SEEP

Seabed conditions for platform abandonment

Seabed baseline conditions for platform abandonment

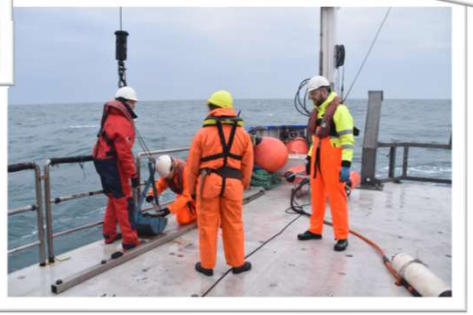
Lasse Tésik Prins[1], Paul Knutz[1], Bodil W. Lauridsen[2] , Ole Rønø Clausen[3], Katrine Juul Andresen[3] and Hans Røy[4]

[1]Marine Geology Department, GEUS

[2]Department of Geoenergy and –storage, GEUS

[3]Department of Geoscience, University of Aarhus

[4]Department of Biology, Microbiology University of Aarhus

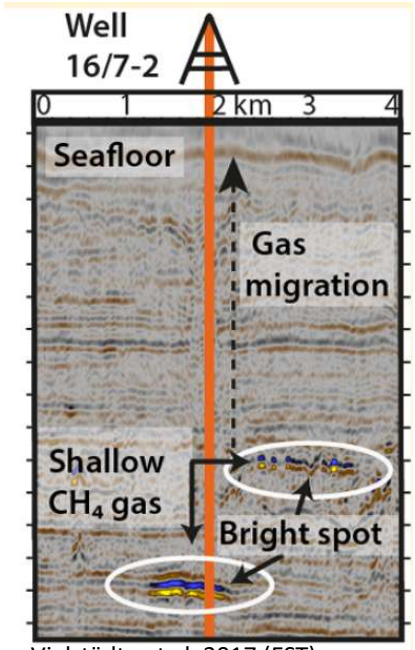


DTU

DTU Offshore
Danish Offshore Technology Centre

Motivation

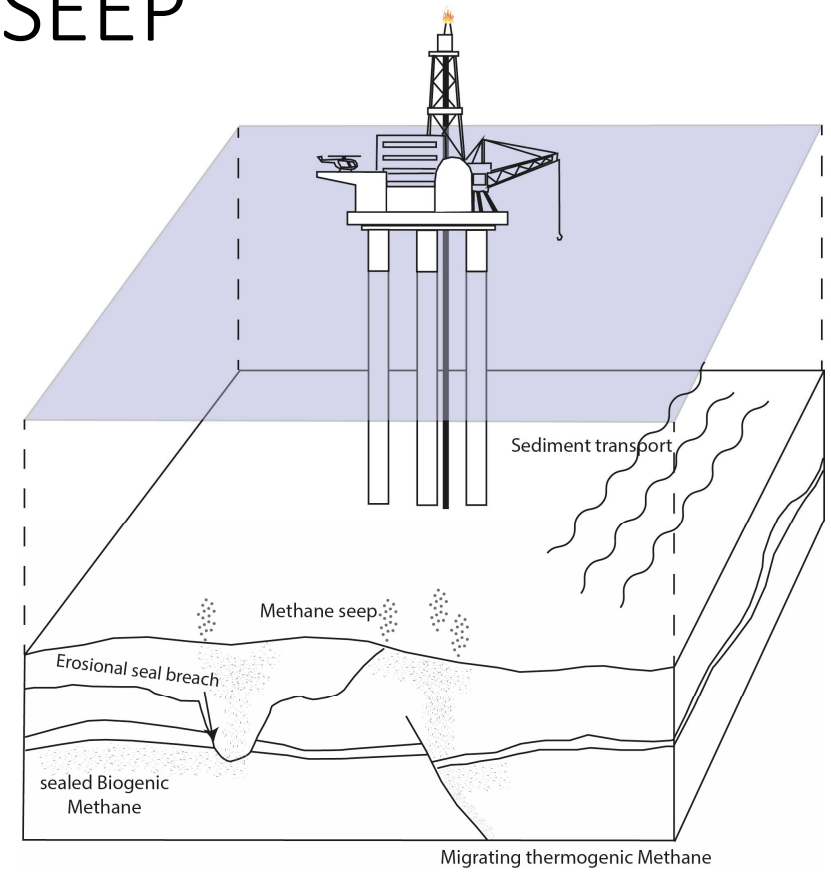
- Drilling and HC production changes the fluid dynamics in the overburden
- HC Wells may leak methane to the seafloor, but there is natural seepage that disturbs the image
- Distinguishing between anthropogenic and natural seepage is critical in relation to abandonment

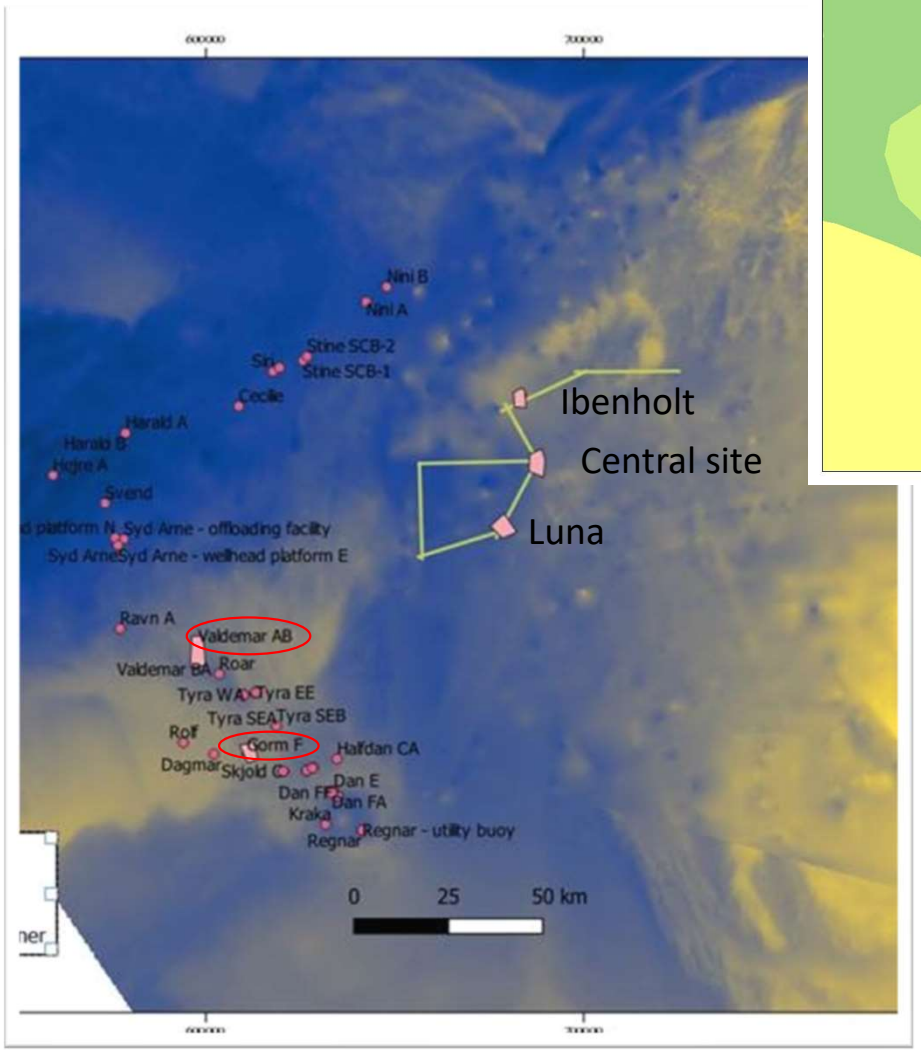


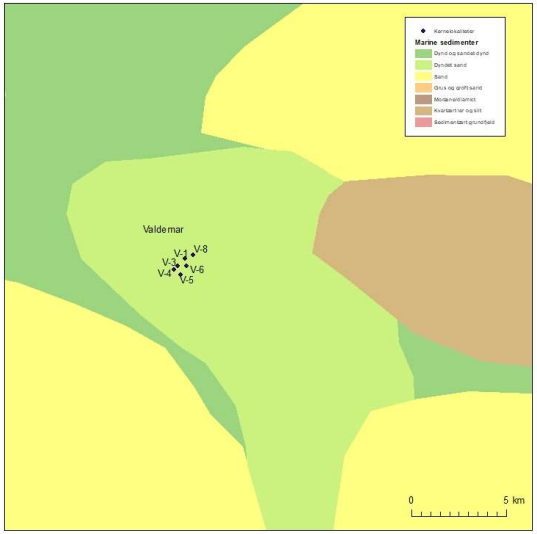
Vielstädte et al. 2017 (EST)

