Environmental Risks

Geotechnical risk (CAU)

CO_2-induced processes in the subsurface and leakage mitigation (GEOMAR)

Risk of leakage at boreholes and natural structures (GEOMAR, BGR)

Impacts of acoustic noise on harbour porpoises (DMM)

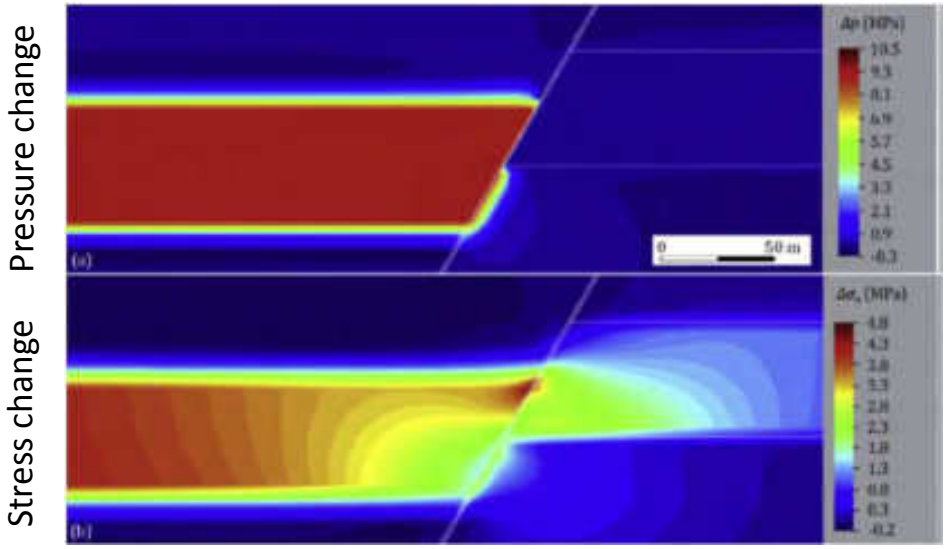
Geotechnical Risk

- Change of in-situ effective stresses and induced deformation fields on existing faults due to the injection pressure

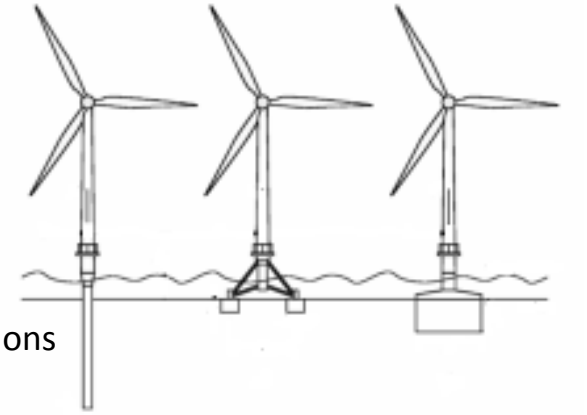
- Analysis of micro-seismic events and wave fields affecting offshore wind farms

- Mutual influence between the storage and surficial infrastructure on technical functionality and stability

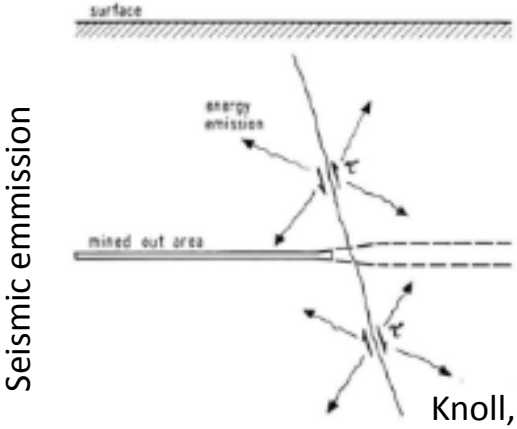
- Potential use of wind farm noise for seismological CO_2 storage monitoring



