

# SHALLOW GAS MAPPING ON NCS – FROM GEOLOGICAL UNDERSTANDING TO CLIMATE IMPACT

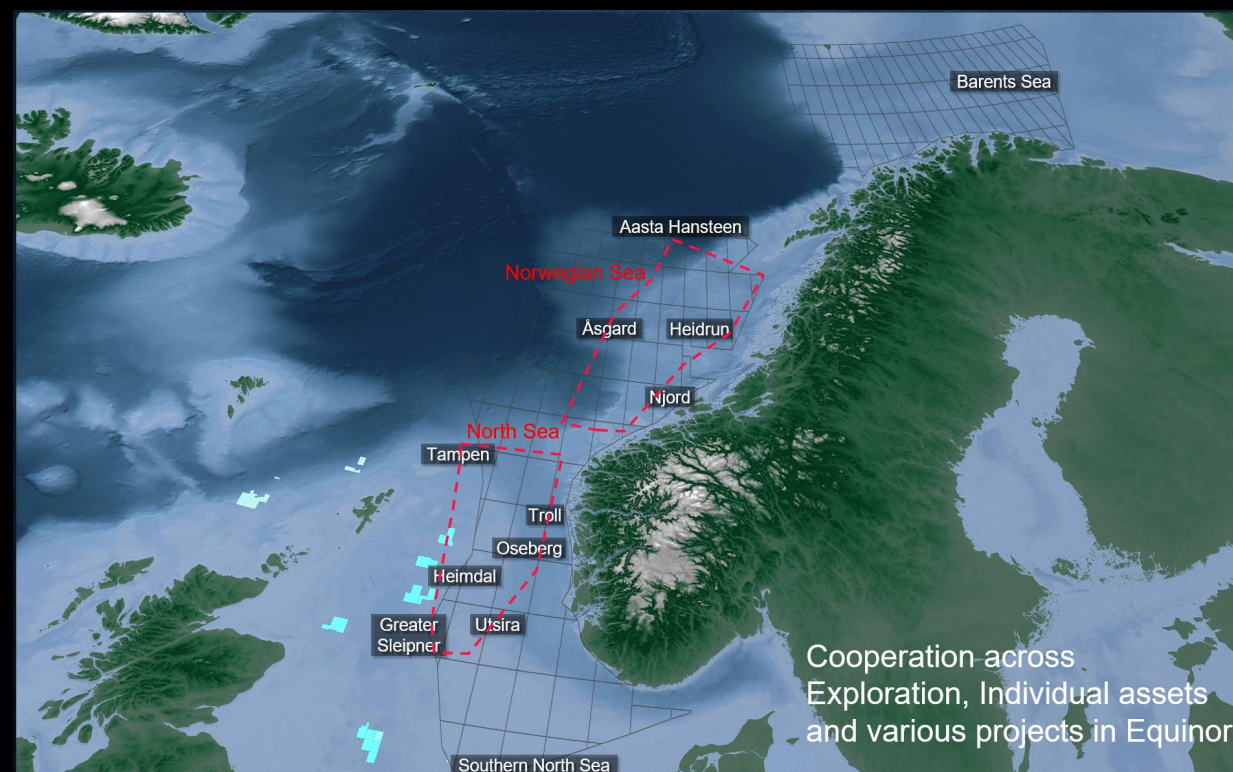
## (2019-2024)



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### Equinor Participants

- Reidar Helland (Project Lead)
- Frode Uriansrud (Sr Advisor Subsurface)
- Lars Petter Myhre (Advisor SSU)
- Sverre Henriksen (Specialist Geology)
- Magdalena-Oana Badescu (Geol/Geophys)
- Jon Basset (Geohazard)
- Nils Sørenes (Geohazard)
- Lucia Perez Belmonte (Geohazard)
- Jørgen Leknes (Geohazard)
- Ole-Marius Hafstad Solvang (Geohazard)

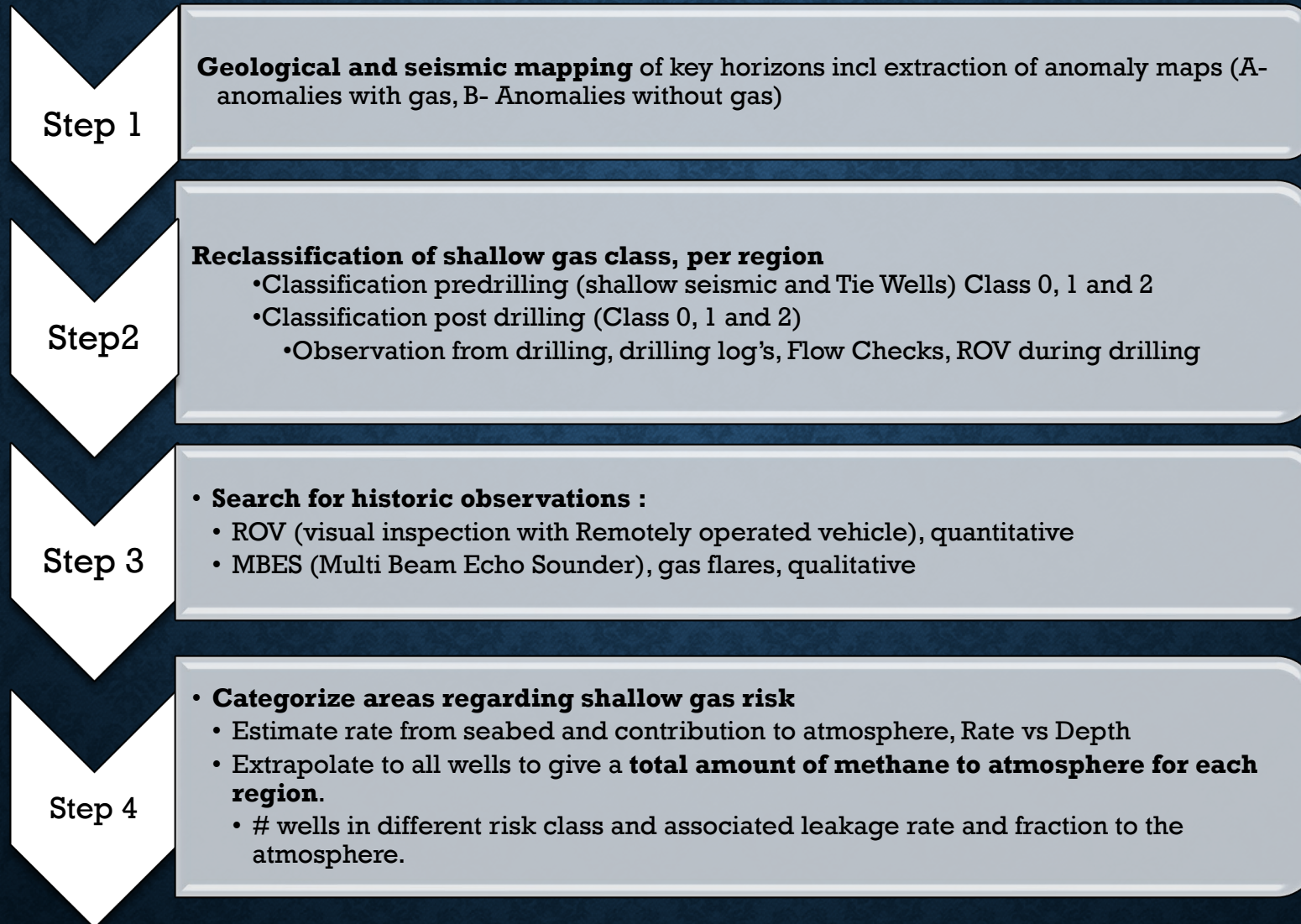


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1. Context
2. Project description
3. Documentation
4. Geological and geophysical mapping
5. Well data
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7. Seep mechanism from shallow gas layers
8. Summary



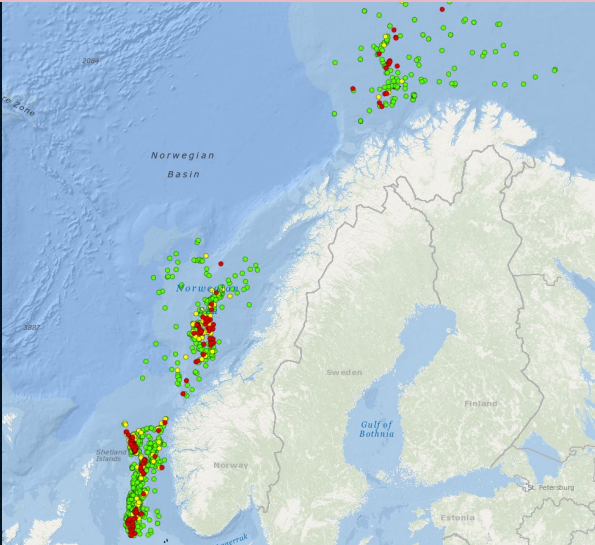
# Methane project workflow



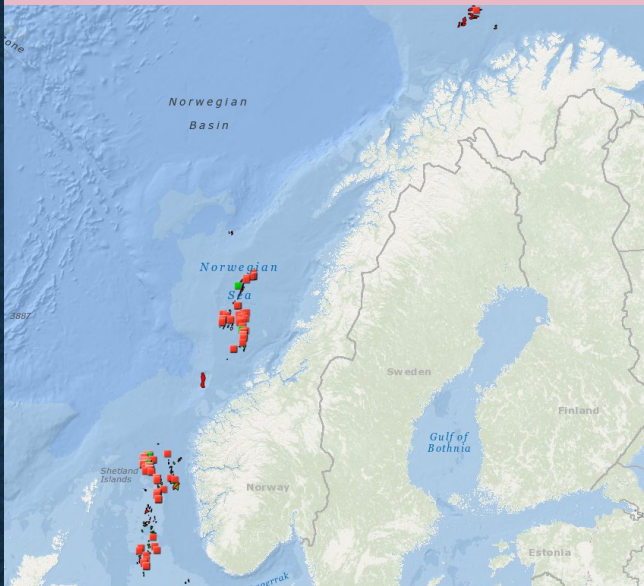


# Visualization and documentation (examples)

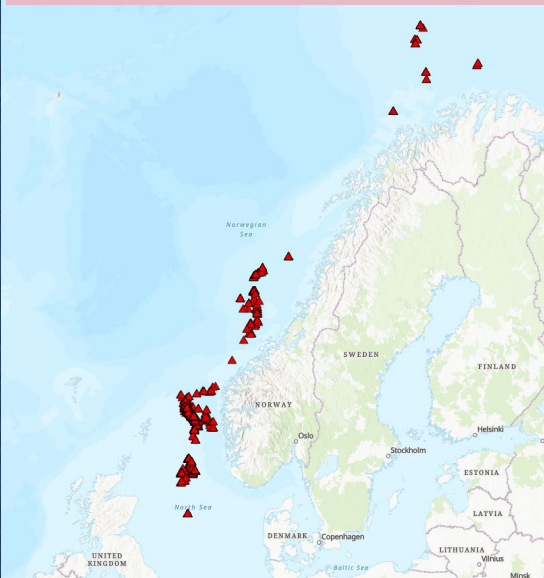
Well classification shallow gas – post drilling



