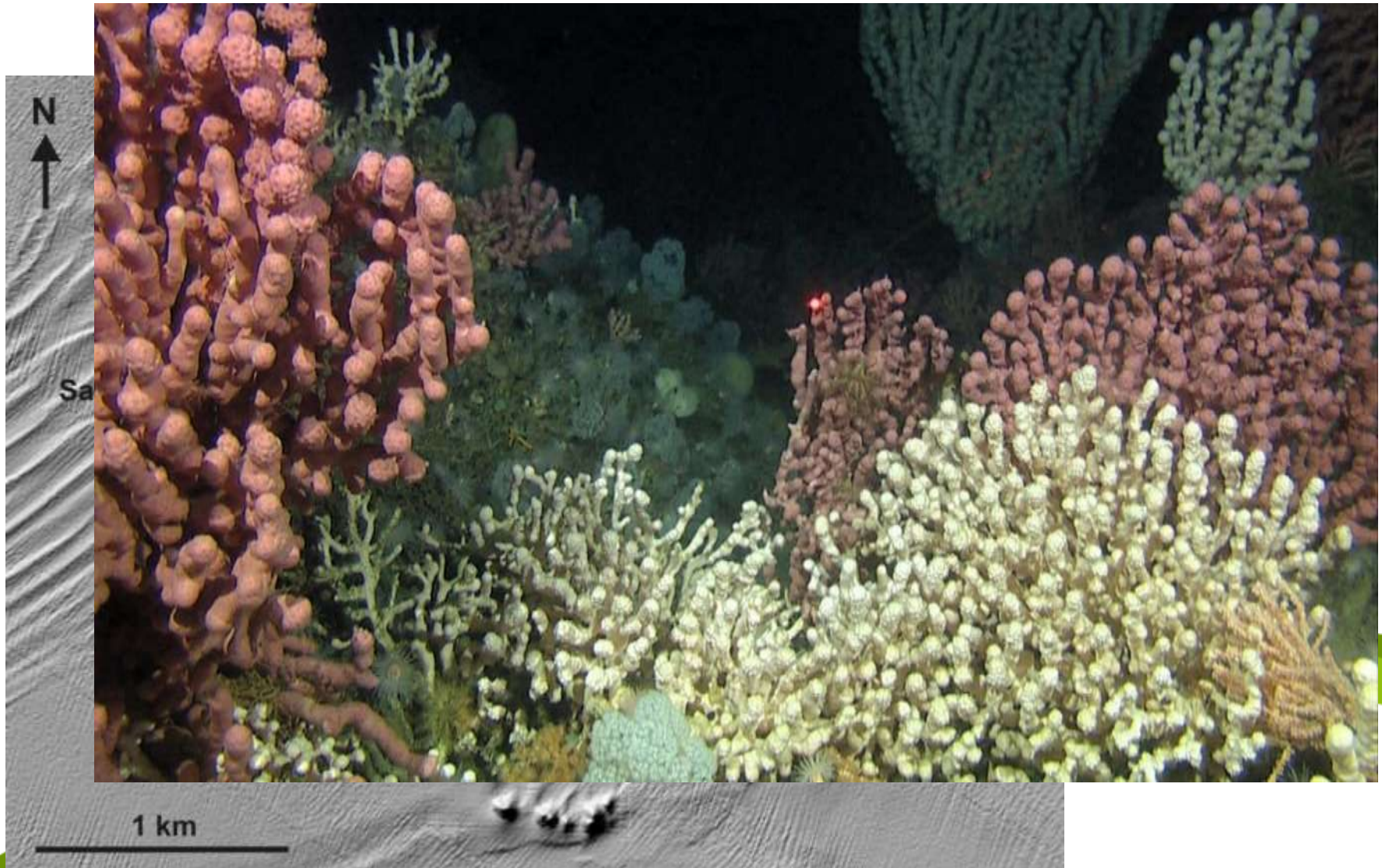
Ribban

Lofoten

Vestfjorden