Vilarrasa etal. 2016



Wind energy installation foundations



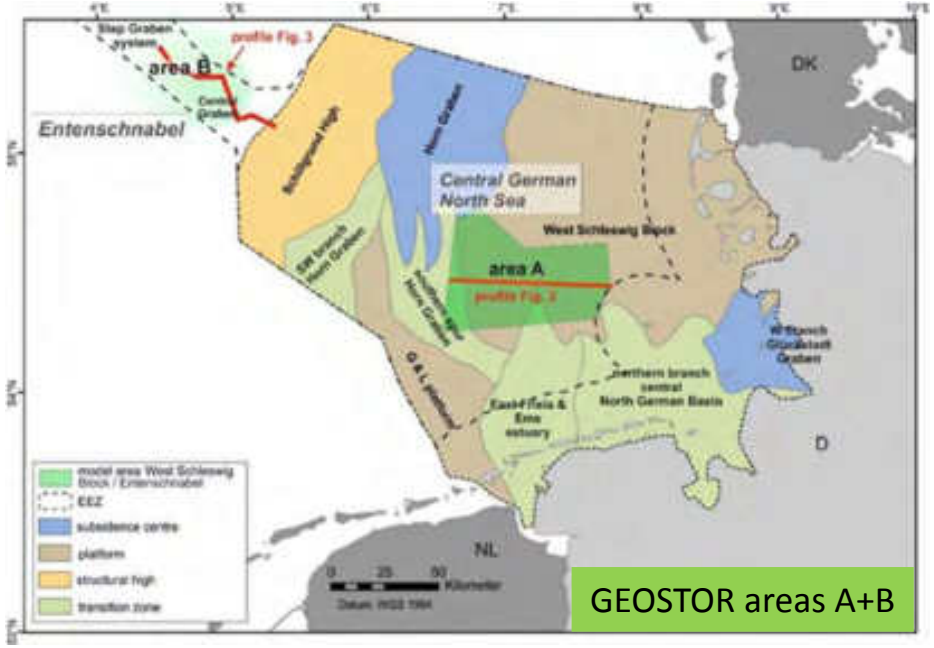
Seismic emmission

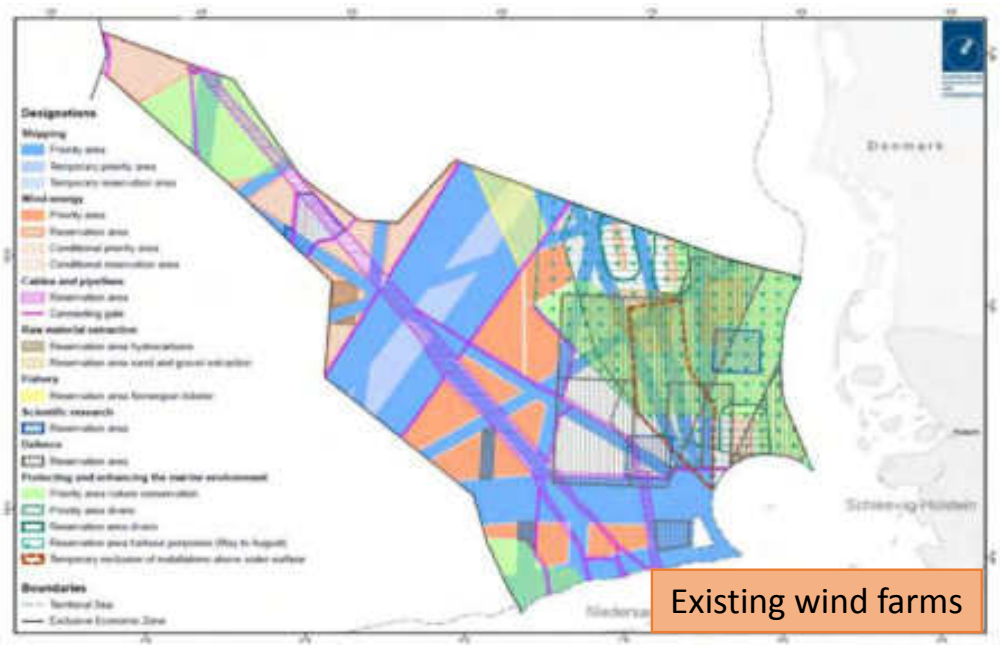
Knoll, P. 2014

Geotechnical Risk

Christian-Albrechts-Universität zu Kiel

Characterization of potential risks/hazards, existing geology, utilities and infrastructures





Existing impacts on wind farms

- Wind load (environmental load)
- Hydrodynamic load (environmental load)
- On-site load (self-imposed load and operational load)
- ***Induced seismicity*** (***due to the storage operation***)

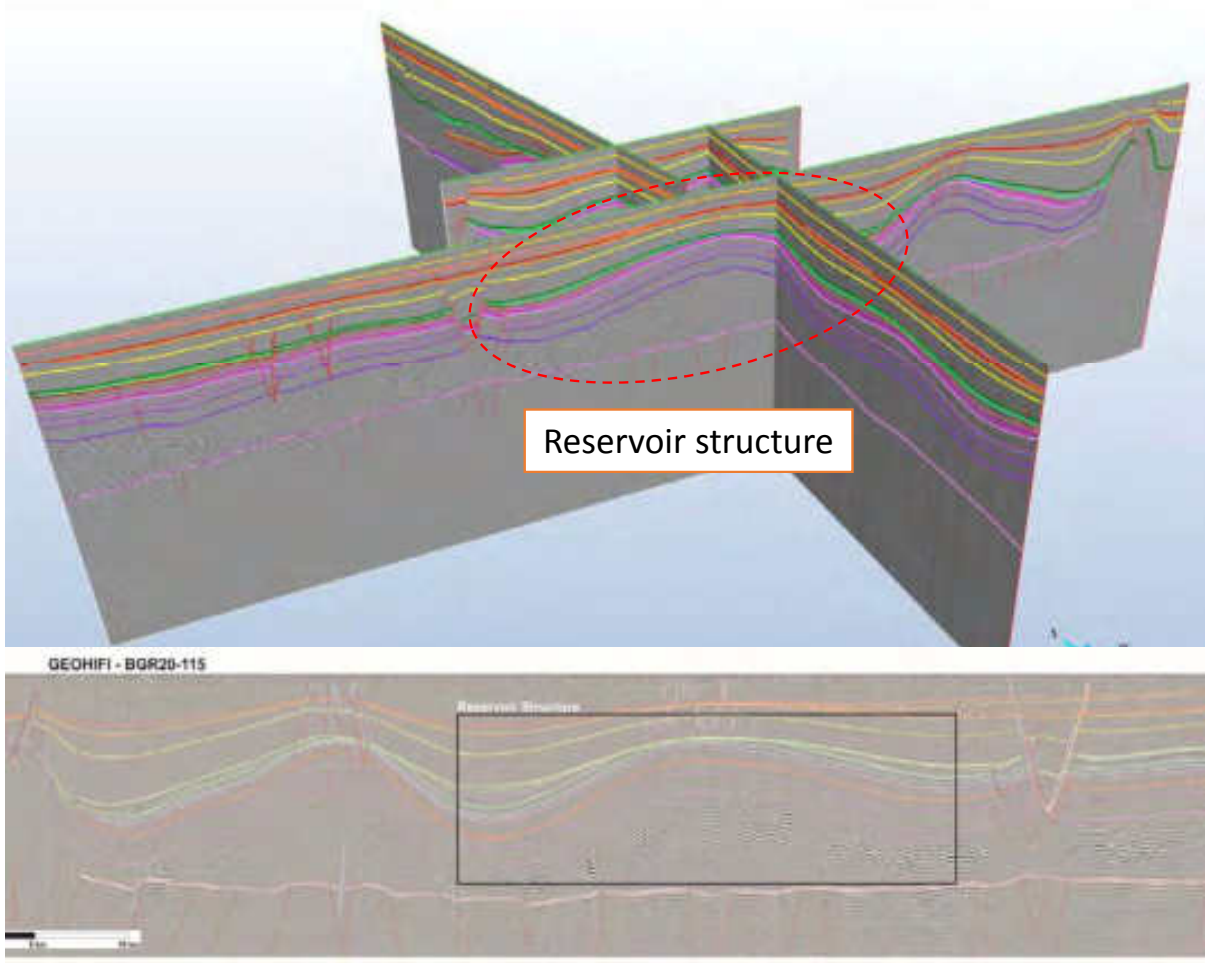
Essential boundary conditions

- Spatial arrangement, distance to faults
- Wind energy installations details: height, material, type of structure
- Type of foundation, depth, diameter, embedment
- ***Geological structure***