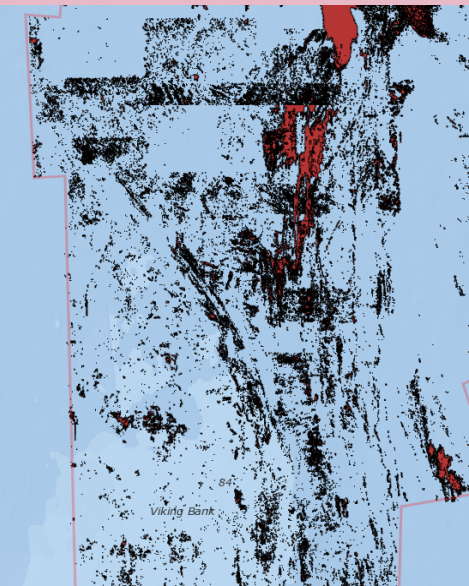
Visual observations ROV



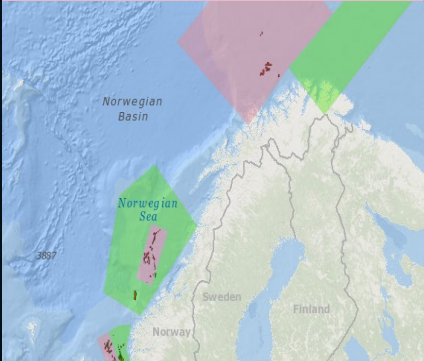
MBES Observations



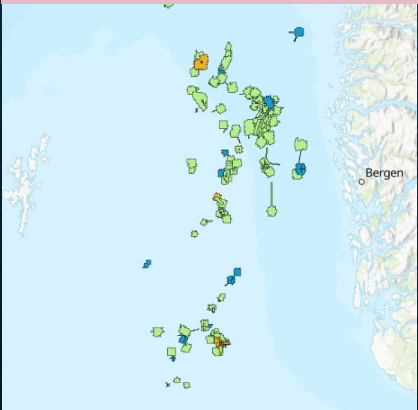
Seismic amplitudes



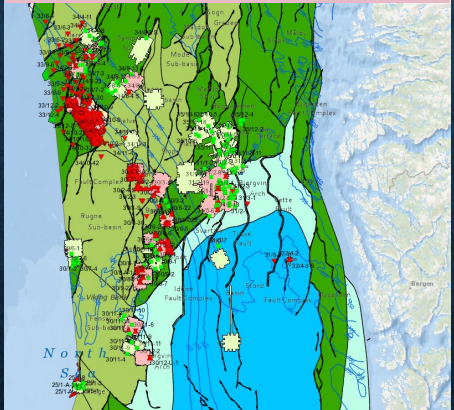
Risk areas - shallow gas



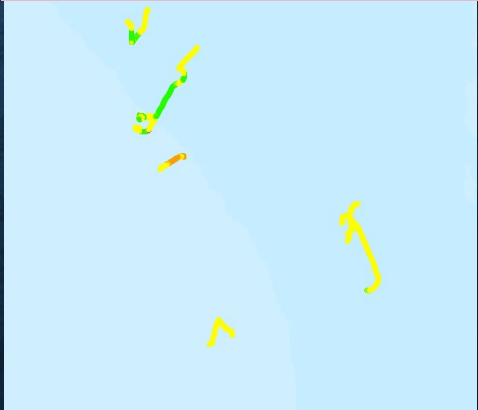
Data coverage MBES



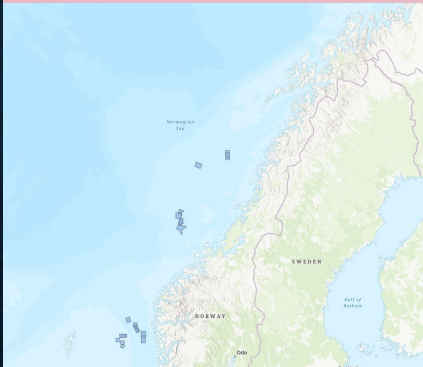
Geological mapping



Methane sensor data



Planned data acquisition



Methane:Introduction

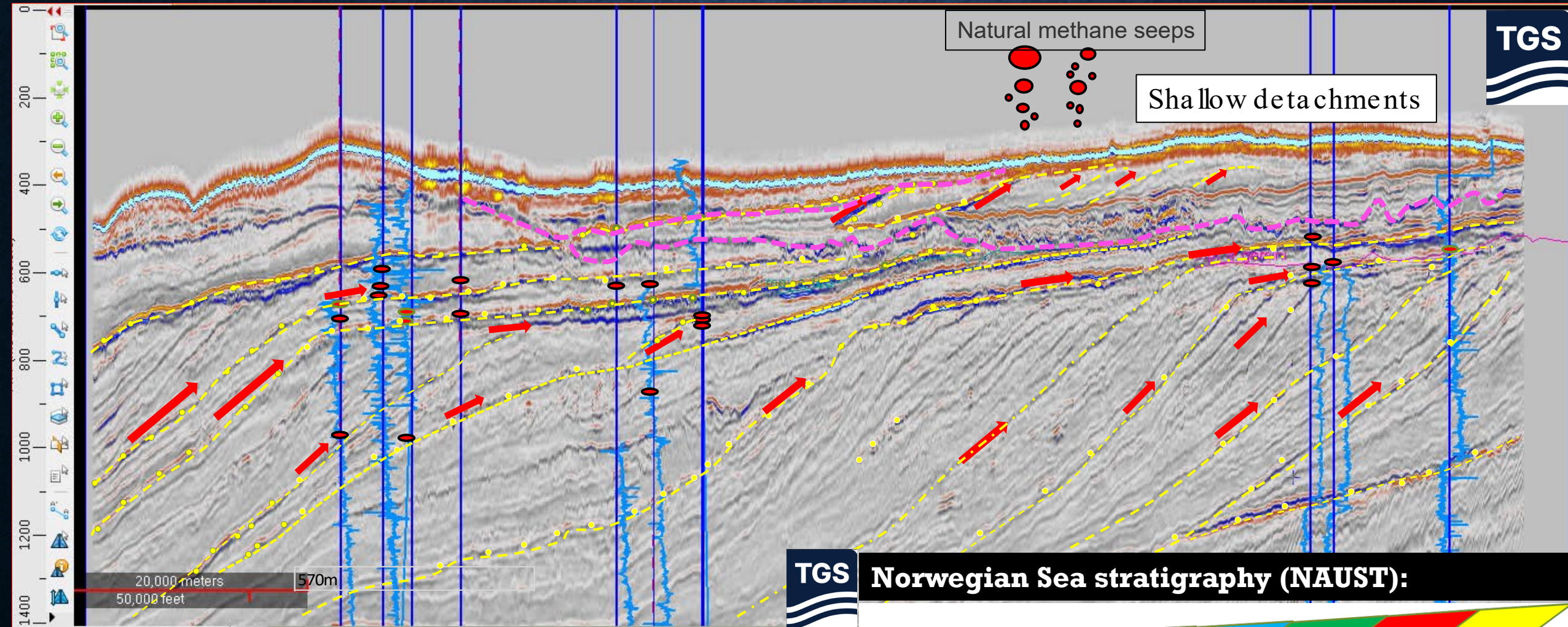
Introduction	Database	Seismic Evaluation	Post well shallow gas interpretation	Visual observation	Environmental impact	References	Recommendations
Executive summary				Glossary		Contacts	