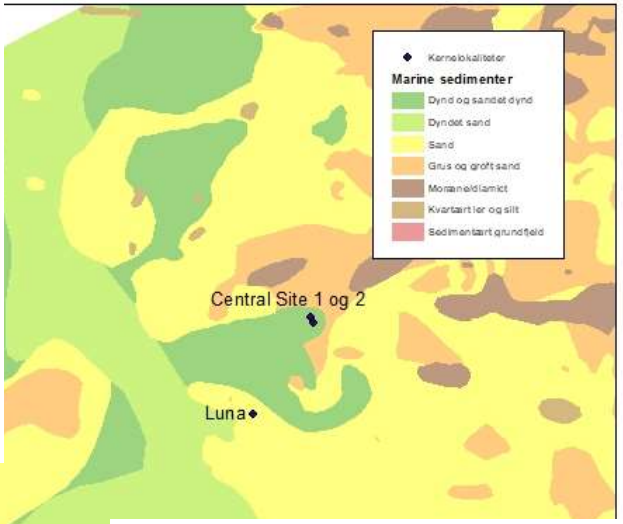
Building a SEabed Environmental baseline for Platform abandonment - SEEP

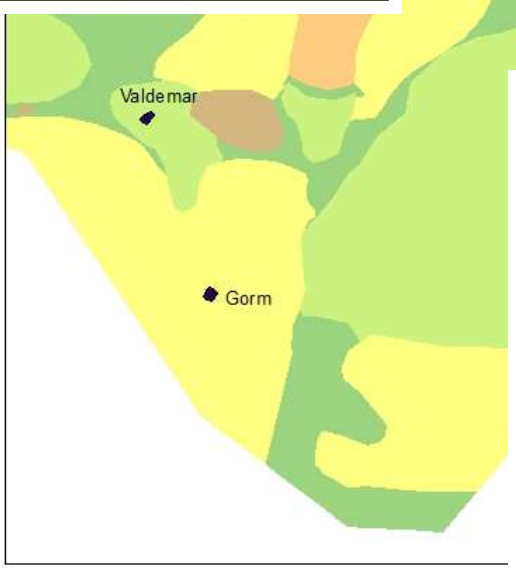
- Baseline conditions – A geological model
  - Pre-production – outside the central graben
  - Syn/post-production – within the central graben
- Focus on methane seepage
  - Thermogenic or biogenic
  - Production related or natural occurrence
  - Identification of fluid migration paths

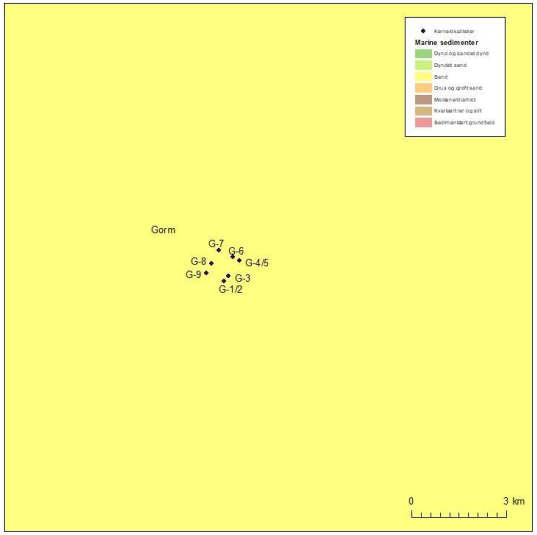



Nini B
Nini A
Stine SCB-2
Stine SCB-1
Cecilie
Harald A
Harald B
Svend
Syd Arne - offloading facility
Syd Arne - wellhead platform E
Ravn A
Valdemar AB
Valdemar BA
Roar
Tyra WA
Tyra EE
Tyra SEA
Tyra SEB
Rolf
Gorm F
Halfdan CA
Dagmar
Skjold
Dan E
Dan FA
Kraka
Regnar - utility buoy
Regnar
0
25
50 km
Ibenholt
Central site
Luna


Kernelokaliteter
Marine sedimenter
Dynd og sandet dynd
Dyndet sand
Sand
Grus og grovt sand
Morænelerjamict
Kvartærlir og silt
Sedimentært grundfjeld
Valdemar
V-1
V-2
V-3
V-4
V-5
V-6
V-8
0
5 km


Kernelokaliteter
Marine sedimenter
Dynd og sandet dynd
Dyndet sand
Sand
Grus og grovt sand
Morænelerjamict
Kvartærlir og silt
Sedimentært grundfjeld
Central Site 1 og 2
Luna

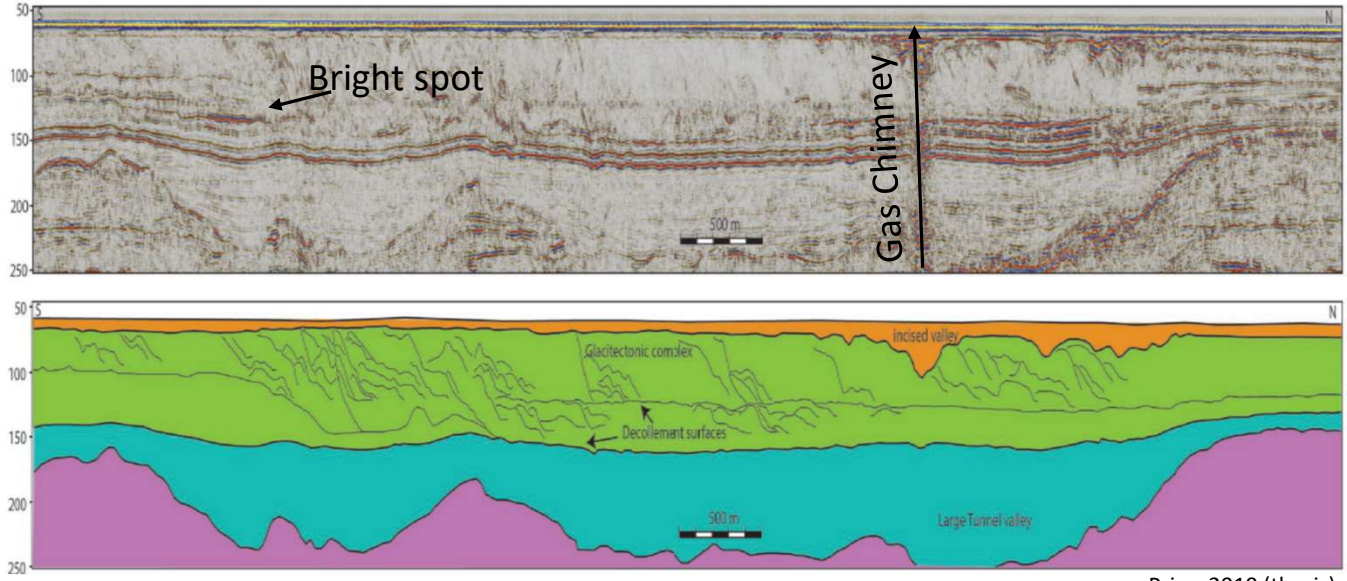

Valdemar
Gorm


Kernelokaliteter
Marine sedimenter
Dynd og sandet dynd
Dyndet sand
Sand
Grus og grovt sand
Morænelerjamict
Kvartærlir og silt
Sedimentært grundfjeld
Gorm
G-7
G-6
G-8
G-4/5
G-9
G-3
G-1/2
0
3 km

Shallow subsurface

- Highly heterogenous
- Sedimentation controlled by rapidly changing climate and sea levels
- Contains potential geohazards
- May facilitate or inhibit natural methane leakage

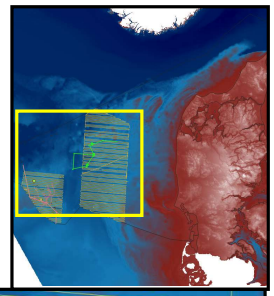
Data from the Danish Central Graben area

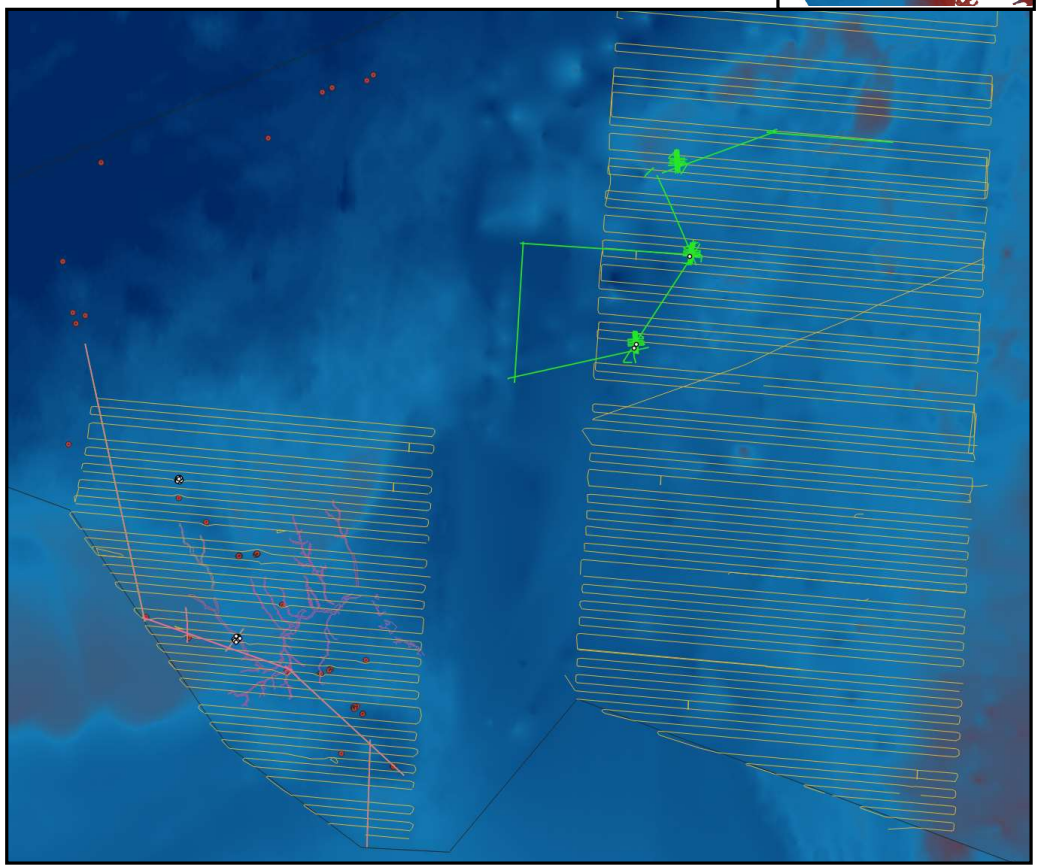


Prins. 2019 (thesis)