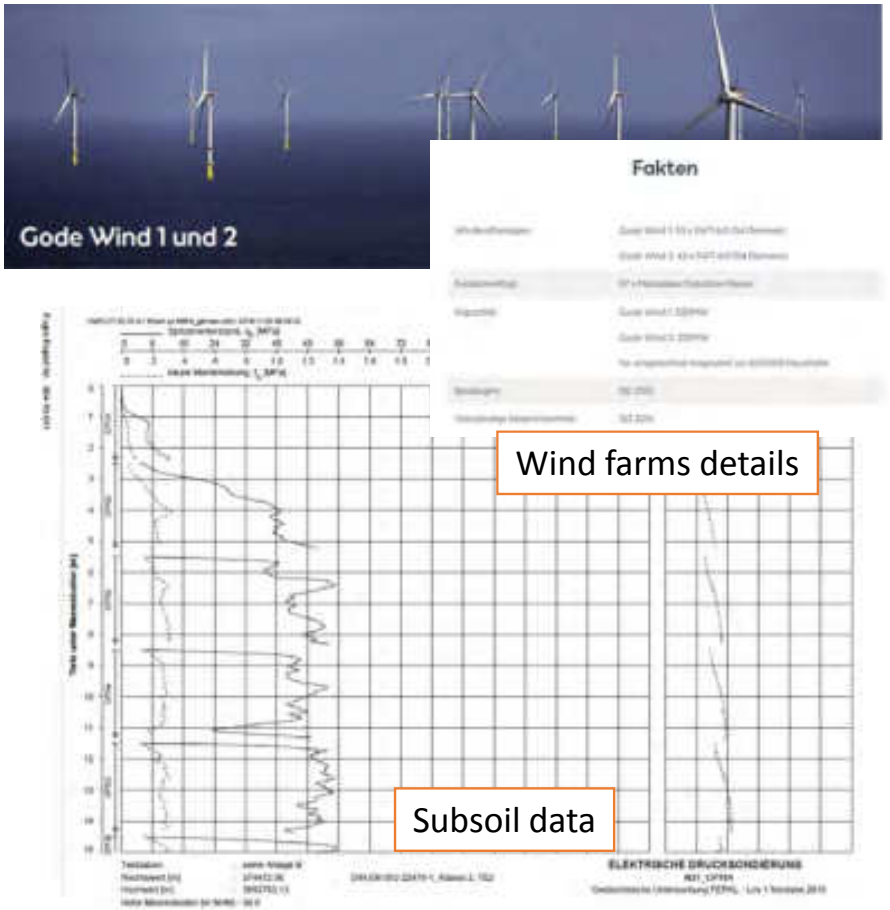
Geotechnical Risk

Christian-Albrechts-Universität zu Kiel

Data of reservoir model



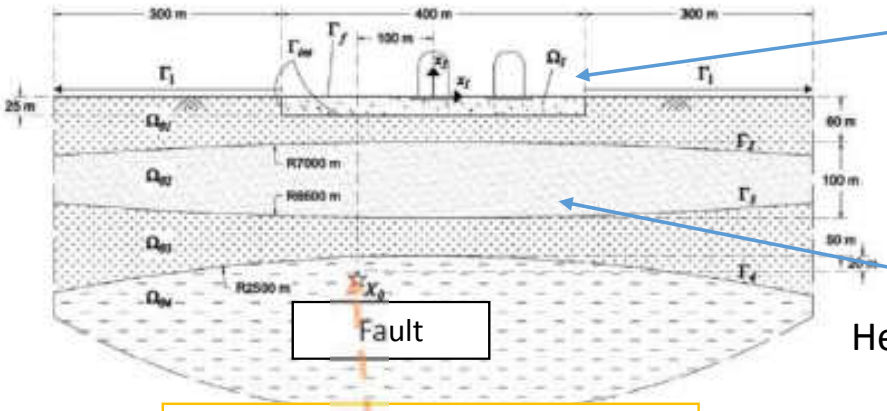
Data on wind farms



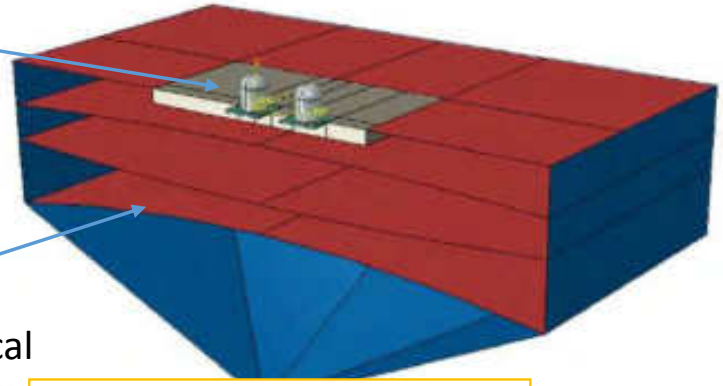
Geotechnical Risk

Example: Simulation of wave propagation in an arbitrary layered half-space

Power plants

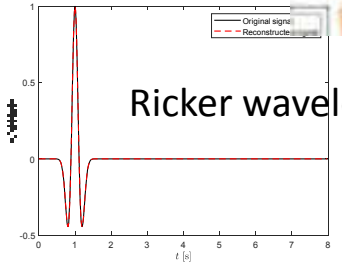


Geological profile / Cross section



Heterogenous geological subsoil

A cut view of the digital model

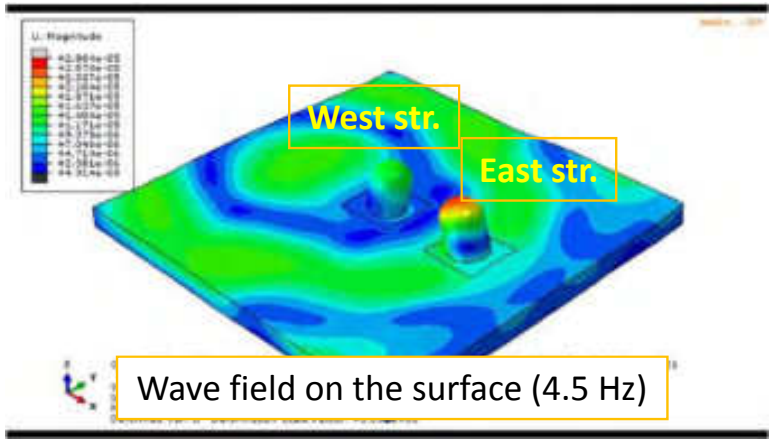


Ricker wavelet

Fracture radiated Seismic Energy

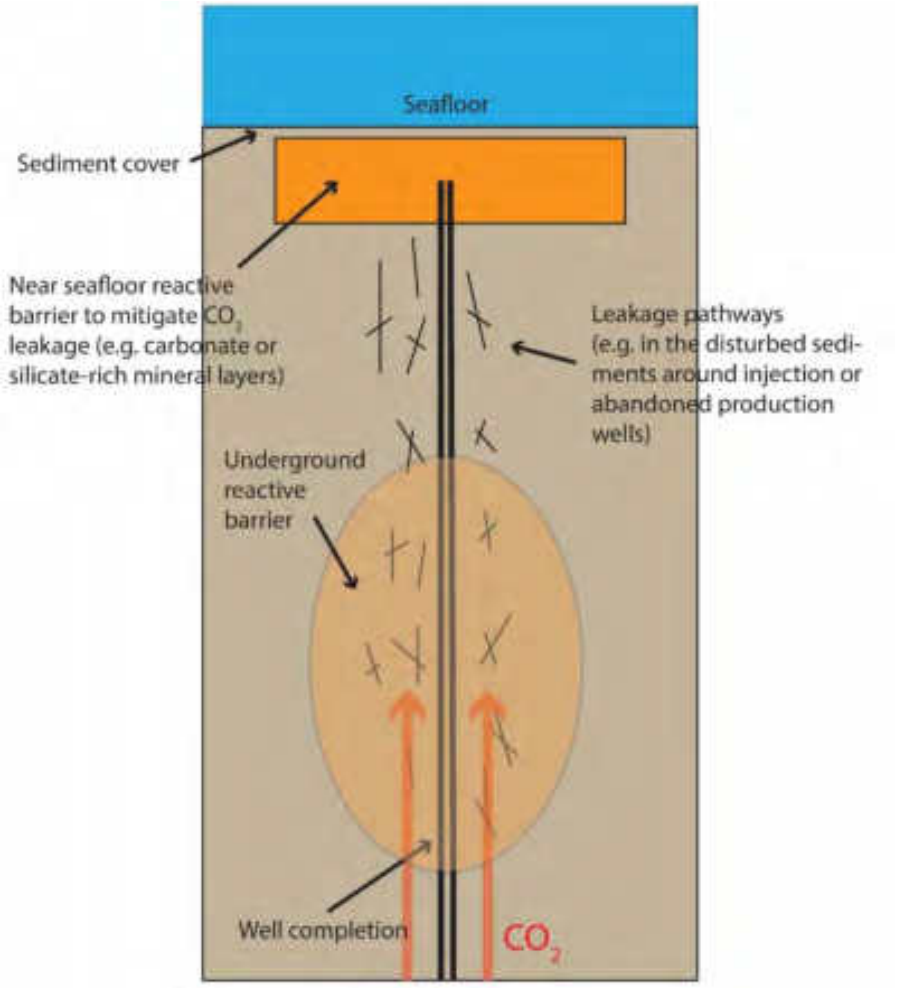
$$E_s = \frac{1}{2}\int [u]\left(\sigma_{ij}^{0} - \sigma_{ij}^{1}\right)\xi_j \, d\Sigma$$