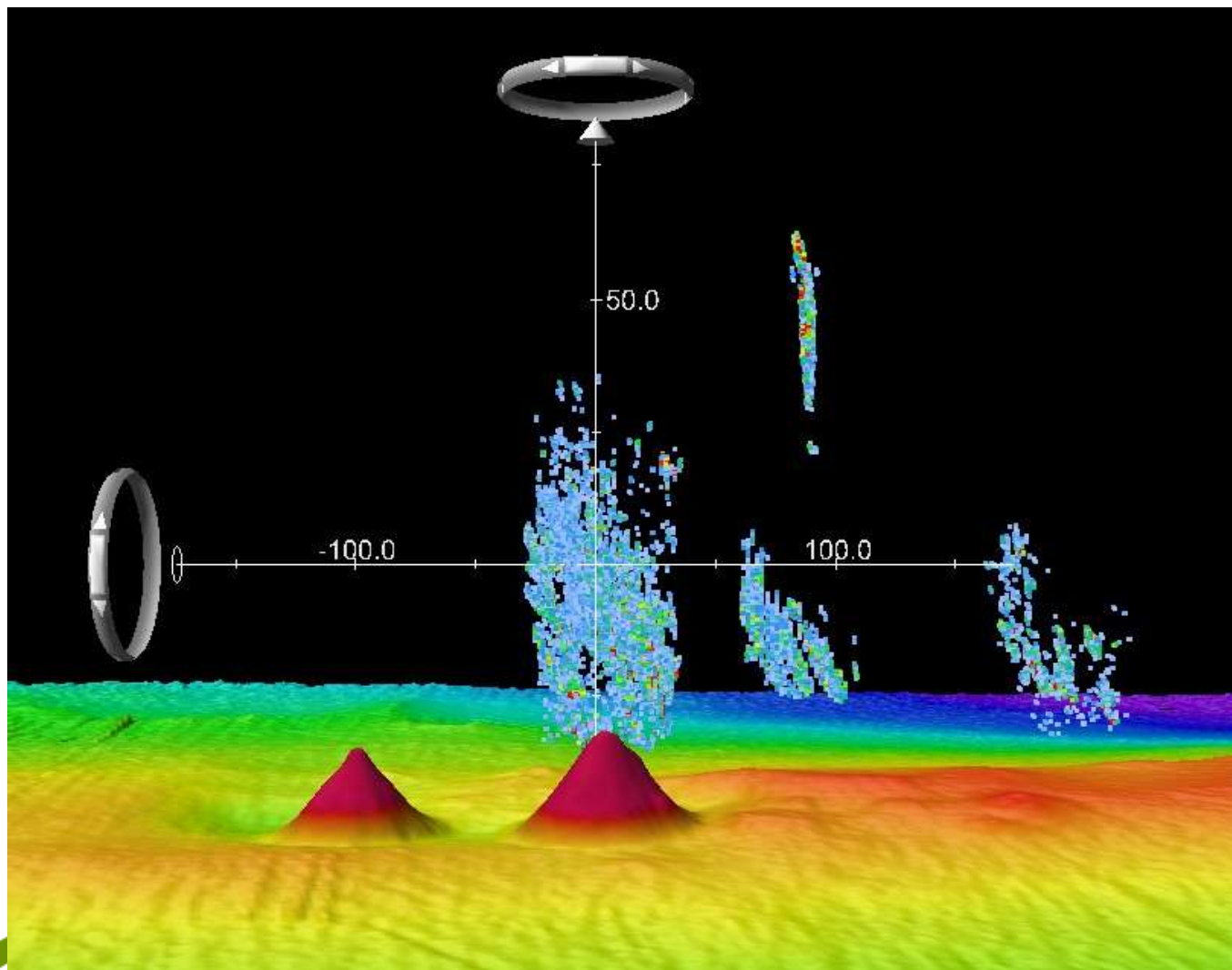
Røstbanken

Hola – sand waves and corals