Geophysical Data – Cruise March and June

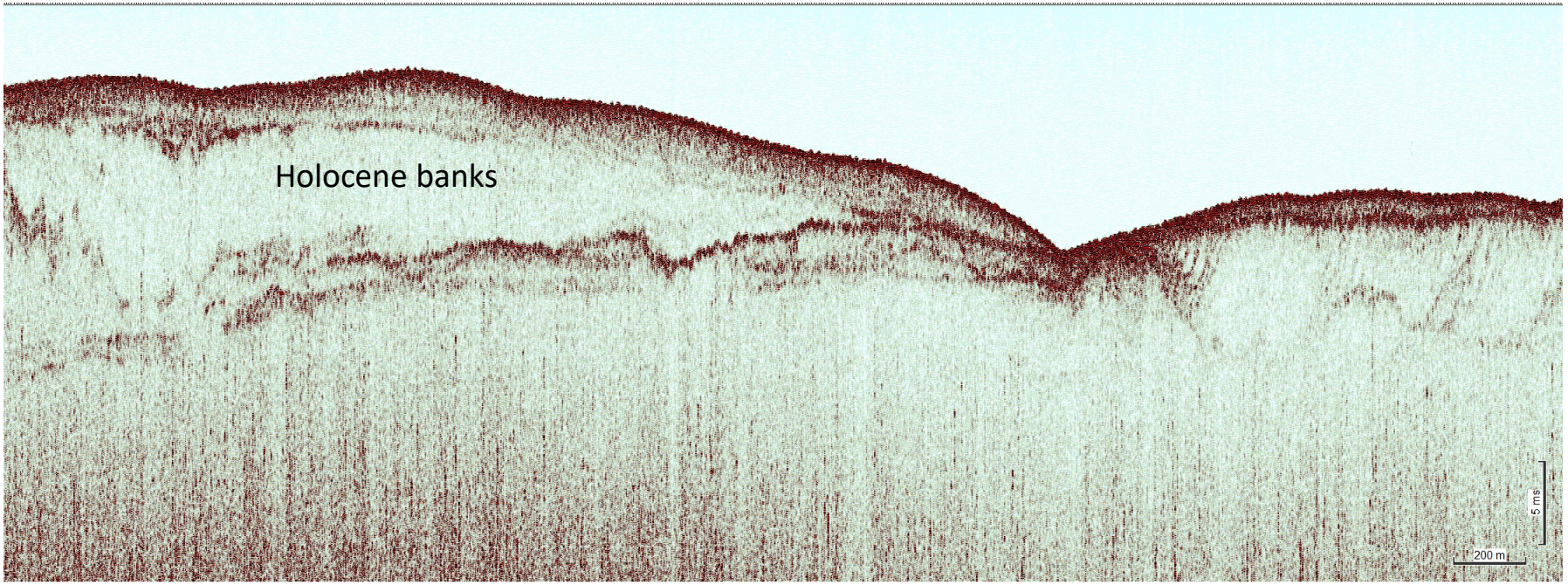
- Multibeam Bathymetry
  - Seabed morphology
  - Identification of gas seeps
- Sub-bottom Profiler
  - Holocene geology
  - Shallow gas
- Ultra-high resolution Seismic
  - Quaternary stratigraphy and geomorphology
  - Fluid migration paths
  - Neotectonic activity
- Vintage industry seismic
  - Mapping potential pathways and shallow gas in the overburden