Induced seismicity



Wave field on the surface (4.5 Hz)

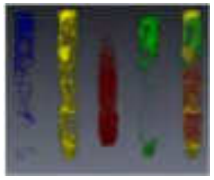
CO_2-induced THCM processes in the subsurface & leakage mitigation



High-pressure flow-through experiments to investigate coupled THCM processes (e.g. permeability changes in leakage pathways, heterogenous mineral dissolution/precipitation, geomechanical feedbacks) during CO_2 leakage as well as experiments with reactive barrier material

Application of tomographic, spectroscopic and online measurements

MRT



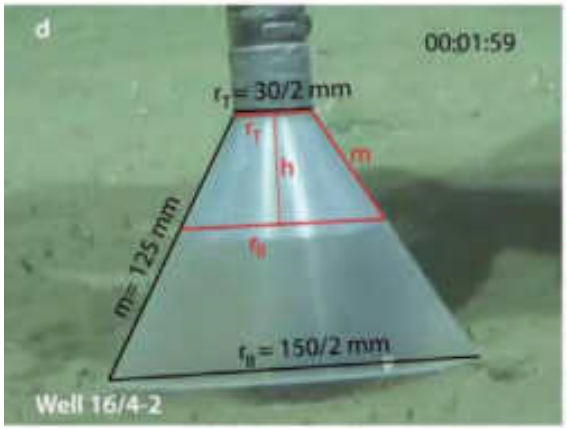
Permeability mapping and distribution of fluid phases in sediment