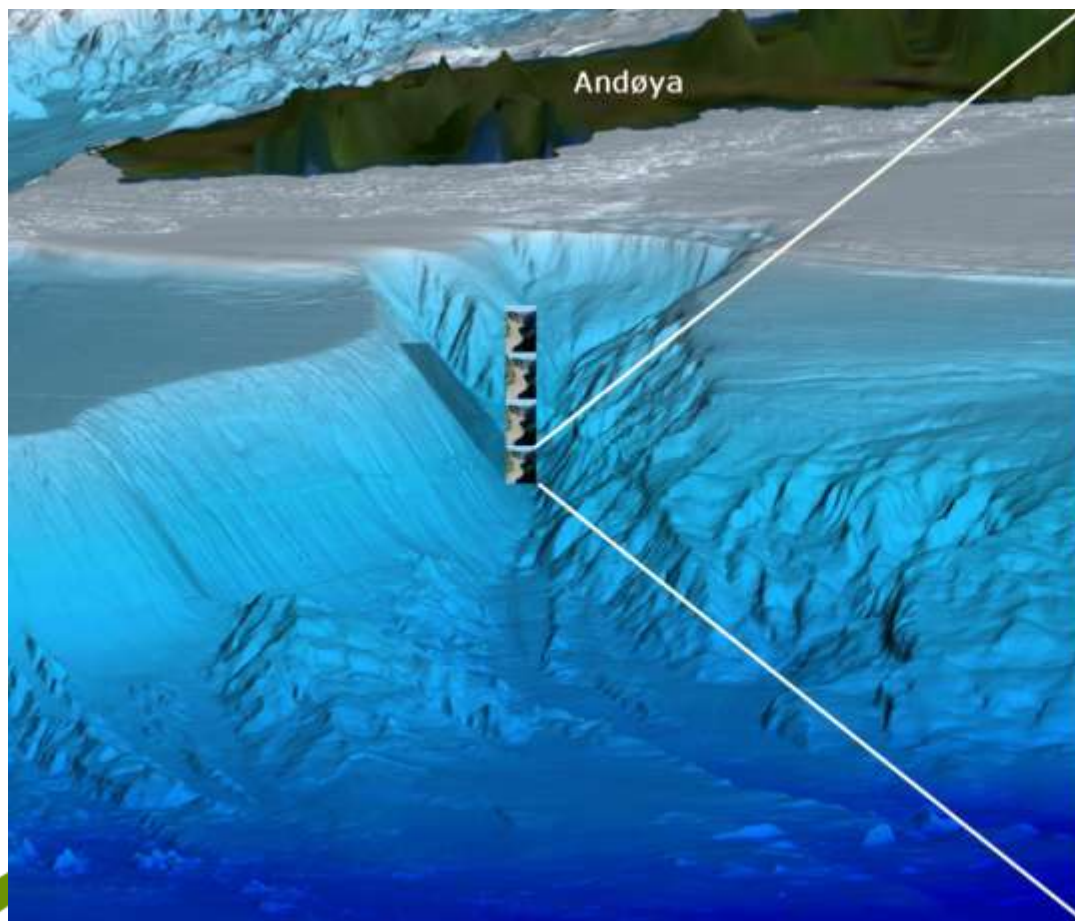


Coral reefs and gas seepages