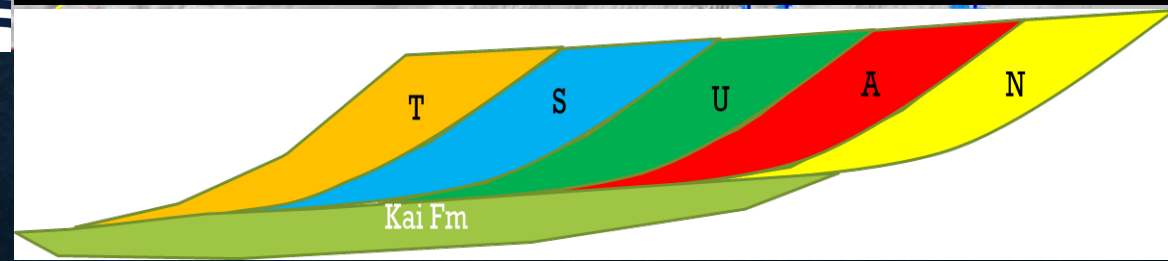


# NORWEGIAN SEA- NAUST details

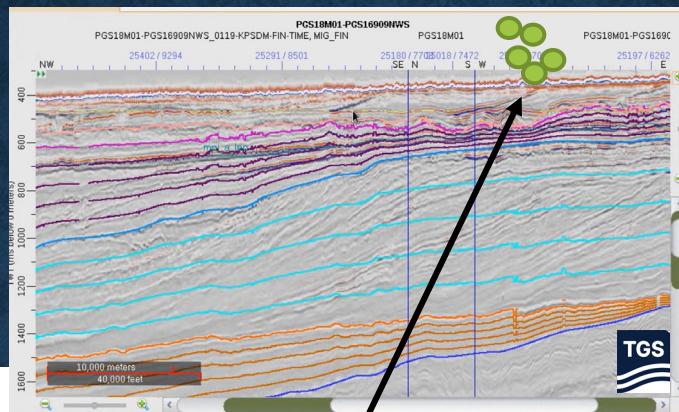
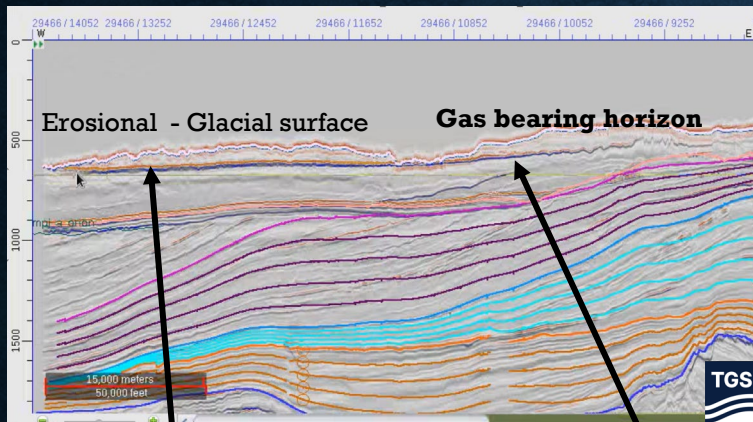


- Methane in well
- Sand (proven and predicted)
- ➔ Routes of migration

## Norwegian Sea stratigraphy (NAUST):

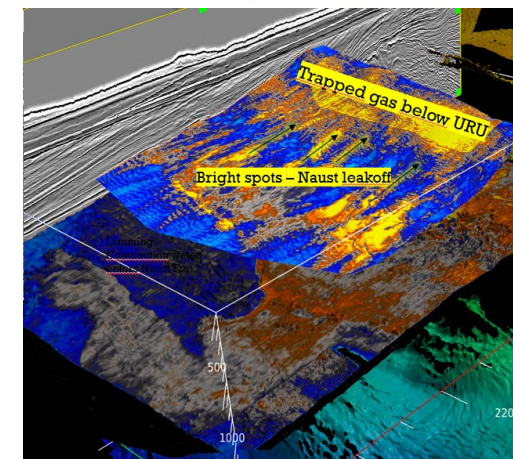
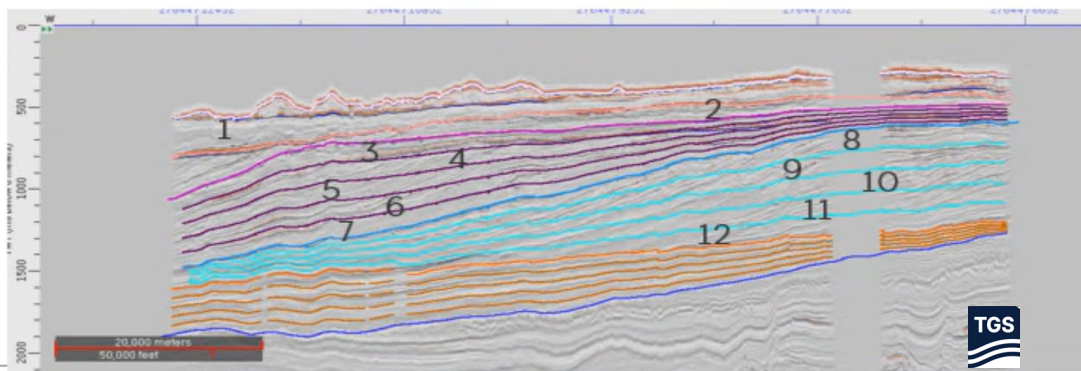
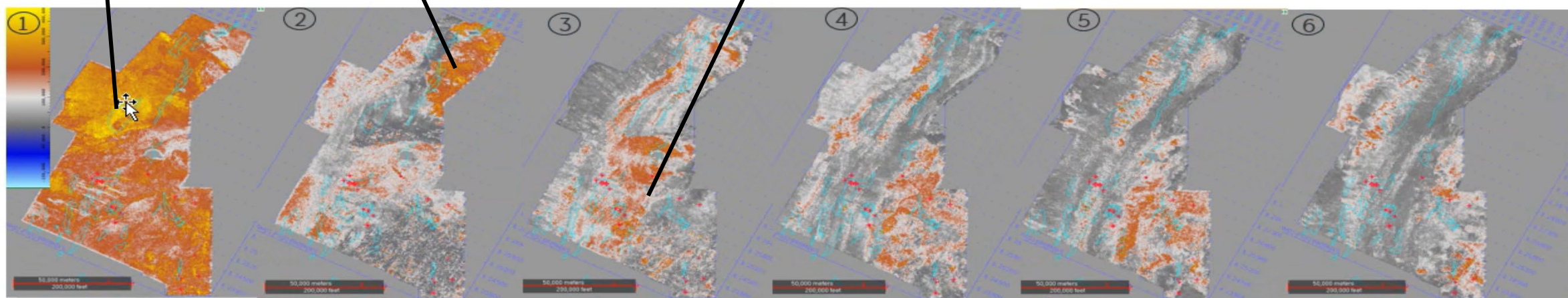






# Geological mapping Amplitudes – Naust Fm.

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# Northern North Sea

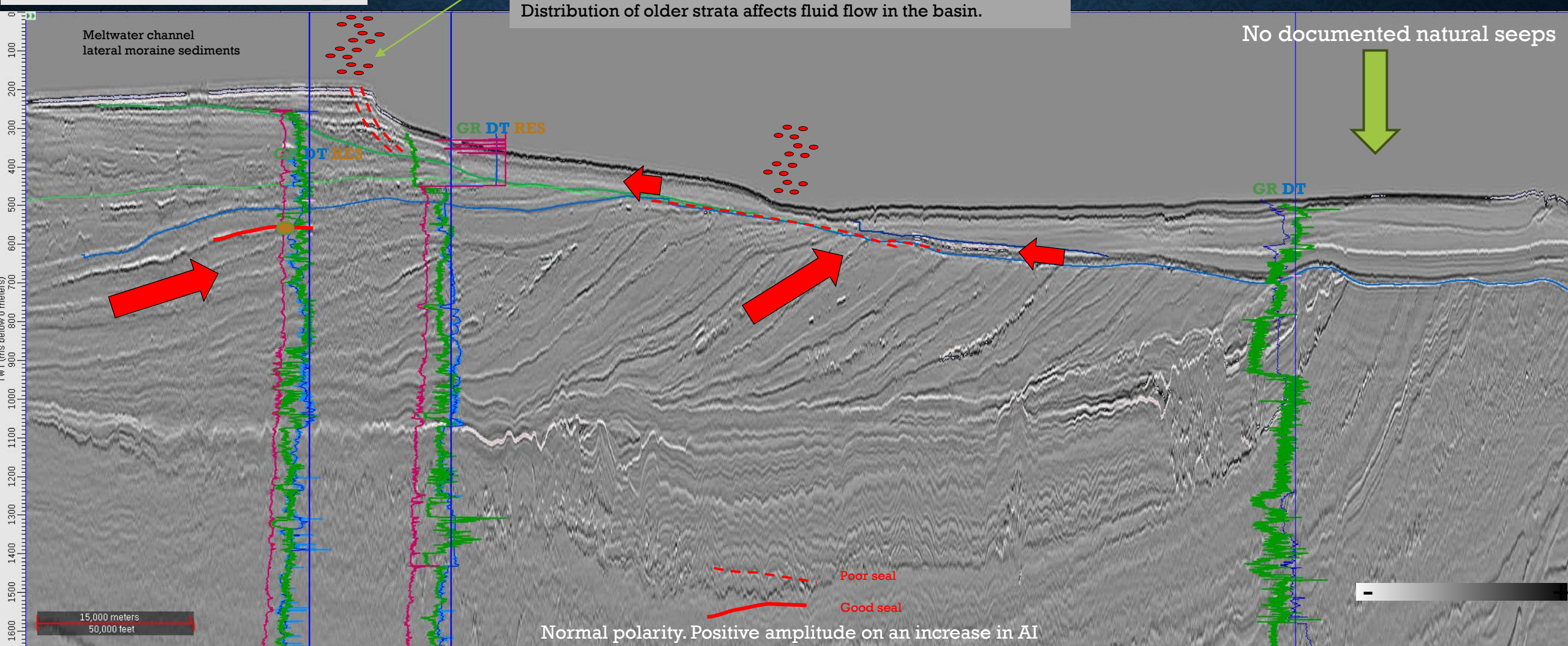
## Northern North Sea

Shallow gas trapped in the topsets of the progradation unit  
Natural leakages to seabed due to eroded topsets and weak zones at the margins of the Norwegian channel.  
Distribution of older strata affects fluid flow in the basin.