SYNCHRO-CT for THCM processes

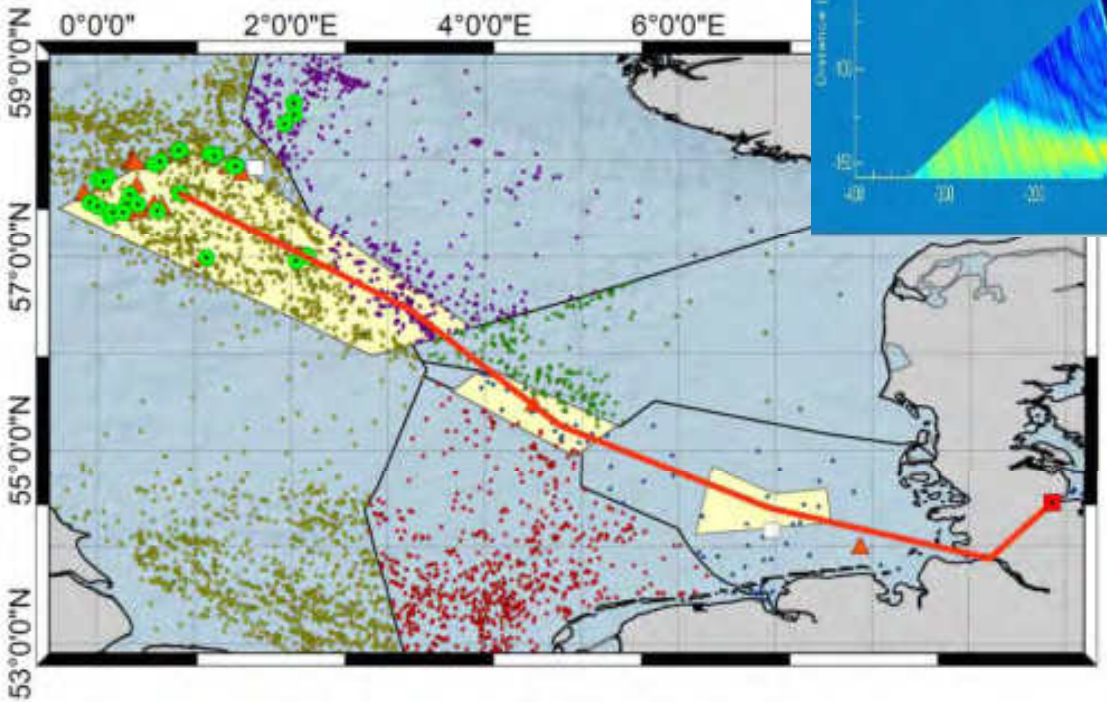
Risk of leakage induced by boreholes

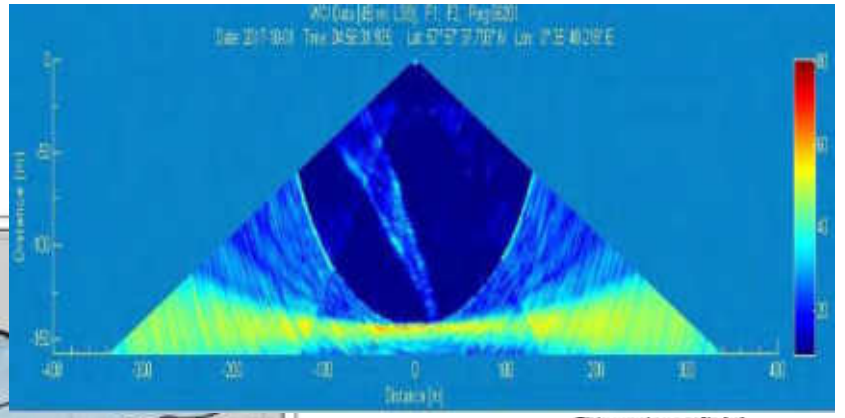
Hydroacoustic + geochemical investigation of gas bubble release at abandoned wells

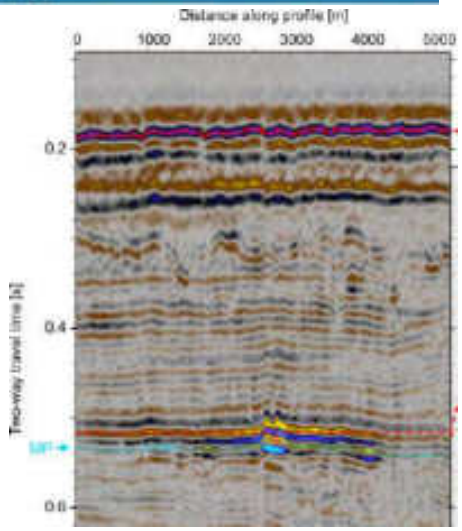
=> Sampling of gases + surface sediments and quantification of gas fluxes



AL575 (28.6. – 13.7. 2022)







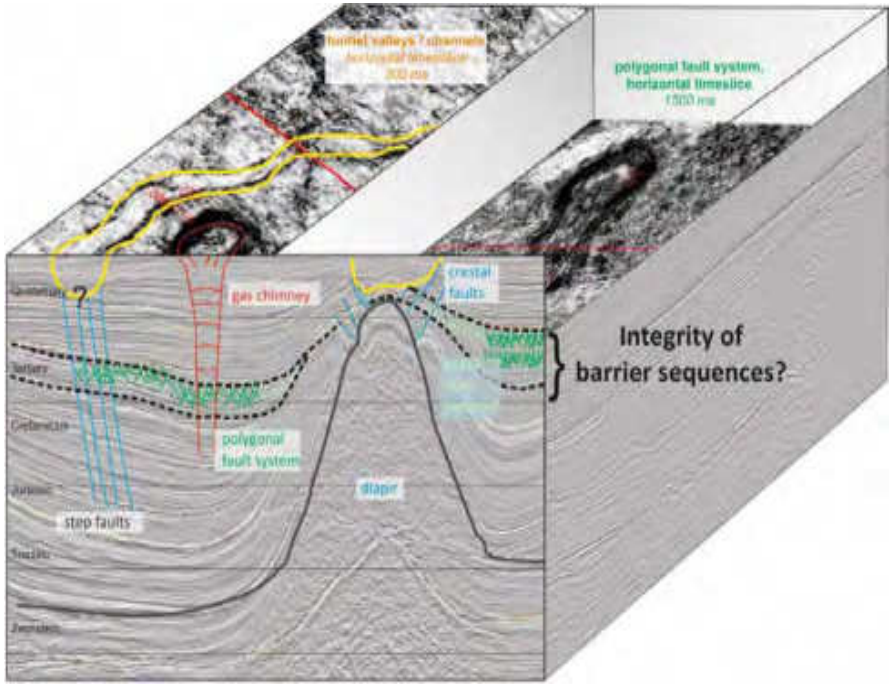
(Vielstädte et al., 2015+2017; Böttner et al. 2020+2022)

Risk of Leakage at Natural Structures

With contribution from the projects GeoHifi and Geobasis-3D

GeoHifi: *High Resolution Reflection Seismic Imaging of the Cenozoic Barrier Structures of the West-Schleswig Block and the Fluid Migration System of the blowout structure 'Figge Maar'* **(MSM97)**