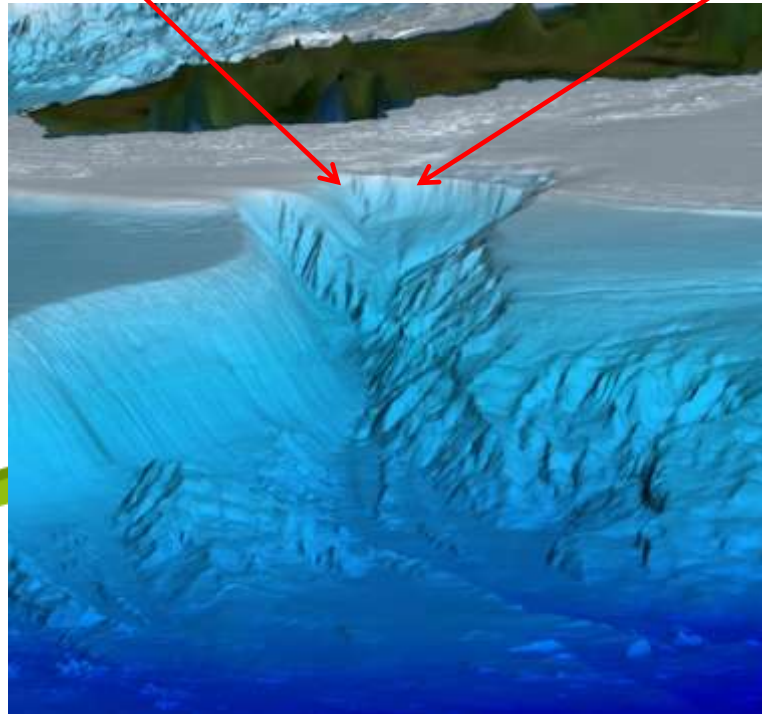
EM710 data and Fledermaus Mid-Water