## Norwegian Channel

No documented natural seeps

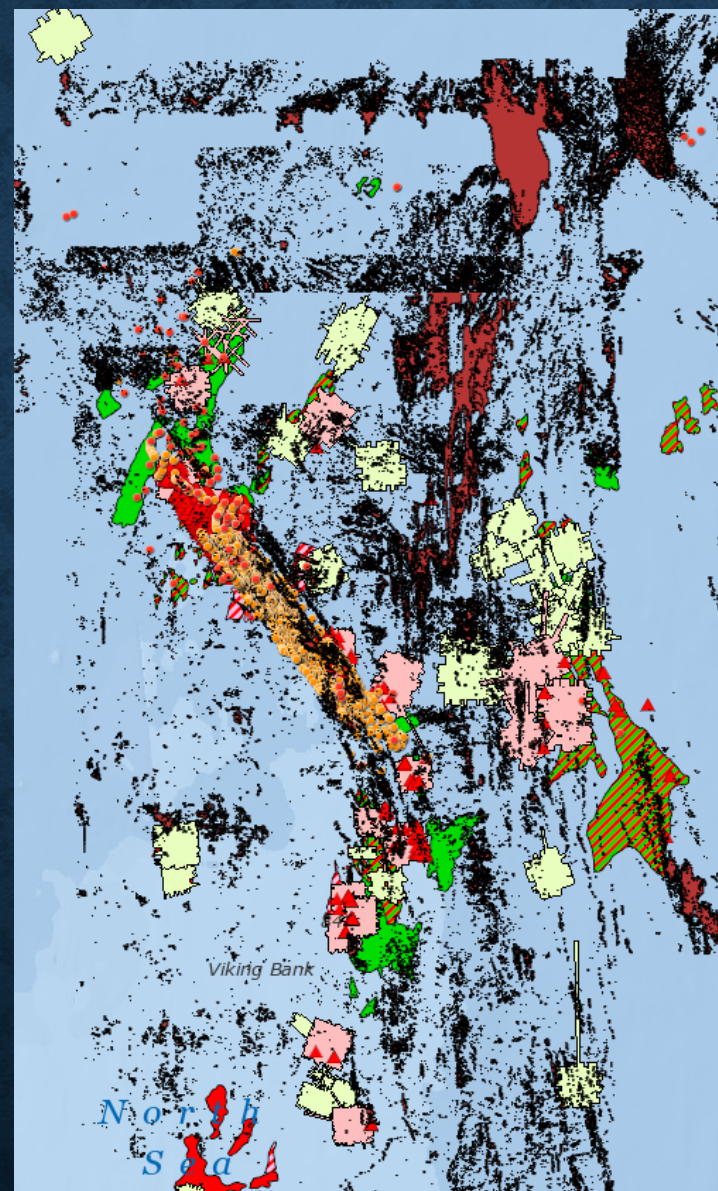
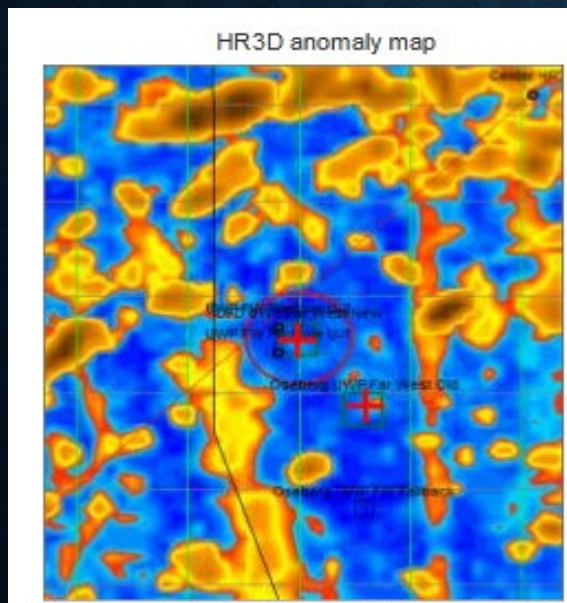
CGG18M01-NVG-PSDM-FINAL-FULLSTACK-TIME, MIG\_FIN





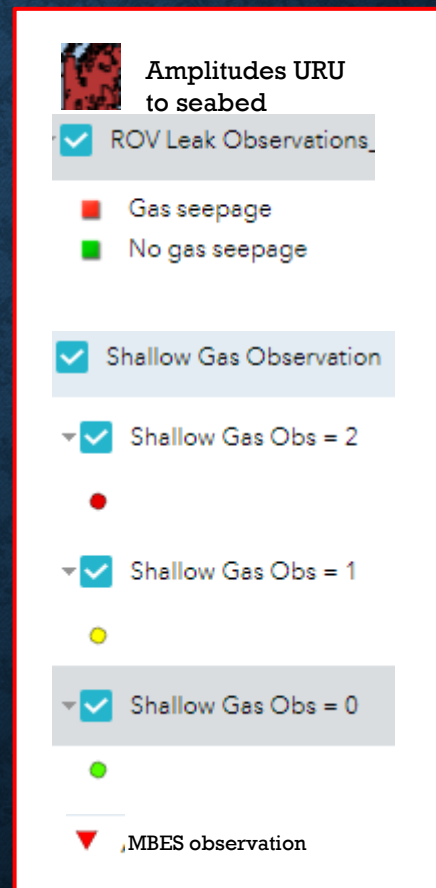
# Northern North Sea

Example – details – Site specific



Correlation of different datasets

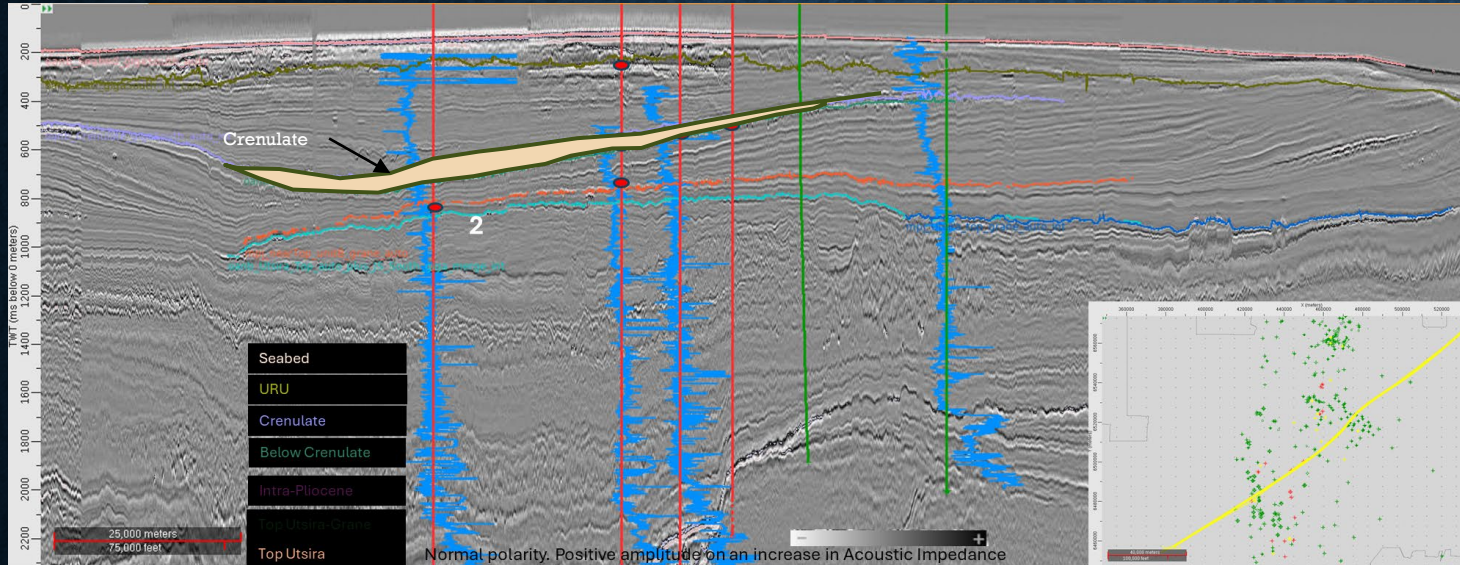
- Seismic amplitudes
- Drilling observations
- Visual observations



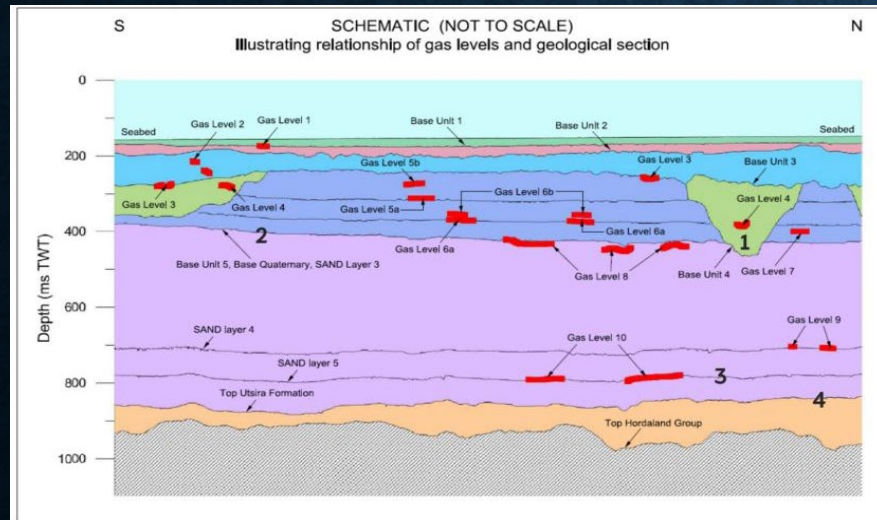
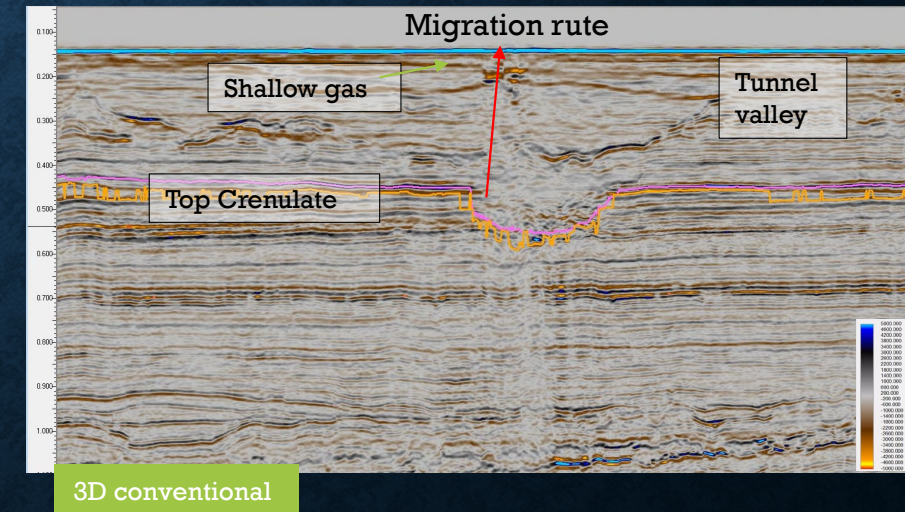
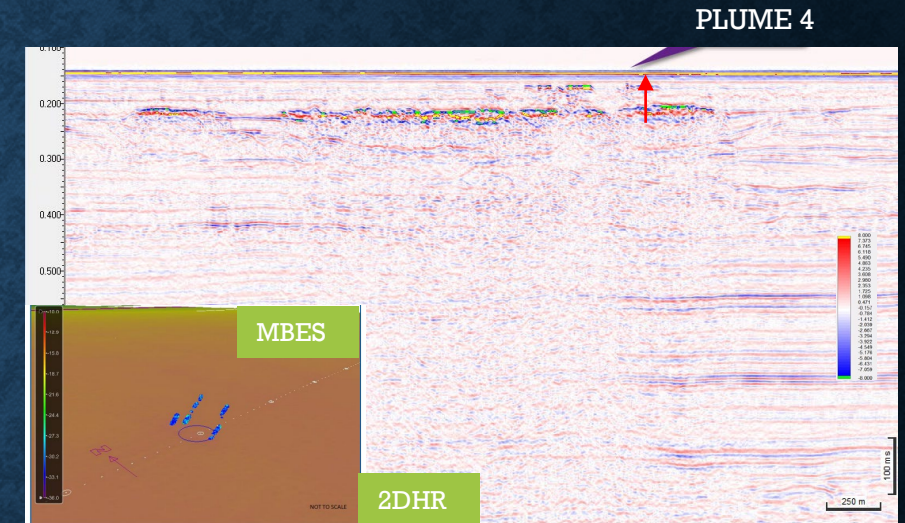