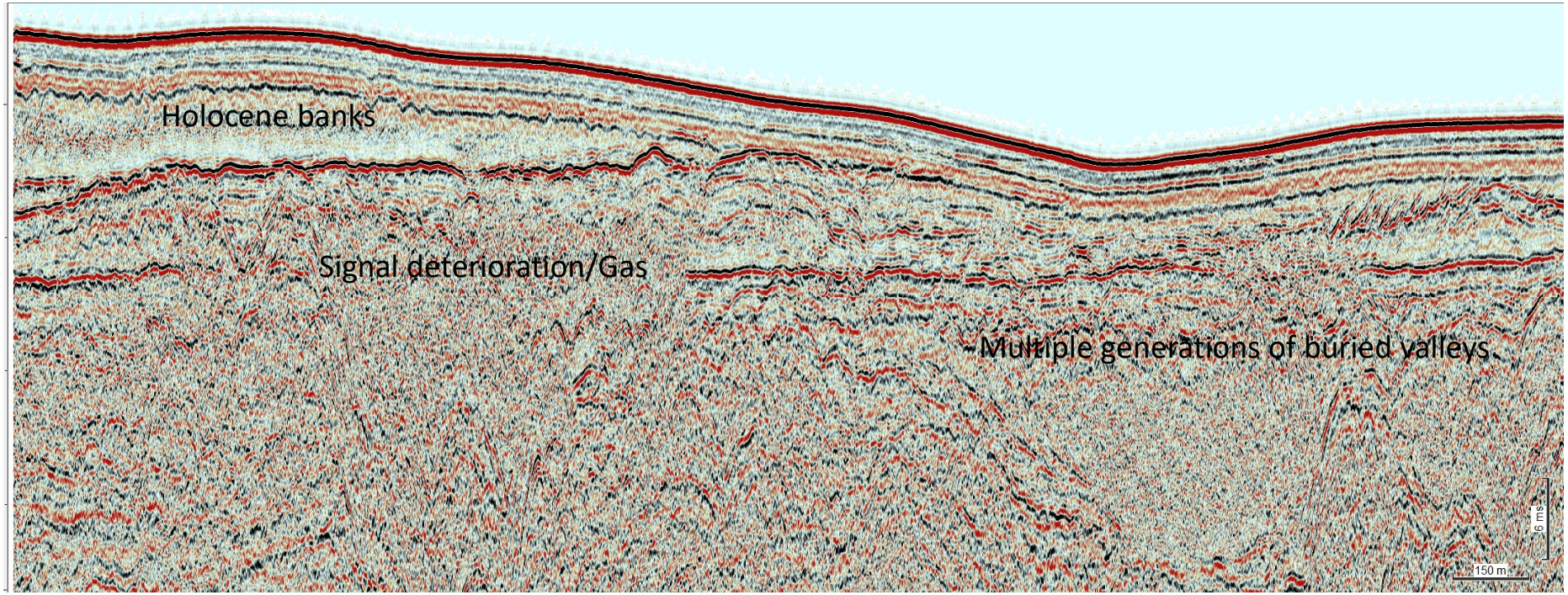
Examples of seismic data

Sub-bottom Profiler data



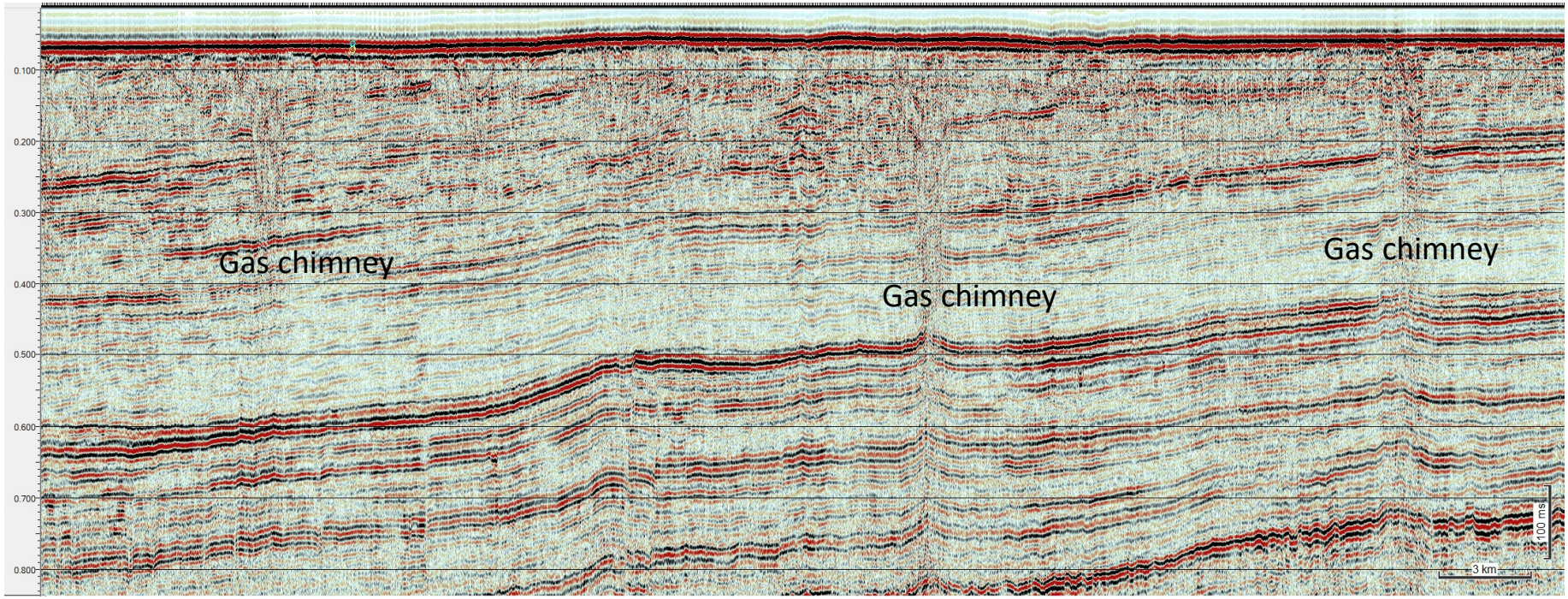
Examples of seismic data

UHR-Seismic data



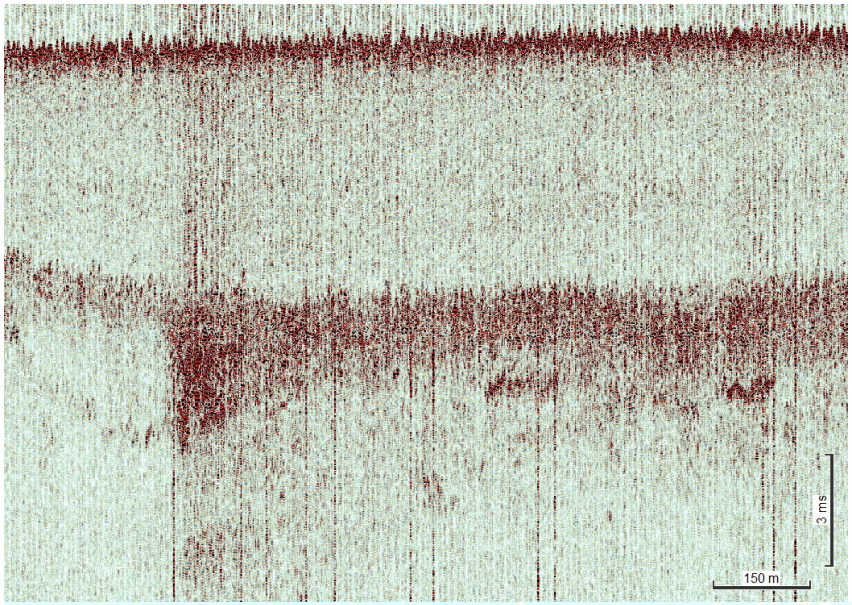
Examples of seismic data

Vintage deep seismic data



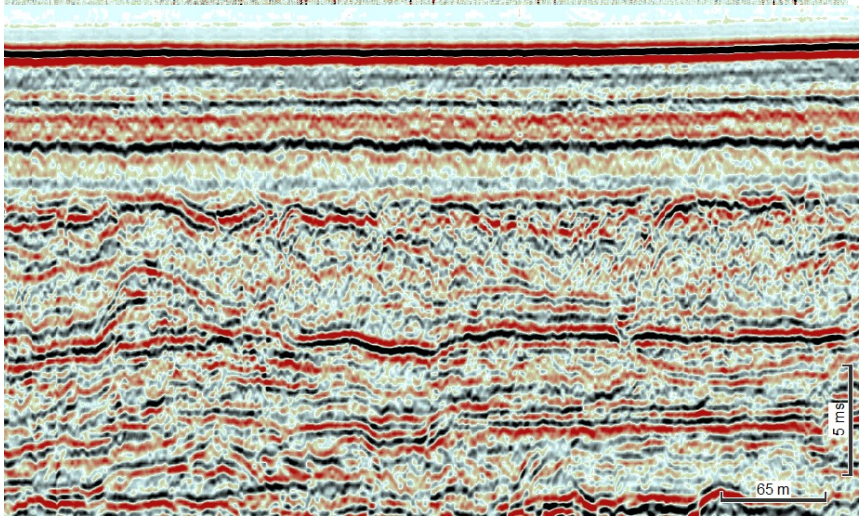
Holocene Unit - two examples

- Transparent
- High amplitude at the base



Innomar Data

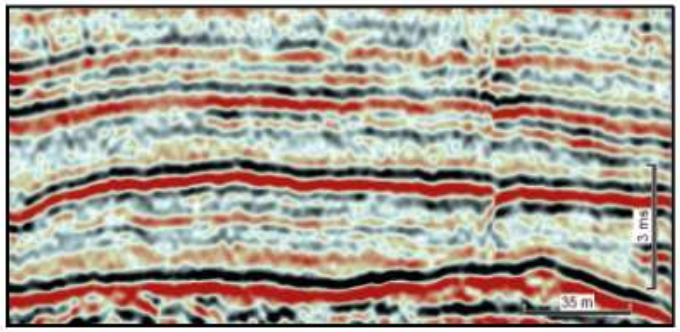
- Erosive base – transgression
- Internal structure masked by seabed pulse



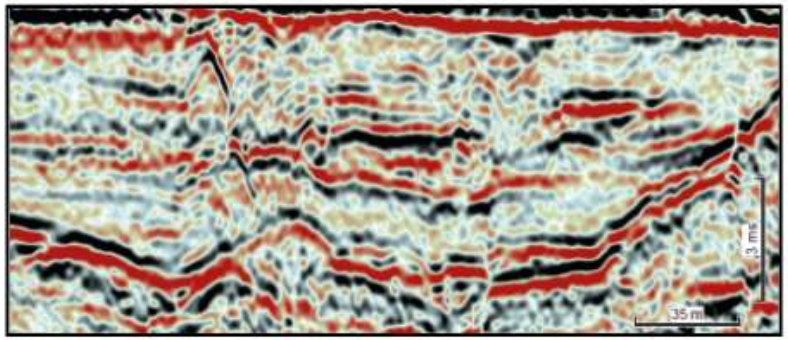
UHR sparker data

Seismic facies from units immedeatly beneath the holocene unit

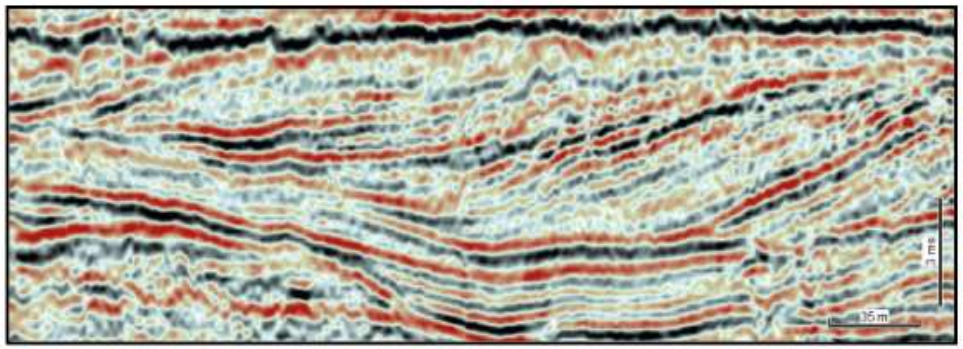
Well stratified, subparrallel reflections



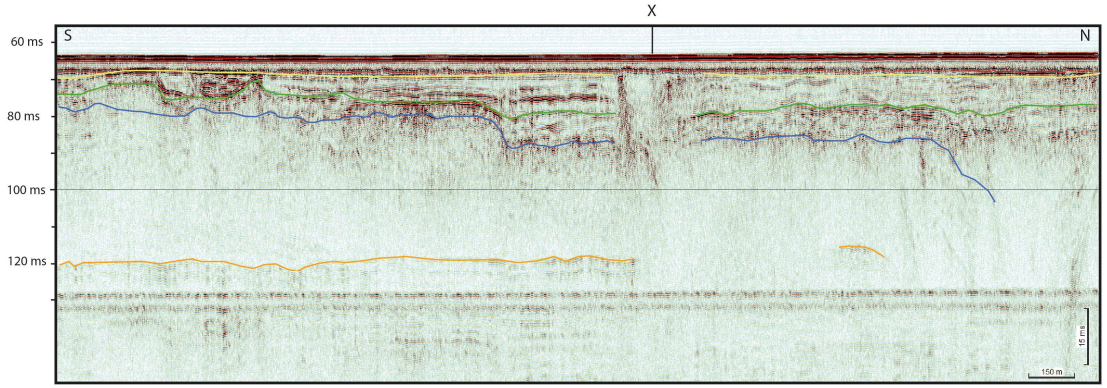
Local channel infill, parrallel reflections
Varying intesity