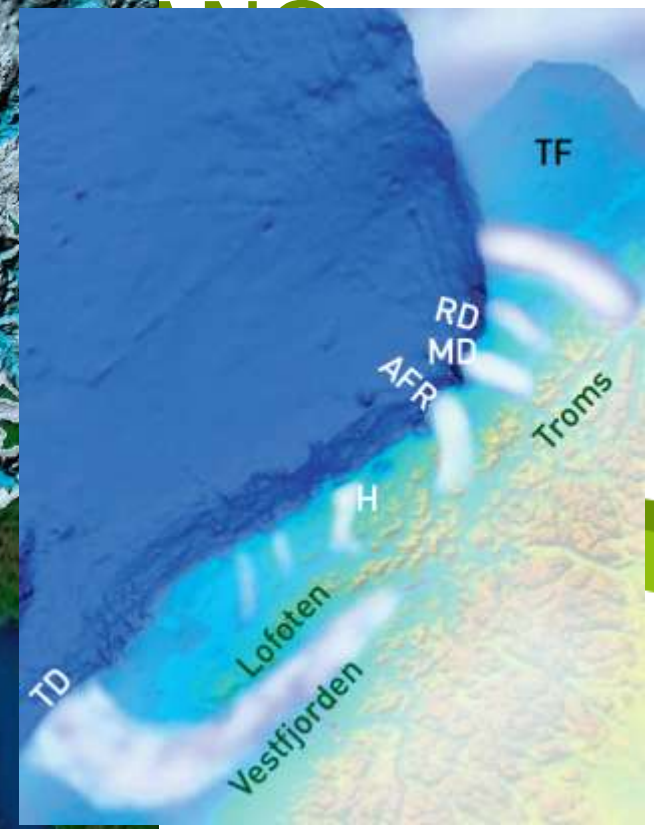
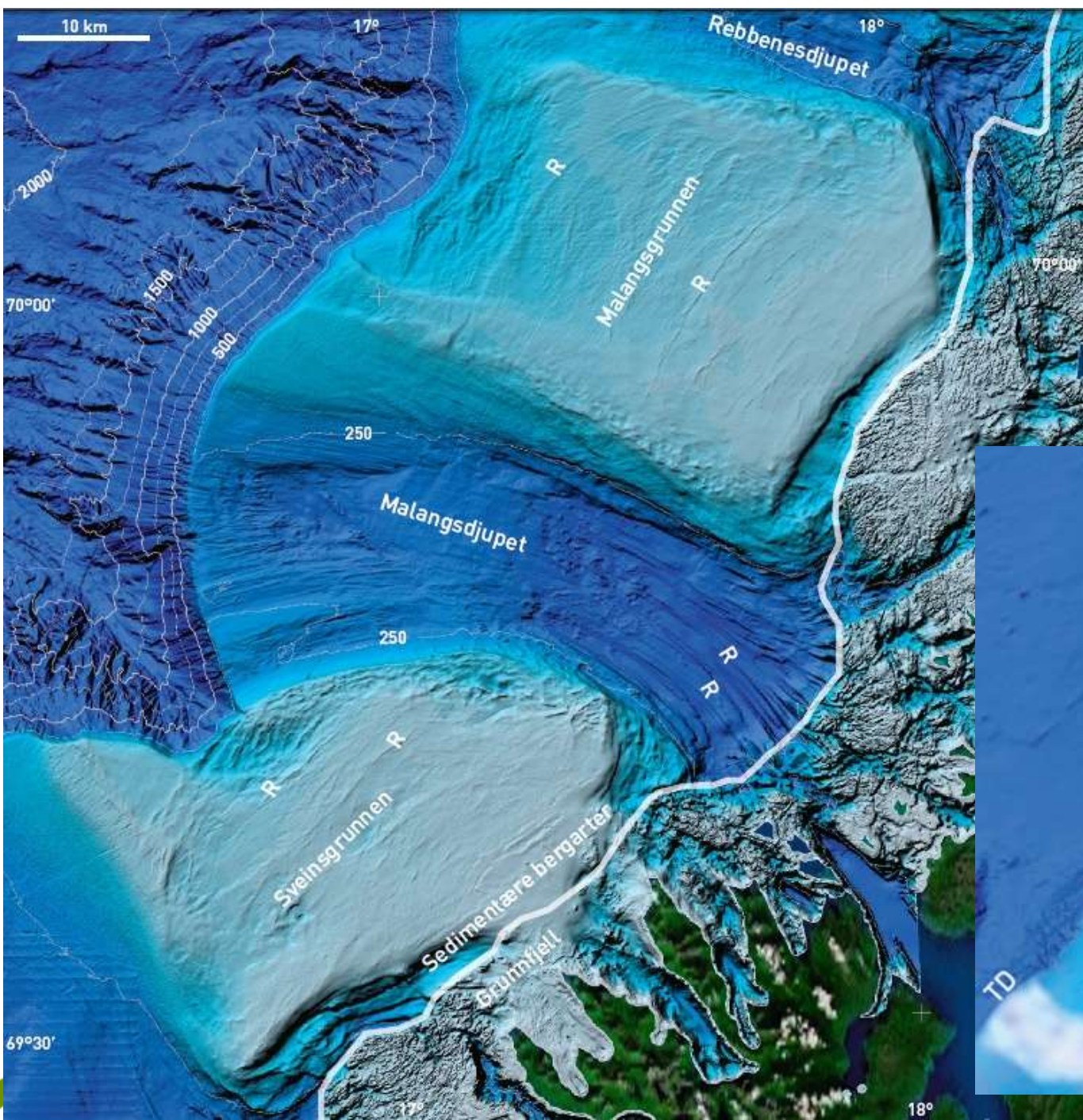