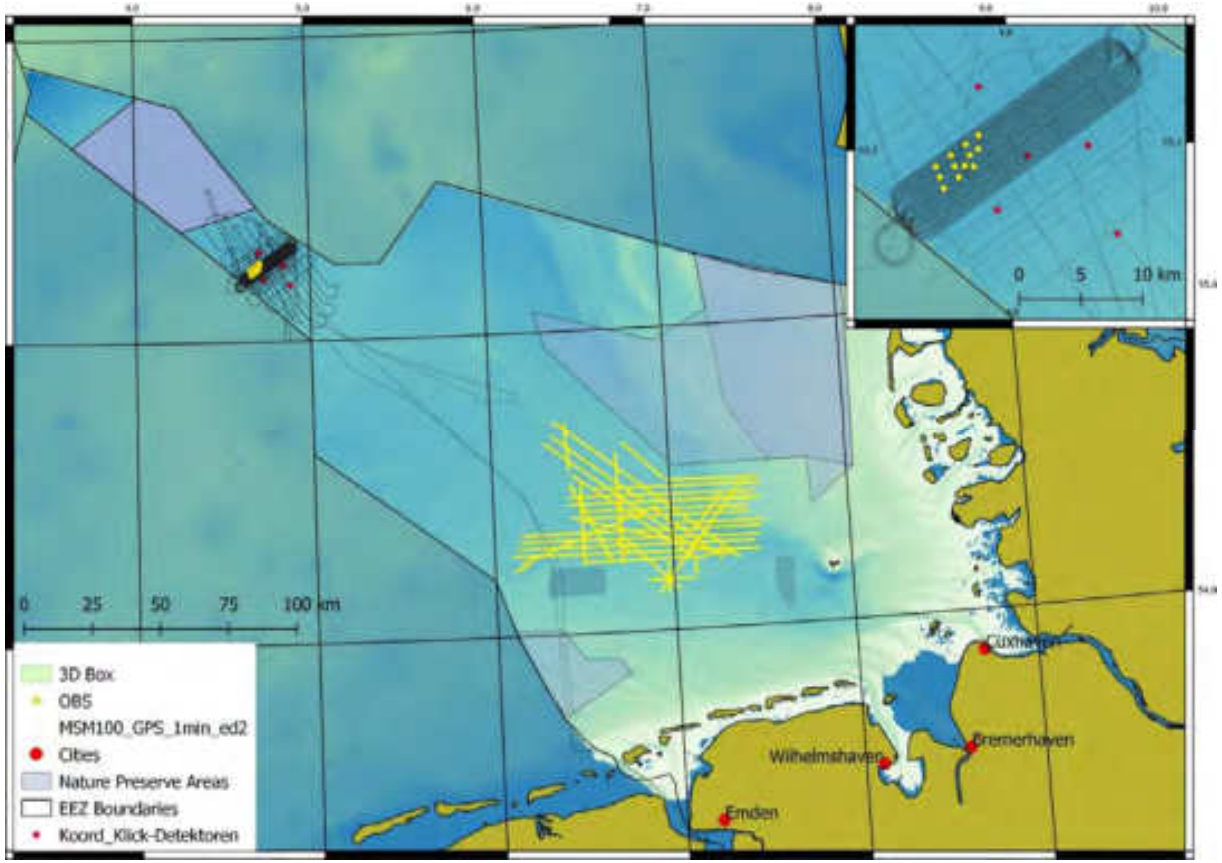
GeoBasis-3D: *Geophysical Investigations for Barrier Structures and their Integrity in the subsurface of the German North Sea by means of 3D-Seismic data* **(MSM100)**