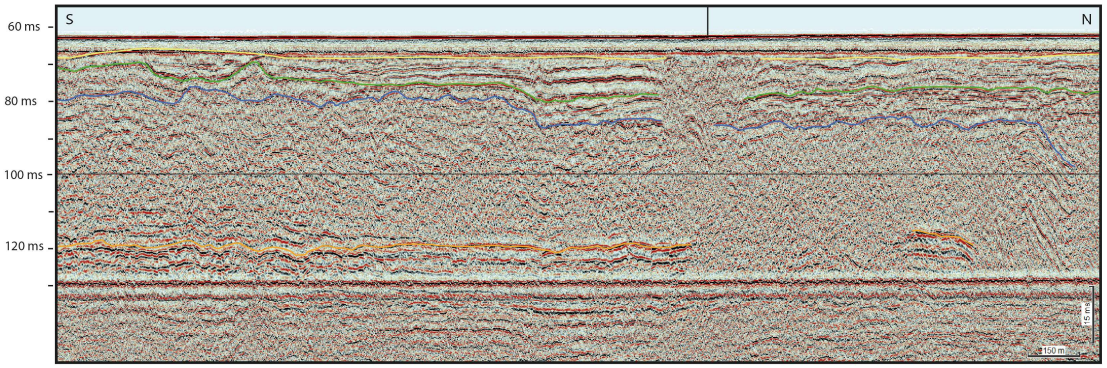


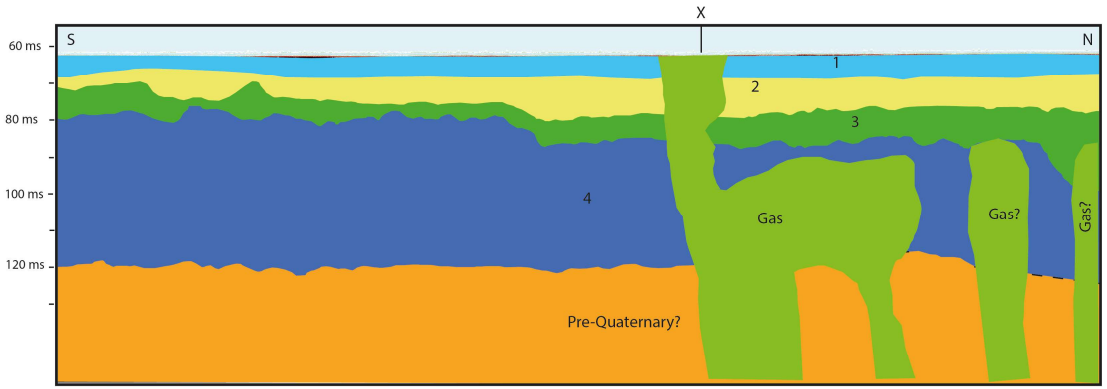
Shingled reflections
downlap, good reflection continuity