Submarine canyons, 1000 m deep

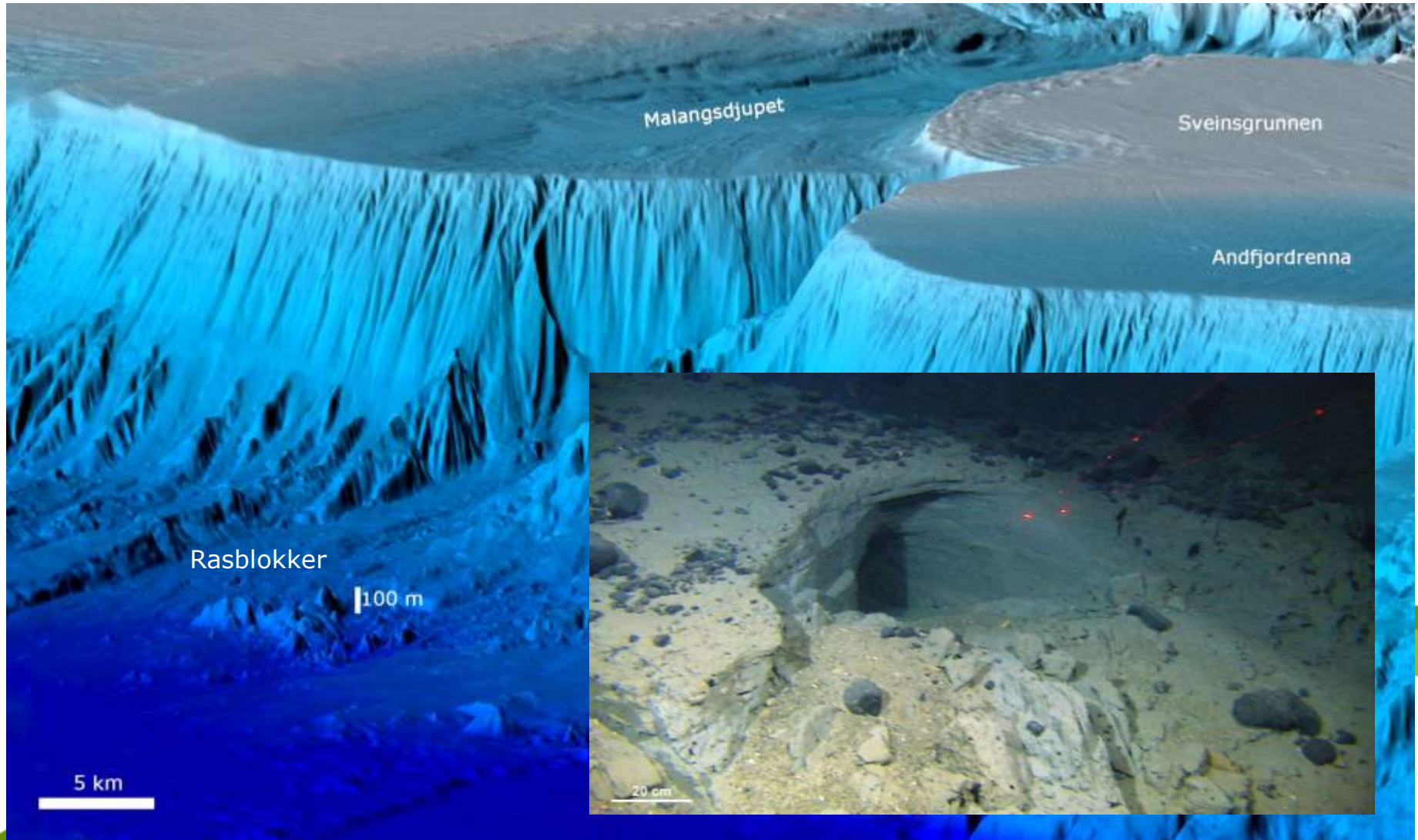


Whale safari, Andøya canyon





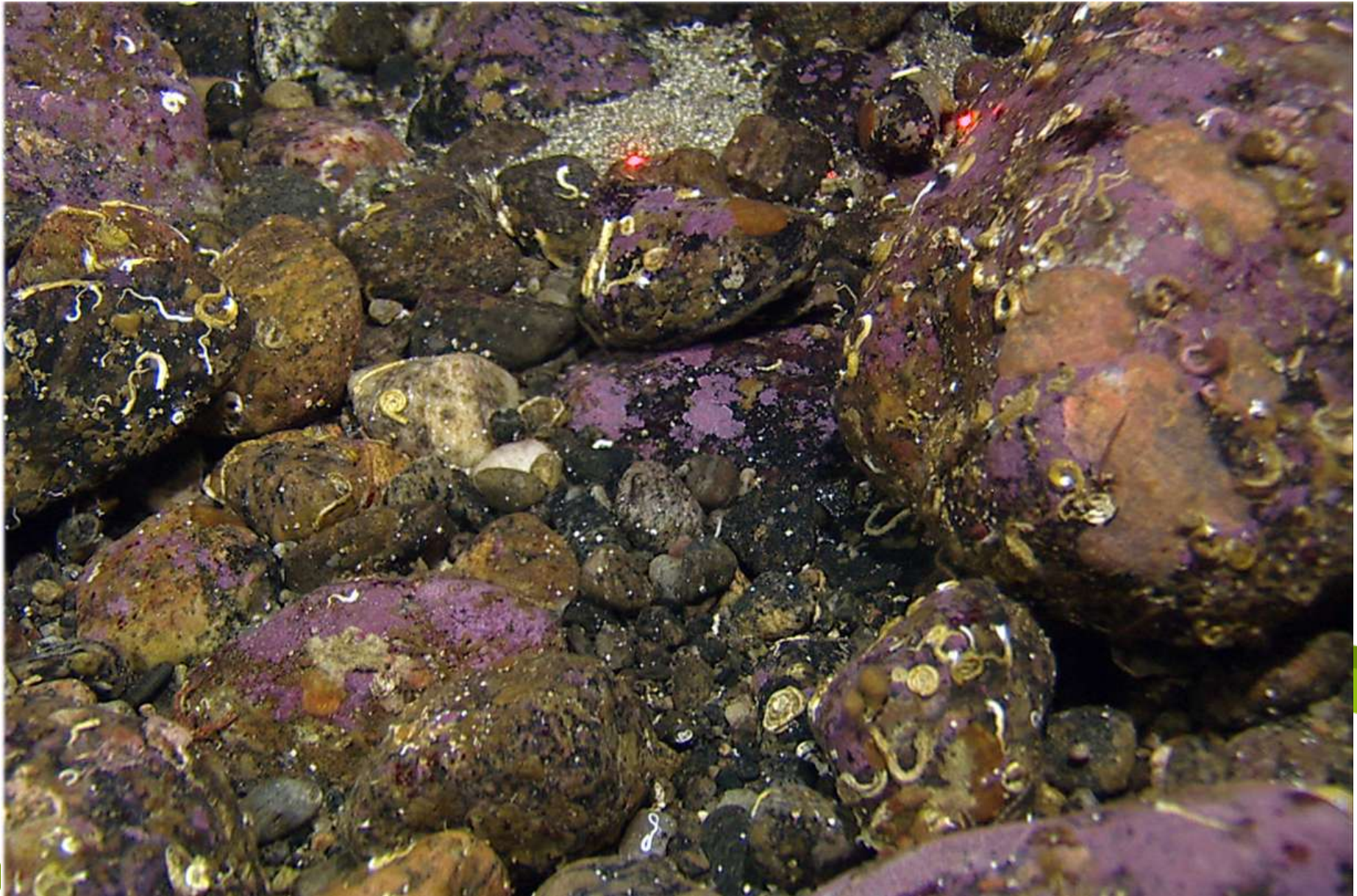
Major slides and gas seeps





Sveinsgrunnen

Gravel with hard bottom fauna

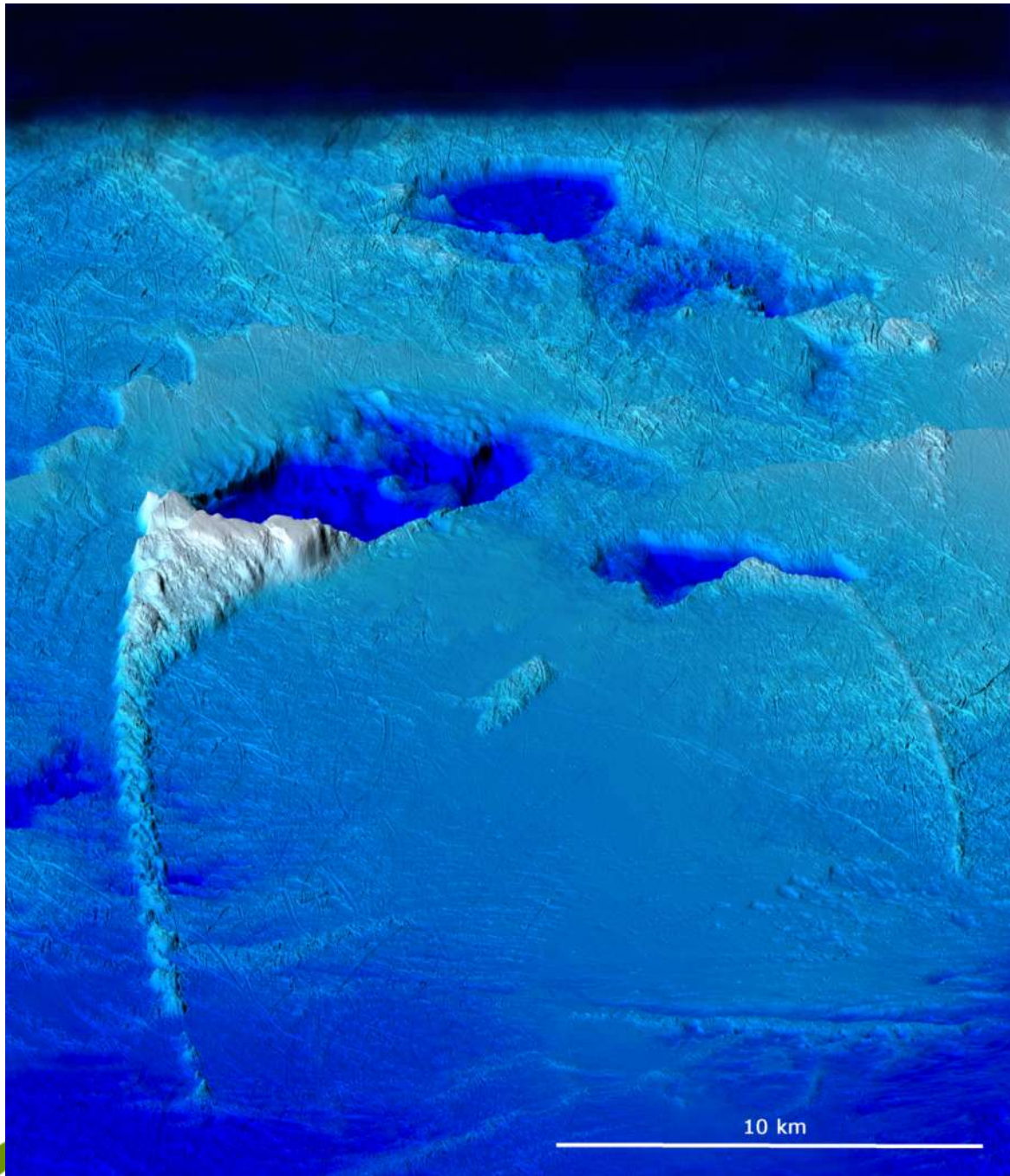


A 3D bathymetric map of a coastal area, likely a fjord or inlet. The map uses a color gradient from dark blue (deep water) to light blue and cyan (shallow water). A red circle highlights a specific location on the seabed, labeled "Steinbitryggen". The map shows various underwater features, including a large, dark, rectangular structure that appears to be a submerged breakwater or pier. The land area on the right side of the map is shown in green and brown, indicating vegetation and terrain. The overall view is from an elevated perspective, looking down at the seabed.

Steinbitryggen

Steinbitryggen –
100 m high og
nearly 40 km
long

Glaciotectonic
feature



The "Sponge Hole"



Source: MAREANO/IMR

The "Catfish Ridge"



Bear Island slide, with unique corals and Medusa head



International trends...

Ireland – INSS
and InfoMar

UK - MareMap

France – 12 000
km² LIDAR

Spain - coastal



Conclusions

- MAREANO – part of government ocean management strategy, and the high North strategy
- Budget 2012 – 11 Mill. Euro
- 15 000 km² pr. year
- Integrated mapping is the key for new insights
- High quality in all parts of the chain important
- Future – more detail, faster data acquisition
- Very valuable ecosystems in specific areas
- Continues in the Norwegian Sea and the Barents Sea
- AUV's – a new important platform for data collection?