# Southern North Sea

## Well observations on seismic

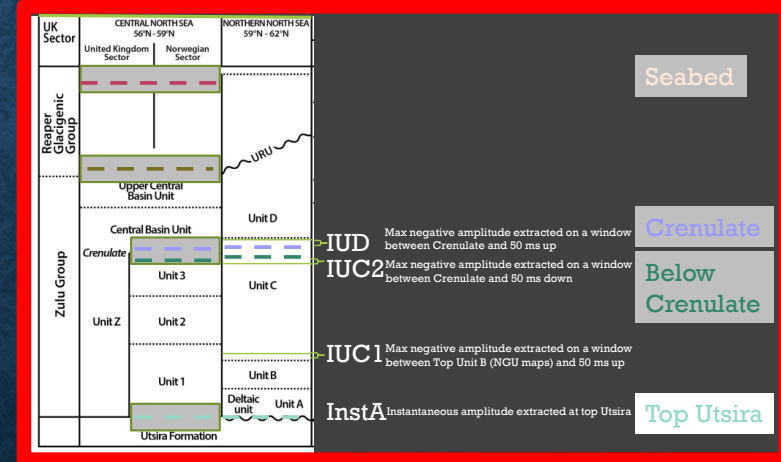
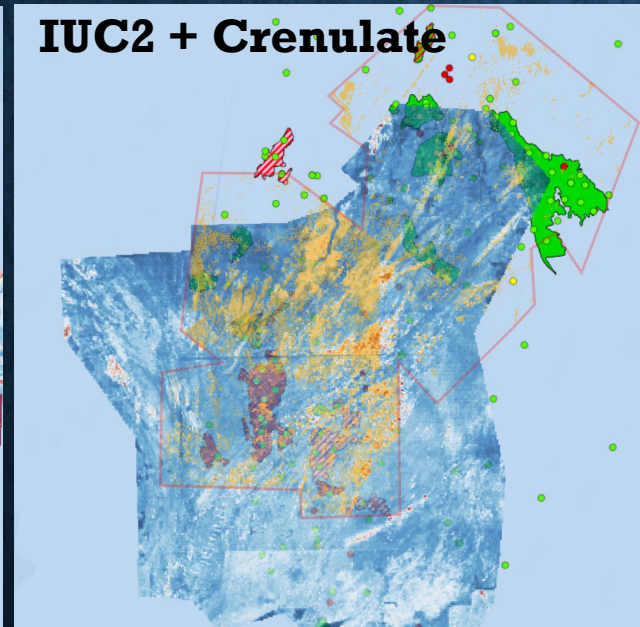
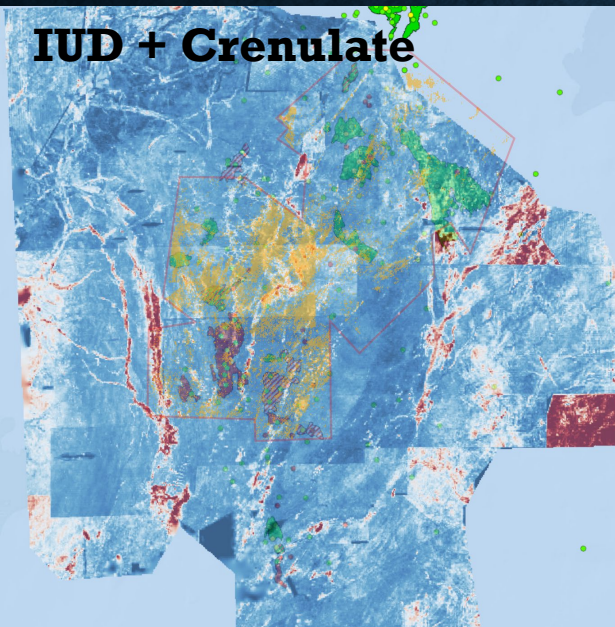
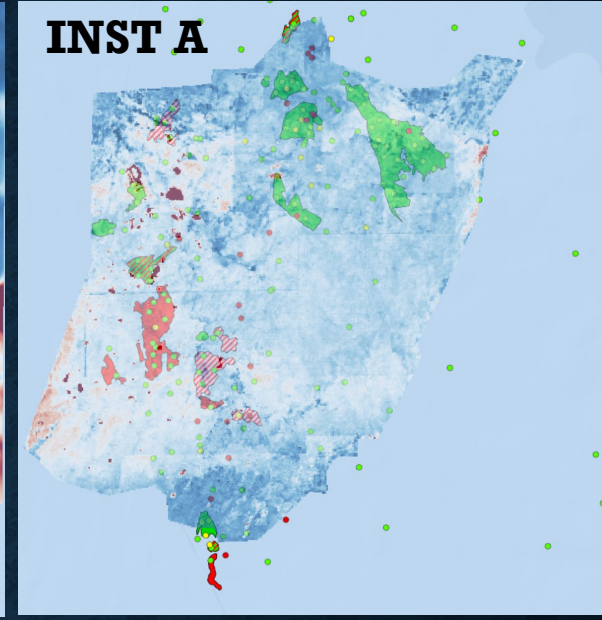
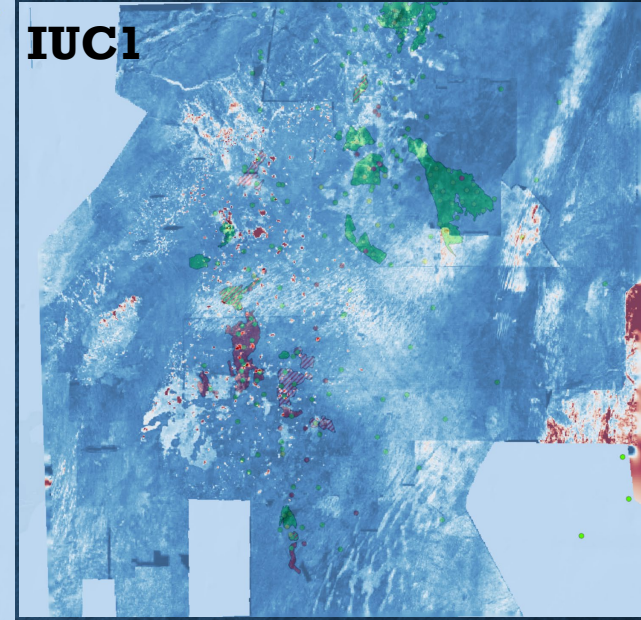
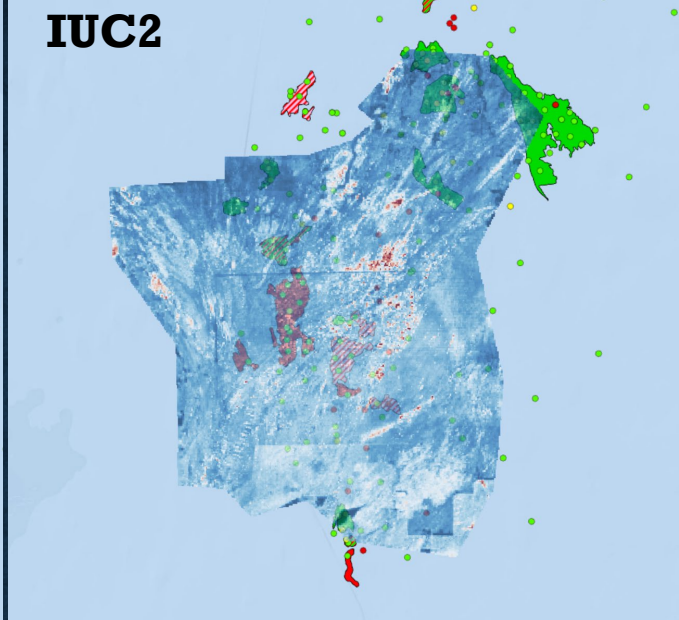
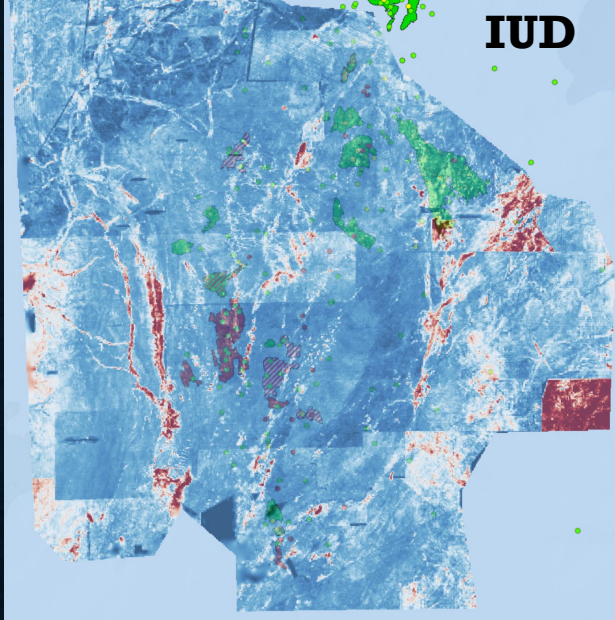