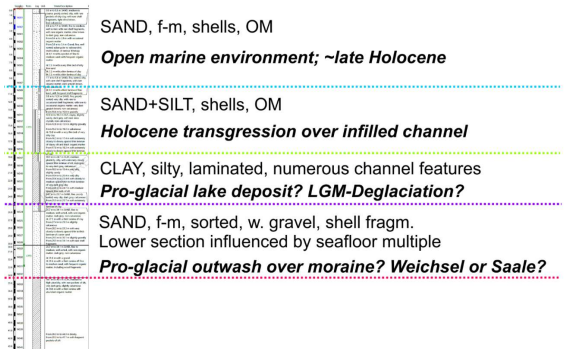


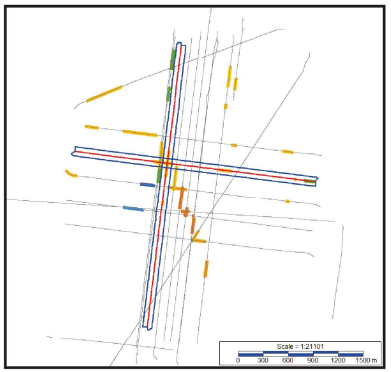
Examples of seismic data



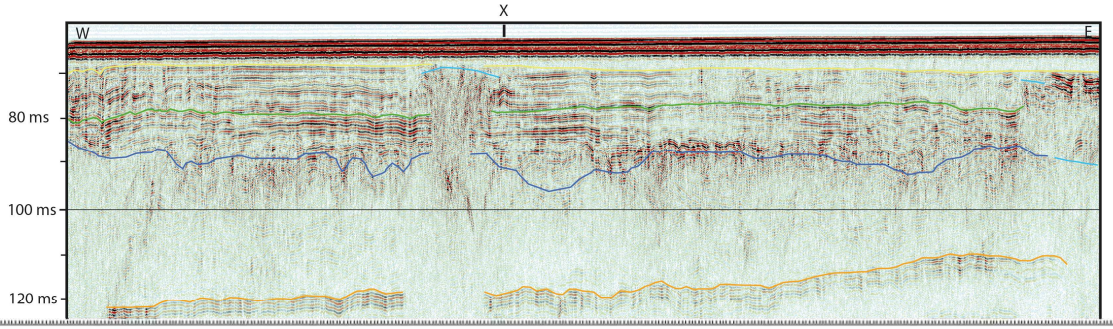


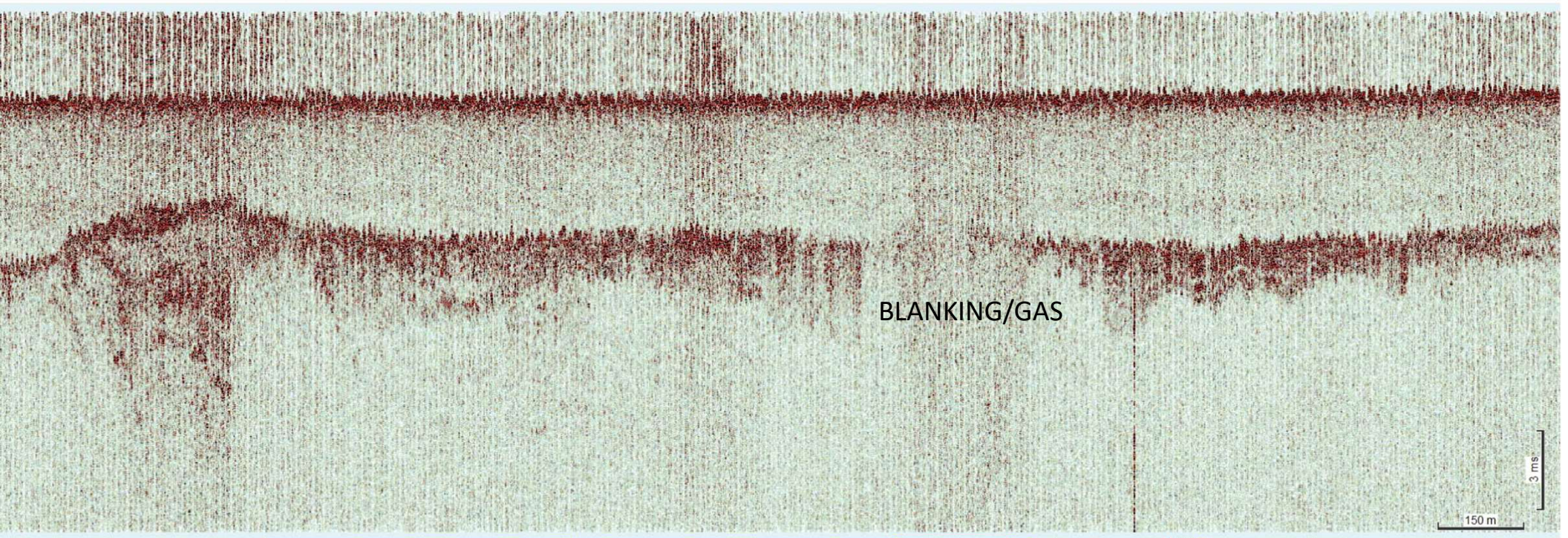


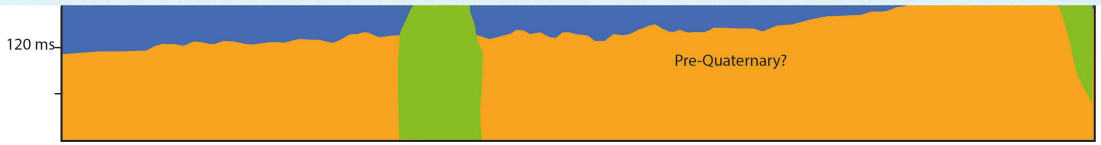


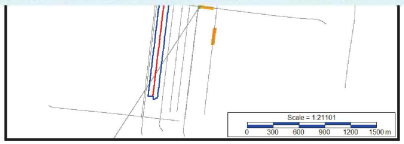


Examples of seismic data



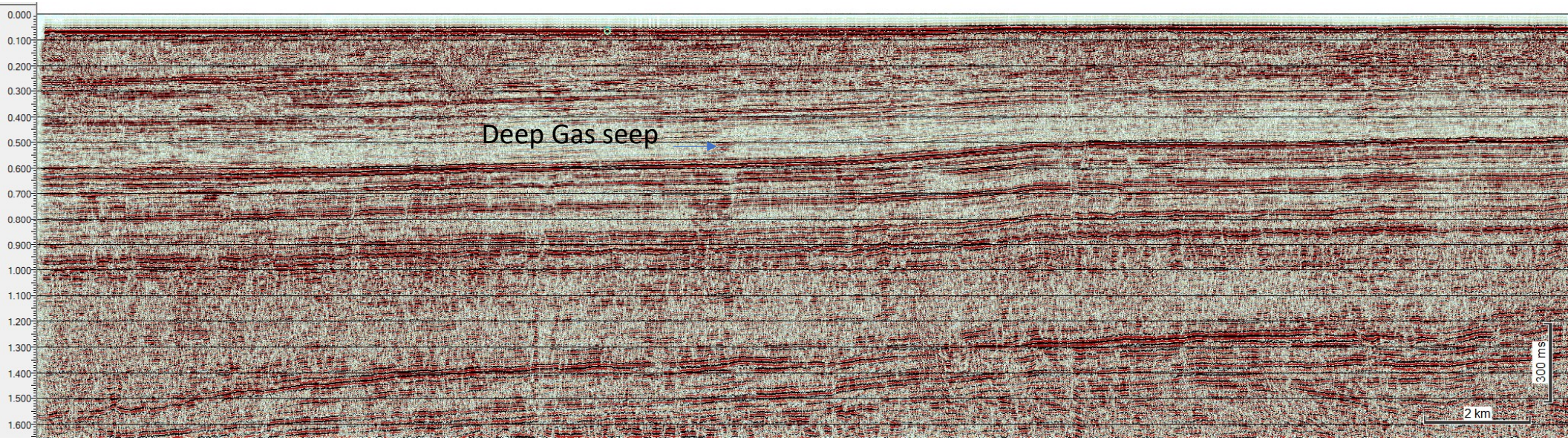


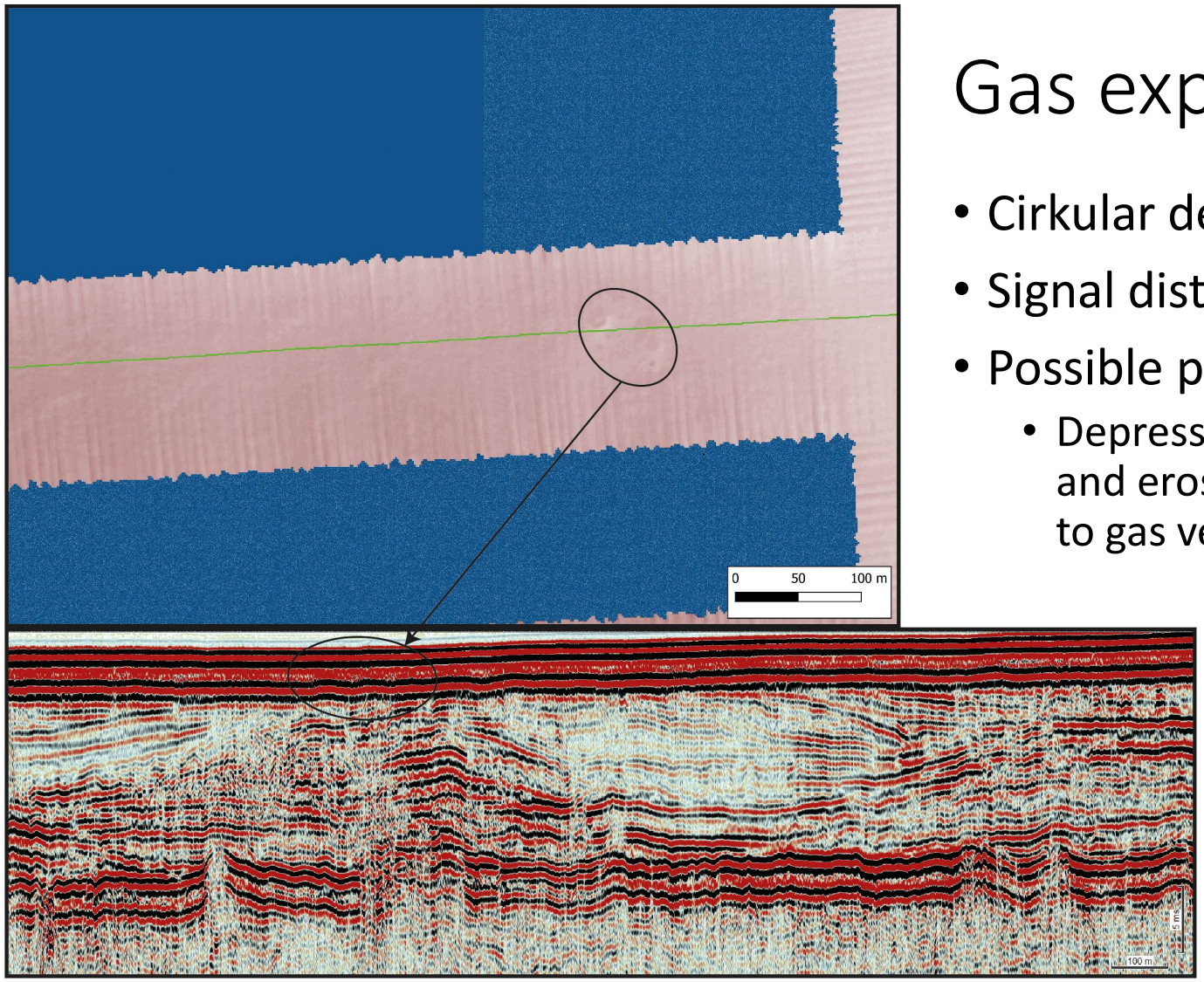




Examples of seismic data

Vintage deep seismic data



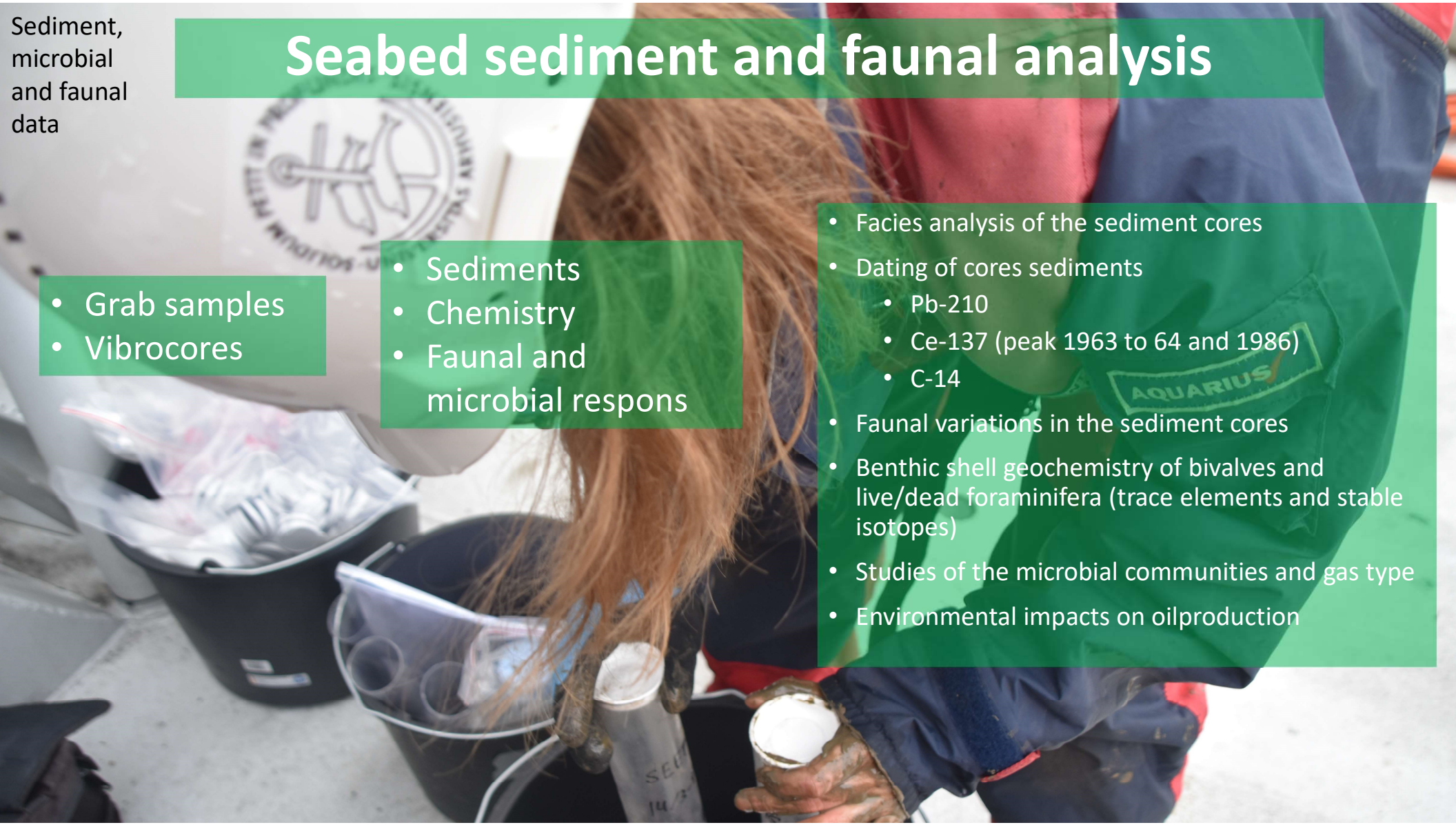


Gas expression on MBES

- Cirkular depression on the seafloor
- Signal disturbance on seismic data
- Possible pockmark formation
  - Depressions caused by fluidization and erosion of seabed sediment due to gas venting