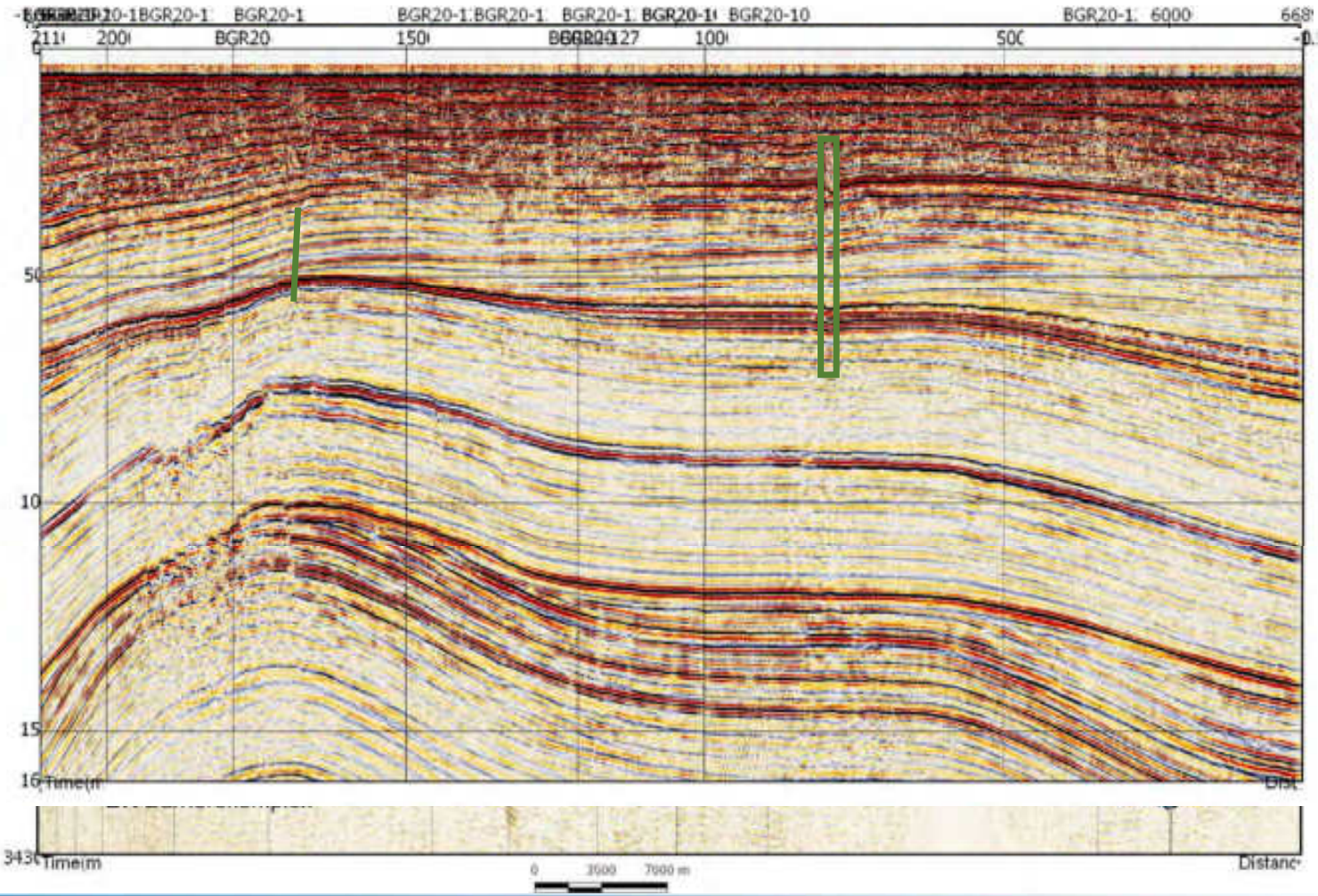
Risk of Leakage at Natural Structures

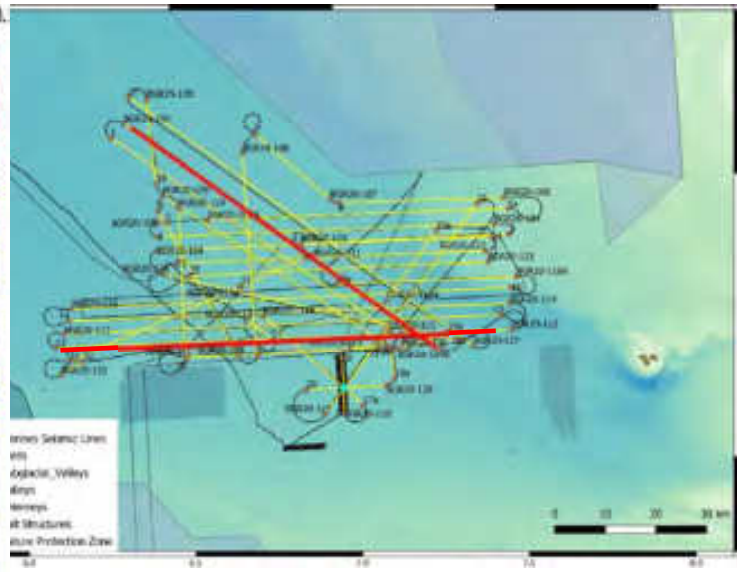
Processing
- Imaging of the sediments from the base Zechstein up to the seafloor
- Precise velocity model
- Undershooting of amplitude anomalies

Interpretation
- Which fault systems are present? Could they act as fluid migration pathway?
- Do different fault systems communicate with each other thus building „seal-bypass systems“?



Geophysical Investigations with High Resolution Reflexion Seismic **Imaging of Barrier and Reservoir units**, Cenozoic faults and a blow-out structure on the West Schleswig Block





GeoBasis-3D: *Geophysical Investigations for Barrier Structures and their Integrity in the subsurface of the German North Sea by means of 3D-Seismic data*

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

Impacts of seismic investigations on harbour porpoises

Extensive seismic surveys for monitoring and surveillance will most likely be required in the future.

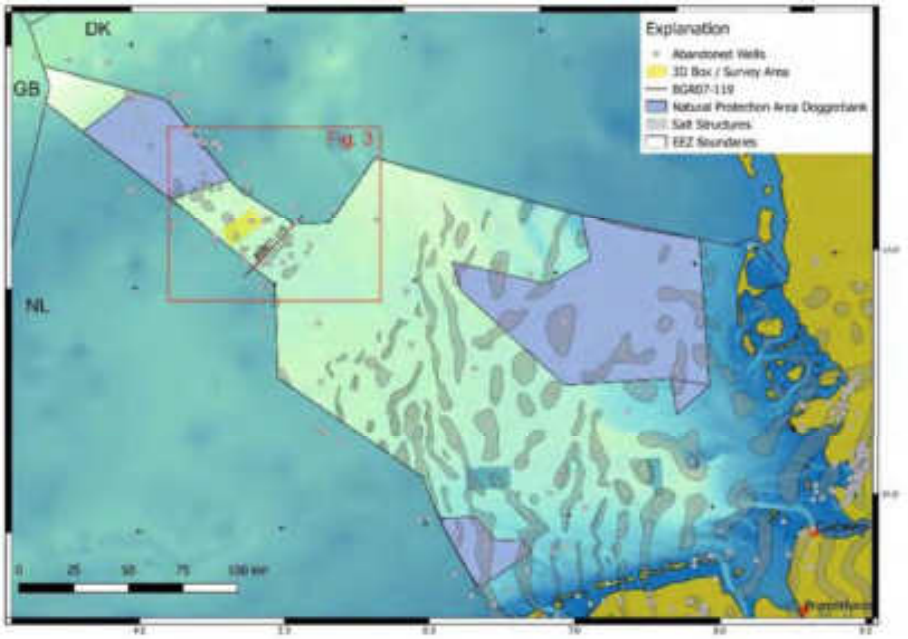
Clarification of the effects on marine fauna will be necessary in order to

- create acceptance
- potentially mitigate impacts

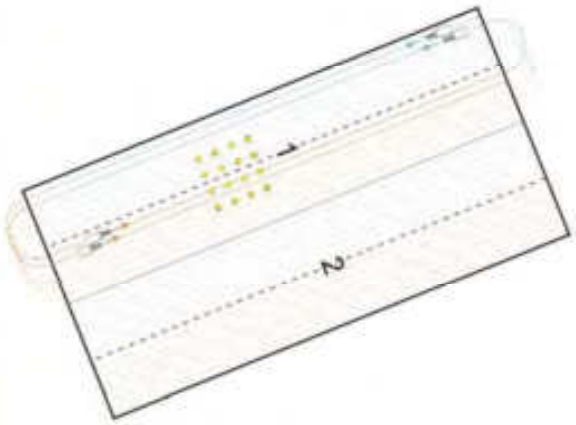
Impacts of seismic investigations on harbour porpoises

1. Is there an increased risk of injury to harbour porpoises by a potential increase of seismic surveys in the North Sea?
2. Are the seismic surveys that required for CCS likely to have long-term negative effects through increased disturbance to harbour porpoises?
3. How does the additional noise from seismic surveys relate to the already existing noise pollution in the North Sea?