## Natural seeping systems- Examples



- 1 Base Unit 4 (URU) gas level 1-4 in tunnel valleys
- Base Unit 5, Base Quaternary, Crenulate (Near to Pliocene) gas level 8
- 2 Sand layer 5- gas level 10 (Intra-Pliocene) derisked- regional thin water-filled silty layer
- 3 Top Utsira
- 4 Top Utsira

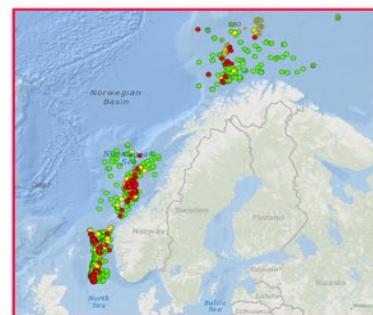
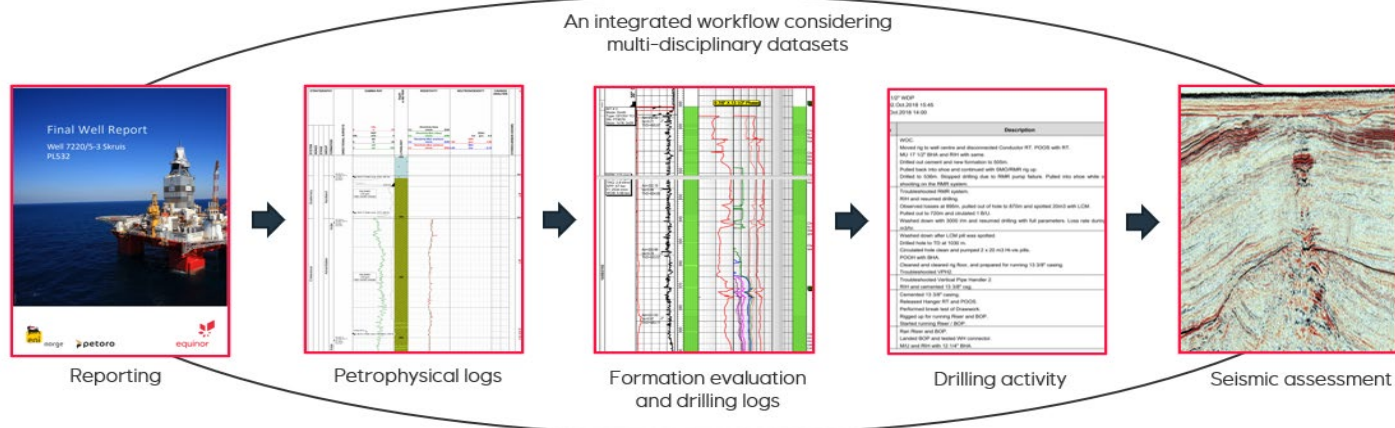




- Amplitudes (Crenulate to Utsira – different stratigraphical units)
- Crenulate- Amplitudes
- Amplitudes Crenulate to seabed

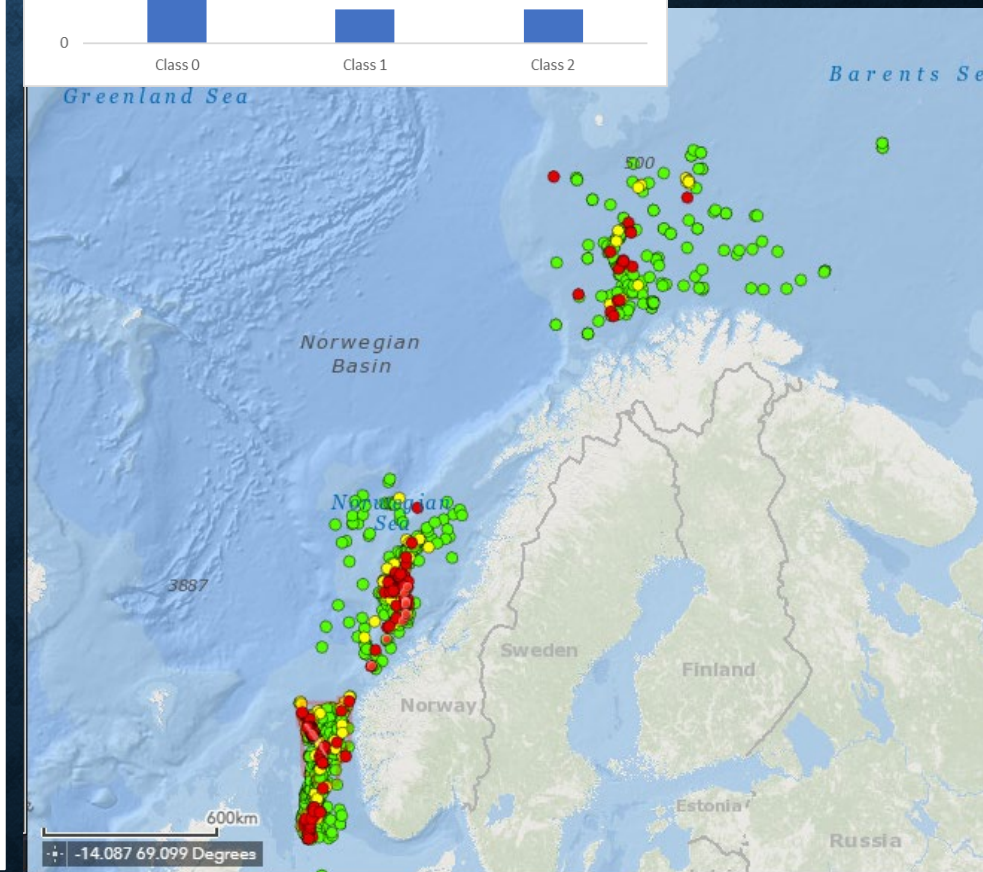
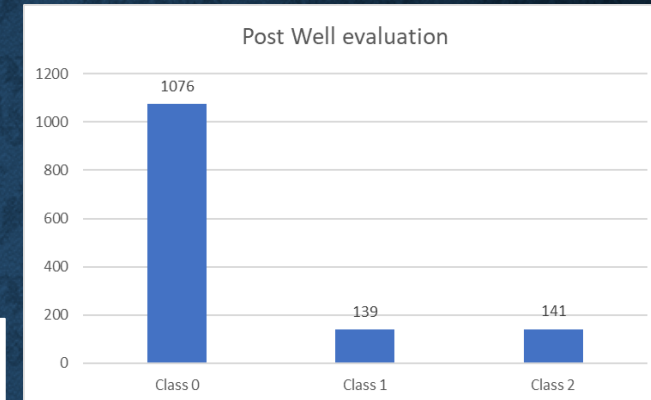


# EXPLORATION WELL CLASSIFICATION



## Post-drill diagnosis

- No shallow gas observed
- Inconclusive shallow gas indications
- Shallow gas observation in the well



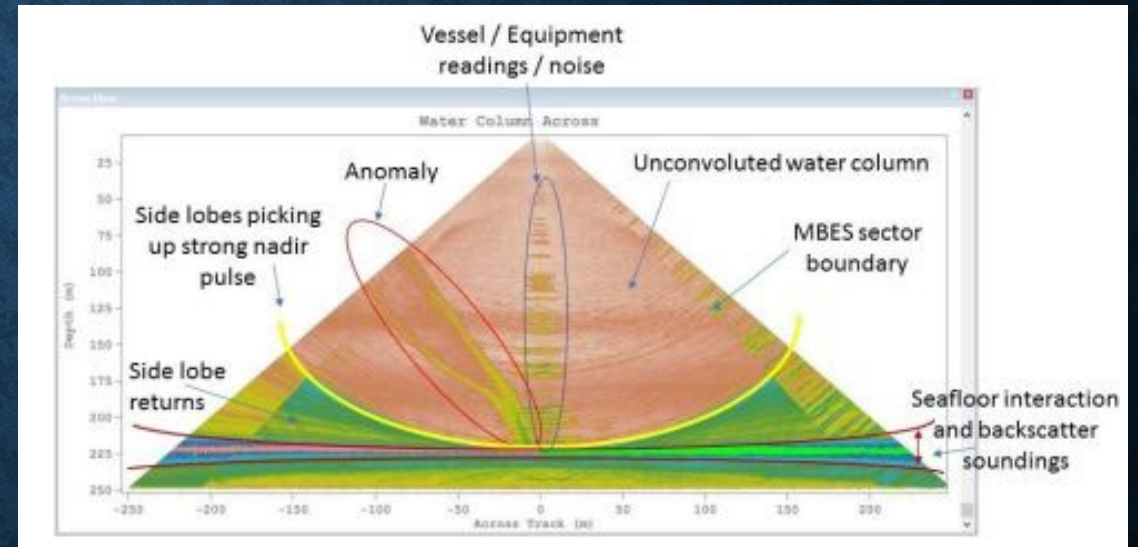
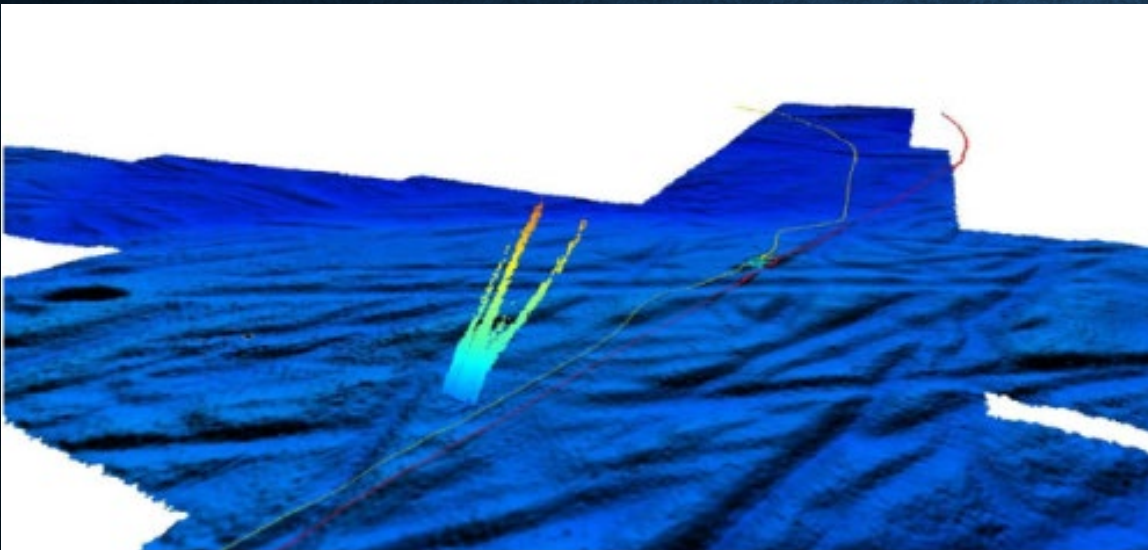