Sediment, microbial and faunal data

Seabed sediment and faunal analysis



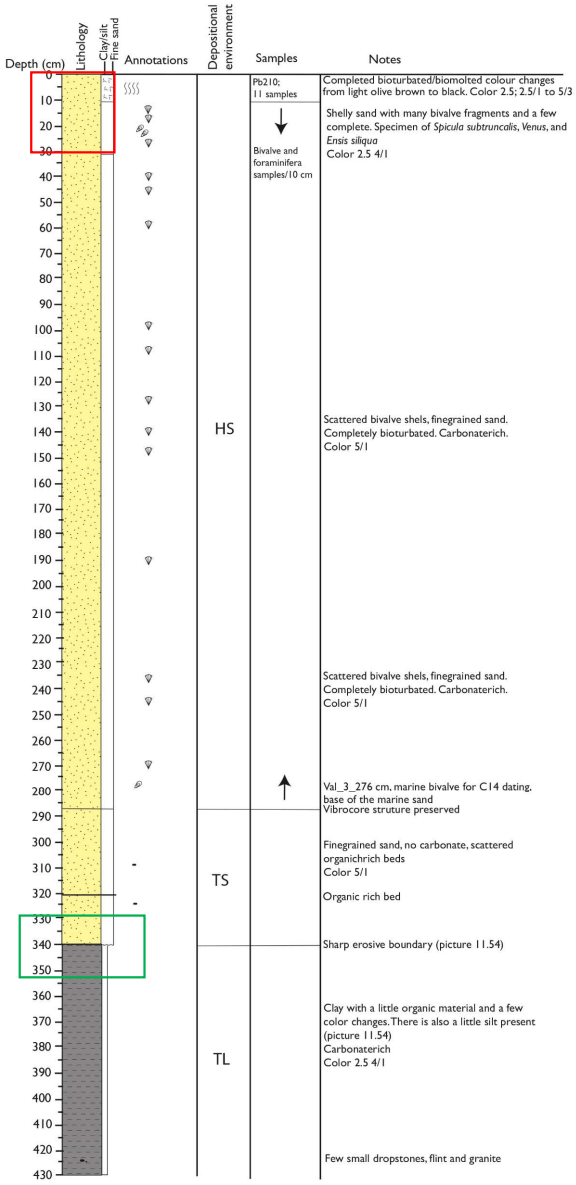
- Grab samples
- Vibrocores

- Sediments
- Chemistry
- Faunal and microbial respons

- Facies analysis of the sediment cores
- Dating of cores sediments
  - Pb-210
  - Ce-137 (peak 1963 to 64 and 1986)
  - C-14
- Faunal variations in the sediment cores
- Benthic shell geochemistry of bivalves and live/dead foraminifera (trace elements and stable isotopes)
- Studies of the microbial communities and gas type
- Environmental impacts on oilproduction