Impacts of seismic investigations on harbour porpoises



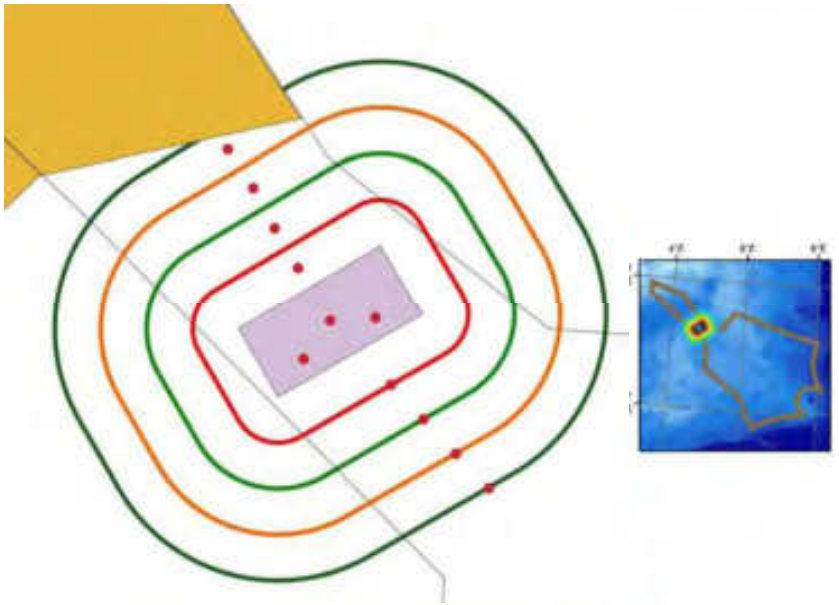
May/June 2021



BGR – GeoBasis 3D Survey 2021

Impacts of seismic investigations on harbour porpoises

- Data acquisition finished
- Second data set (non impact) beneficial (2022 or 2023)



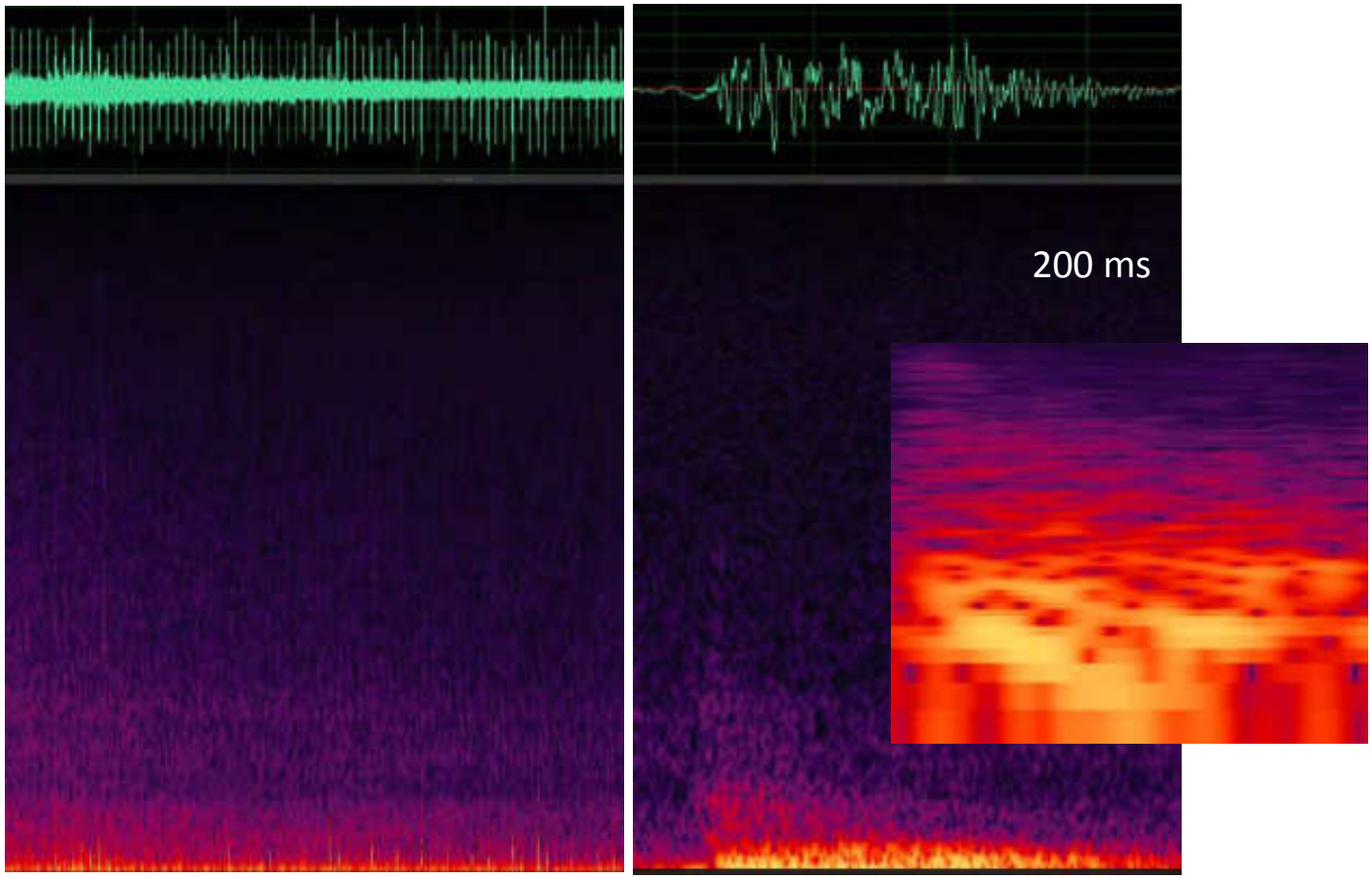
Soundtrap
(Oceaninstruments, NZ)

C-POD / F-POD
(Chelonia, UK)

Impacts of seismic investigations on harbour porpoises

Series

Single Signal



Impacts of seismic investigations on harbour porpoises

Series

Single Signal