# WHAT IS MULTIBEAM ECHOSOUNDER DATA (MBES)

- Multibeam Echosounder (MBES) has been used to acquire data of the water column on several risk defined locations in the NCS. This type of sonar is used to map the seabed emitting acoustic waves in a fan shape beneath the transceiver of the multibeam echosounder.

## Natural seep summary (Norwegian sea and North sea)

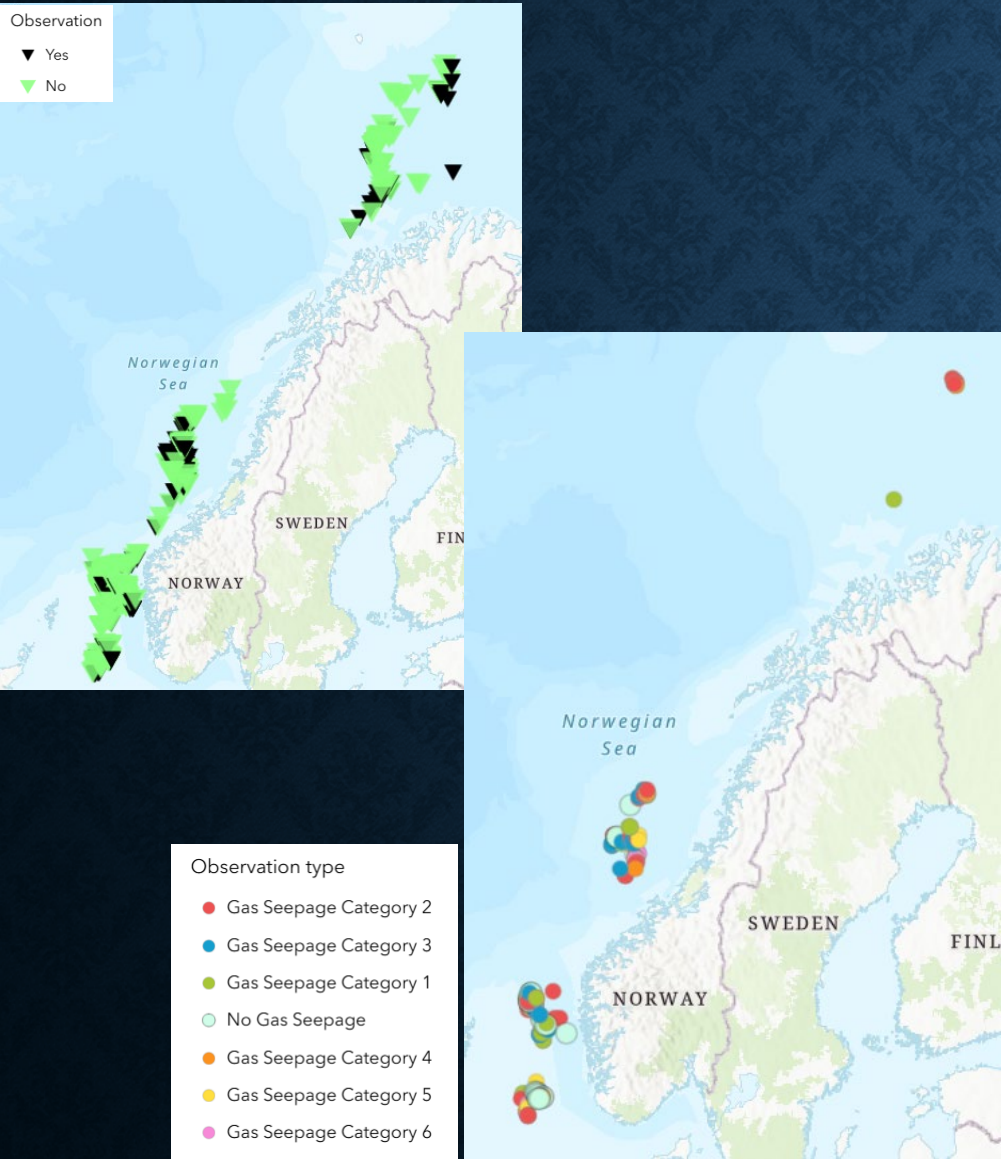
- 2020 – 4 Natural seeps documented
- 
- 2023 – approx 3000 seeps documented (MBES)
- 
- Use om of MBES is of vital importance



Gardline Water Column Report



# ALL OBSERVATIONS (ROV AND MBES)



Water column data (May 2023) incl external data.

- Approx 630 wells with data coverage
- 250 wells with associated seepage observed

## ROV observations

- Approx 200 seep observations

CATEGORY	Rate range (l/min)
1	<0,01
2	0,01-0,1
3	0,1-0,5
4	0,5-1
5	1-5
6	>5

85 % in category 1-3

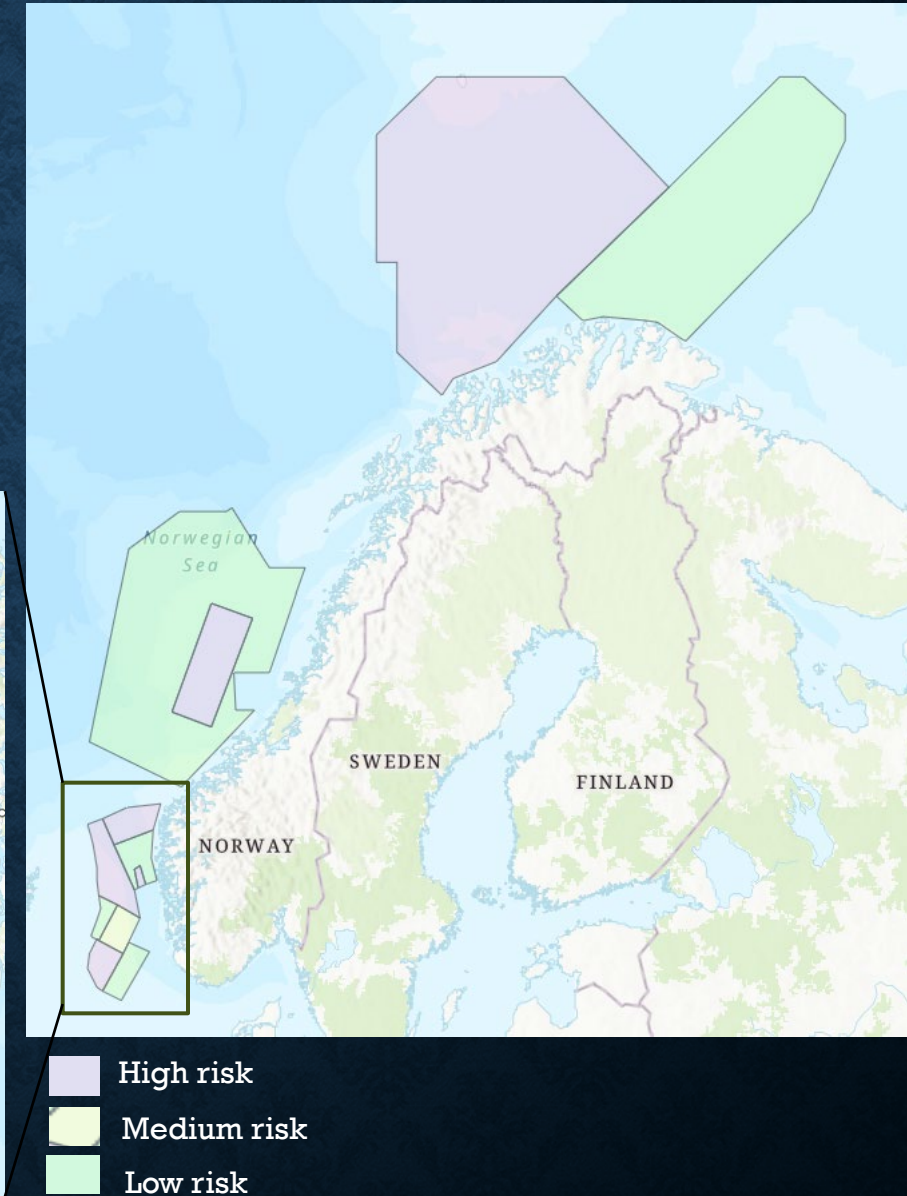
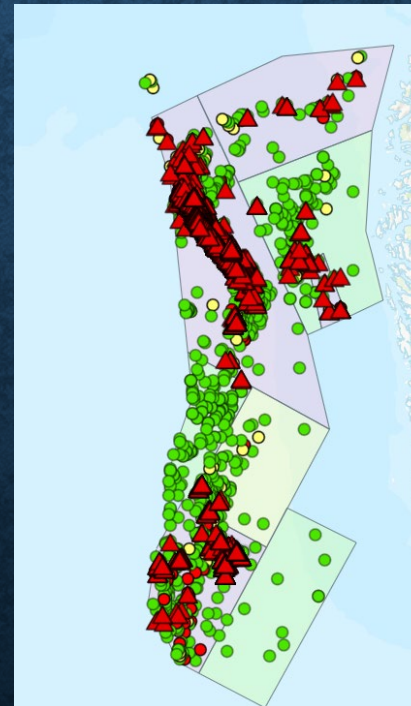
Infrastructure