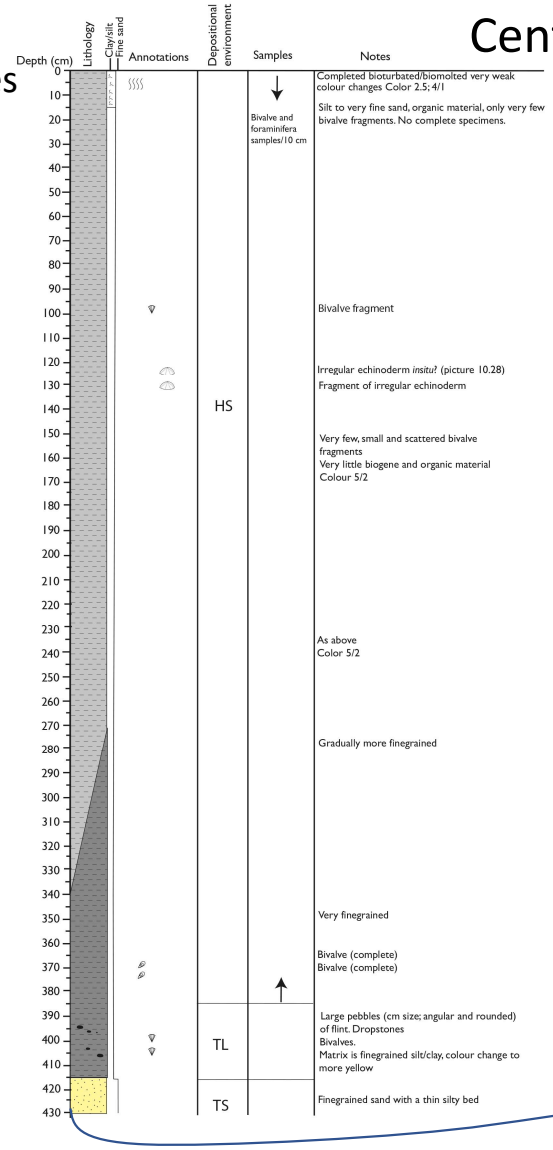
Examples of sediment cores

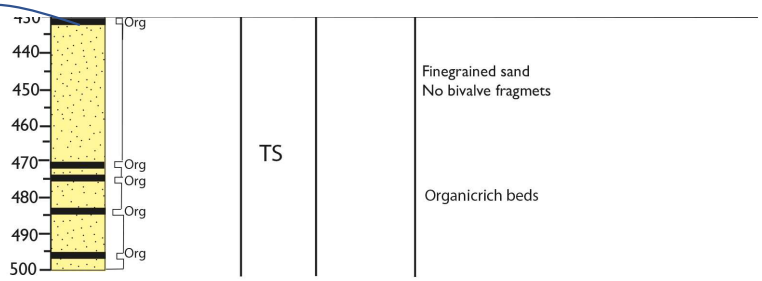
Valdemar-3; production



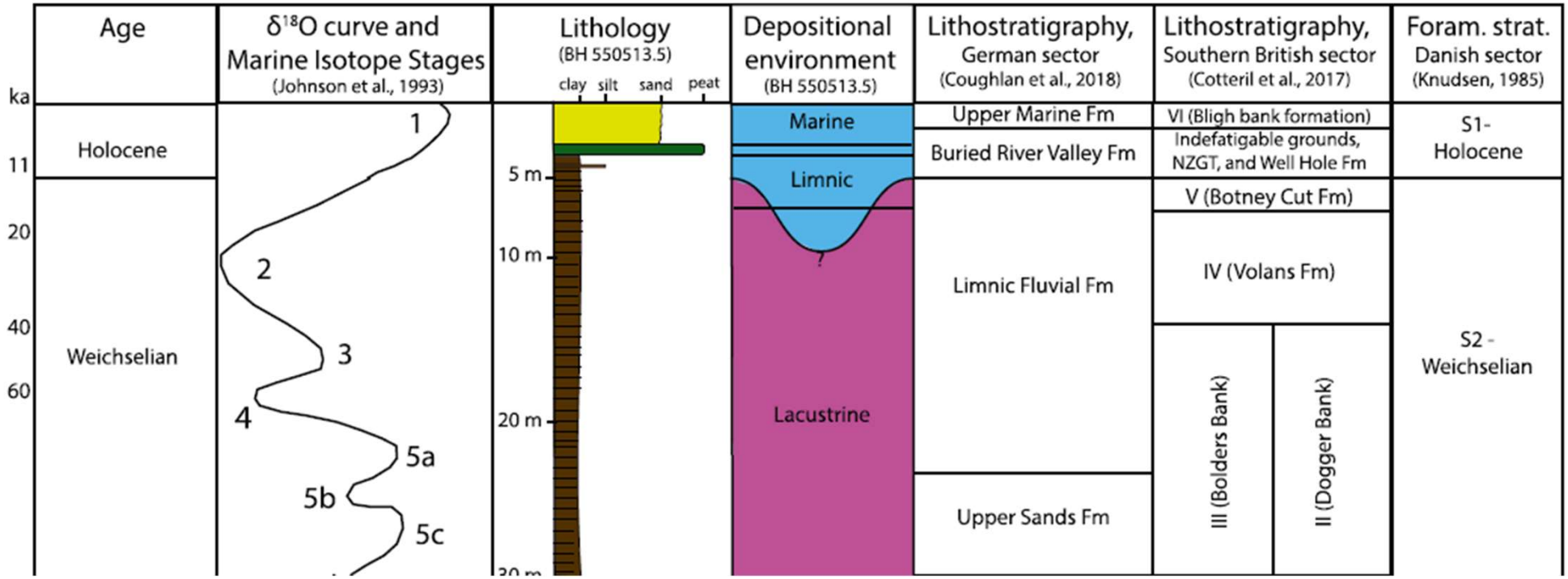
Examples of sediment cores

Central Site-2, no installations





Intepretations of geological ages and depositional environments

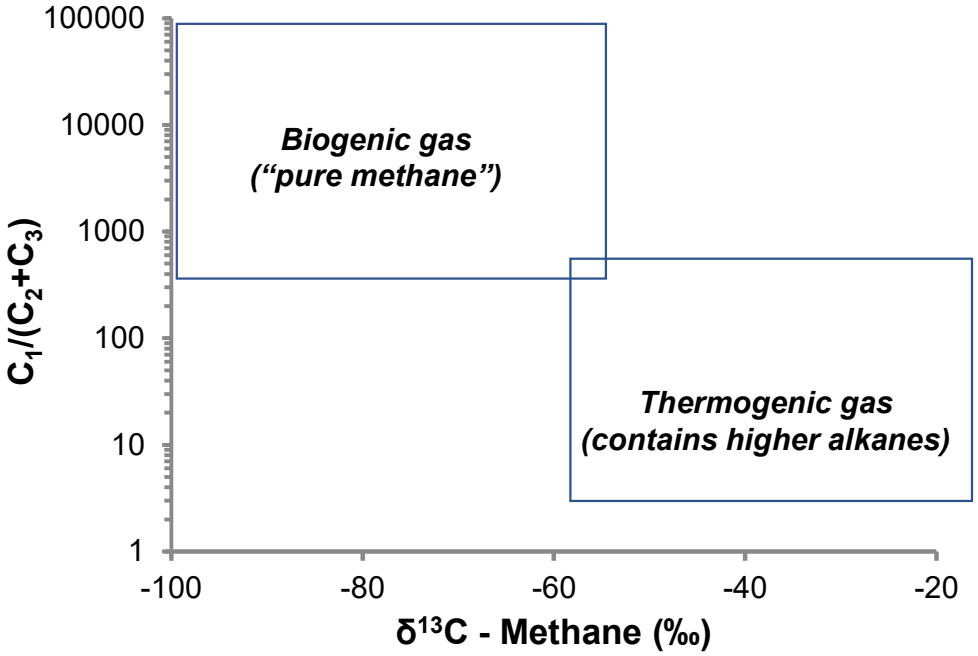


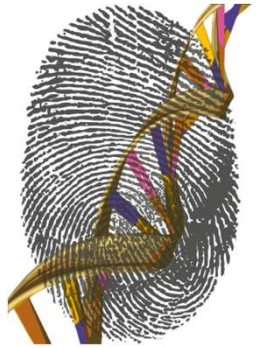
Prins and Andresen, 2019

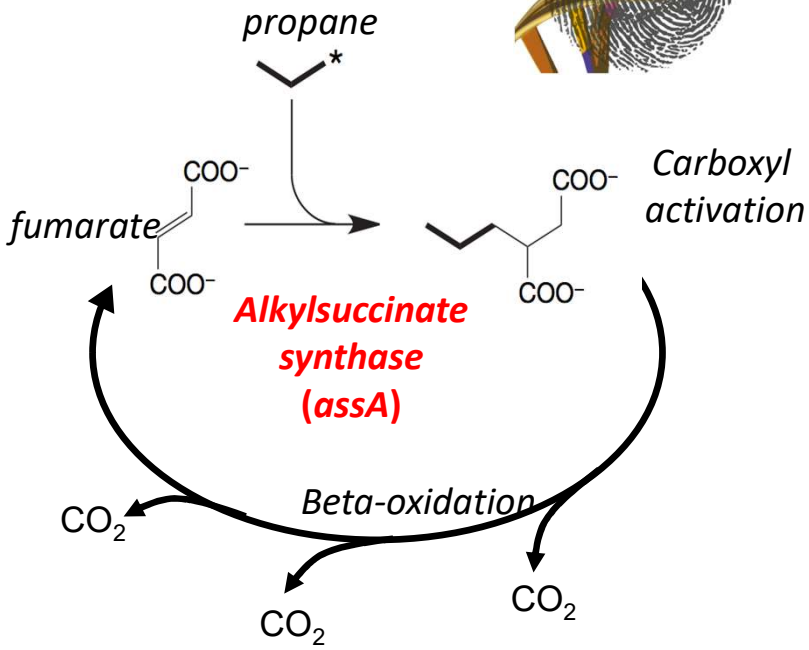
Microbes and gases

What gasses are there? How much? What is the isotopic composition? Which gas-eating bacteria are present and how many?

What is the pattern in pristine seabed, natural seeps, and exploration sites?

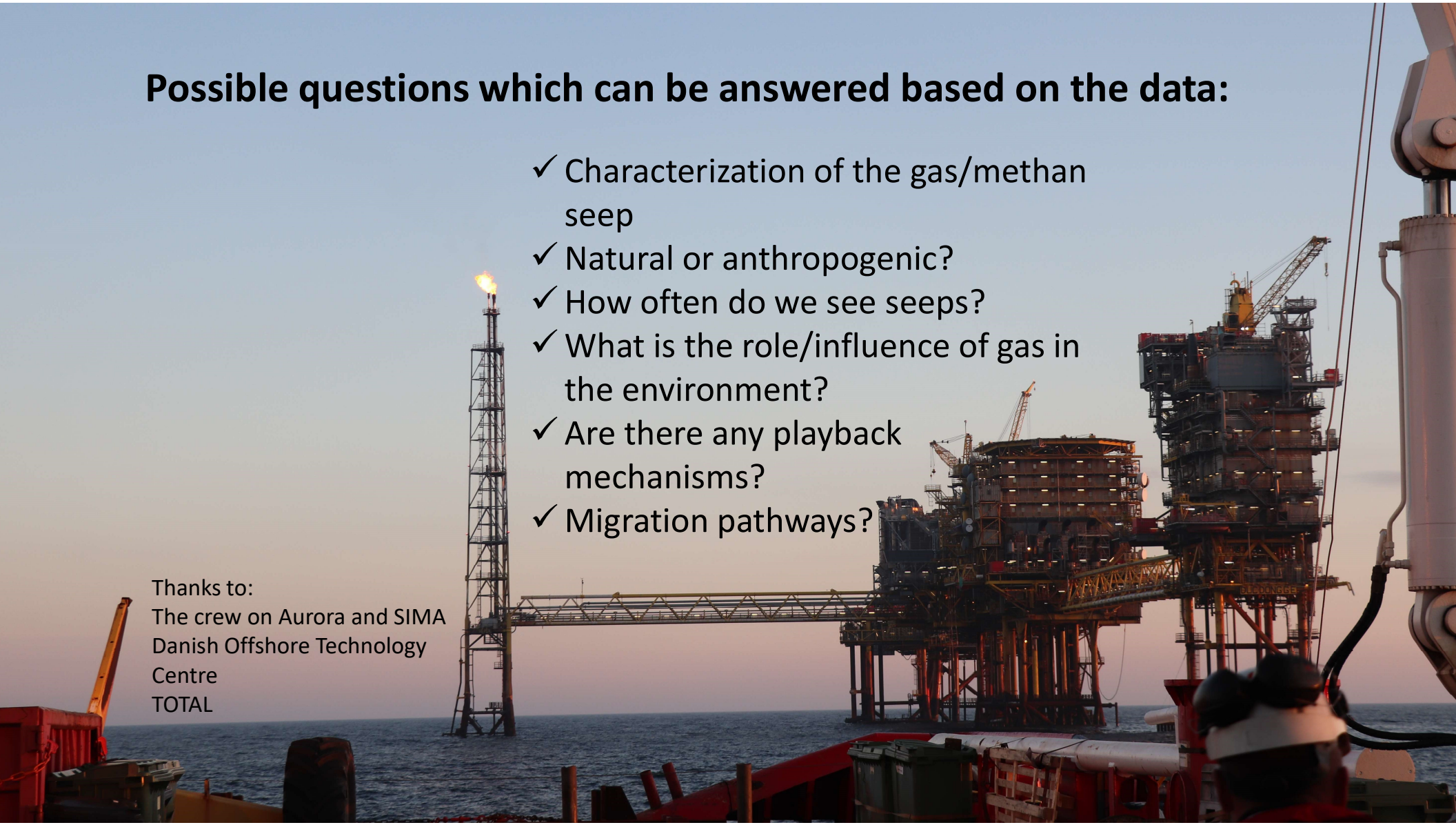






Possible questions which can be answered based on the data:

- ✓ Characterization of the gas/methan seep
- ✓ Natural or anthropogenic?
- ✓ How often do we see seeps?
- ✓ What is the role/influence of gas in the environment?
- ✓ Are there any playback mechanisms?
- ✓ Migration pathways?



Thanks to:
The crew on Aurora and SIMA
Danish Offshore Technology Centre
TOTAL