# CLASSIFICATION OF AREAS (SHALLOW GAS RISK)

Classification based on:

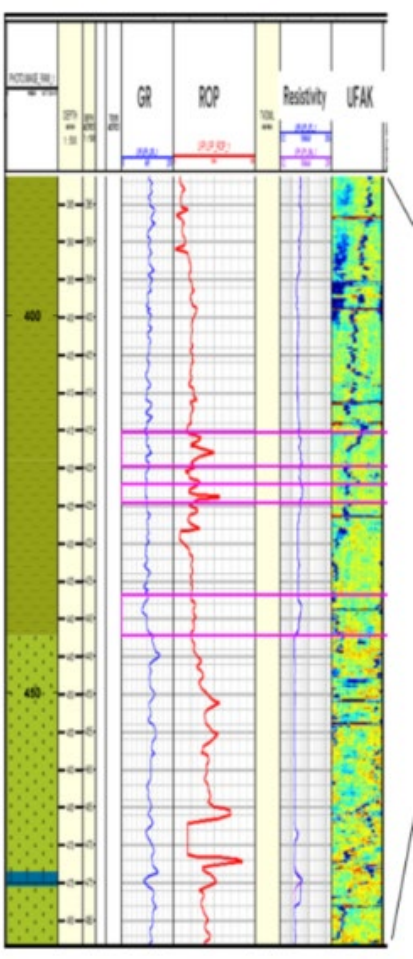
- 1) Mapping of seismic amplitudes
- 2) Well classification
- 3) Seep observations (NOGS/WAGS)



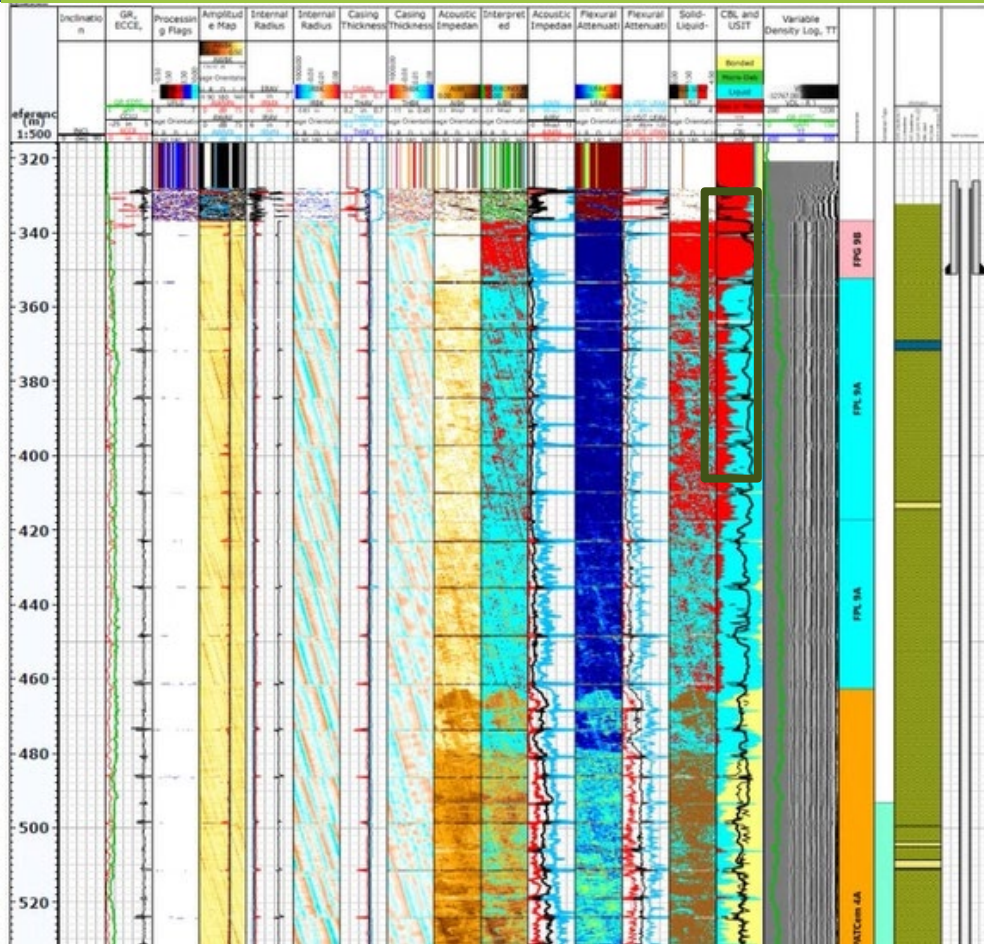


# Discussions Seep mechanism from shallow gas layers

**A – USIT Log**



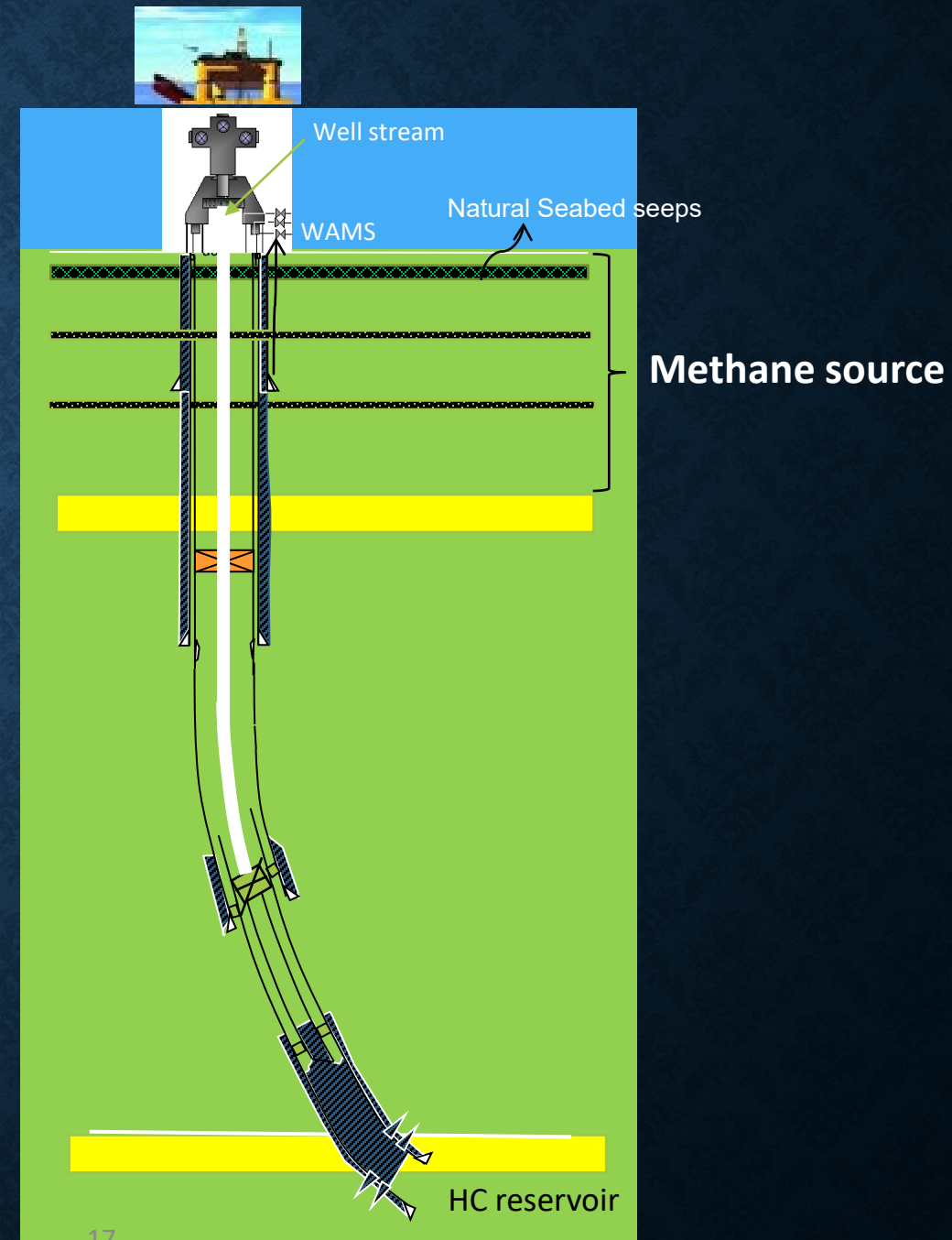
**B - USIT Log**





# MAIN FINDINGS SUMMARY

- Geological and seismic mapping of the Nordland/Naust Fm. have been performed in Norwegian Sea, Tampen/Horda Platform and Southern North sea.
  - Norwegian sea: Naust Fm. contains shallow gas on several intervals (High risk areas)
  - Horda Platform– No natural seeps – very few wells with observed shallow gas
  - Tampen – A lot of natural seeps (High risk areas)
  - Southern North Sea – Several intervals with shallow gas (From Utsira to seabed). Numerous natural seeps (High risk areas)
- About 35 % of the MBES inspected wells have associated seeps. Those are mainly in areas for high shallow gas risk and areas with natural seeps.
- No indication of seeps from deep reservoirs in geochemical analysis
- Limited amounts of seeps from water depth >250 m will reach the atmosphere (SINTEFF- study) → Halten Terrace, Barents Sea, Horda Platform





# THANK YOU