2nd Baltic Sea Region CCS Conference

3D-modelling the North German Basin

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BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

OUTLINE

PART 1

A 3D model of the North German Basin

P1

- Project TUNB: Motivation
- Structure, starting points
- Challenges and way forward

PART 2

Baltic Sea

P2

MOTIVATION

Increased need for information of the subsurface

The deep subsurface is already in manifold use, e.g. through

- exploitation of fossil fuels such as oil, gas and coal
- storage of oil and gas (in caverns, depleted gas fields, or saline aquifers)
- disposal of waste (liquid, solid, nuclear waste …)
- geothermal heat extraction / electricity production

In addition new forms of subsurface use are developing or under consideration, such as storage of renewable energies (e.g. in the form of hydrogen, compressed air, power-to-gas), or CO_2 storage.

Space is limited: Growing demand could result in conflicts of use. A geological 3D model can support the identification of such potential conflicts and provide a base for subsurface planning and use.

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OVERVIEW

GEOPOWER

Verbesserte geologische Datenbasis zur Nutzung von Erdwärme und zur Speicherung von überschüssiger regenerativer Energien im Untergrund in Syddanmark und Schleswig

TUNB

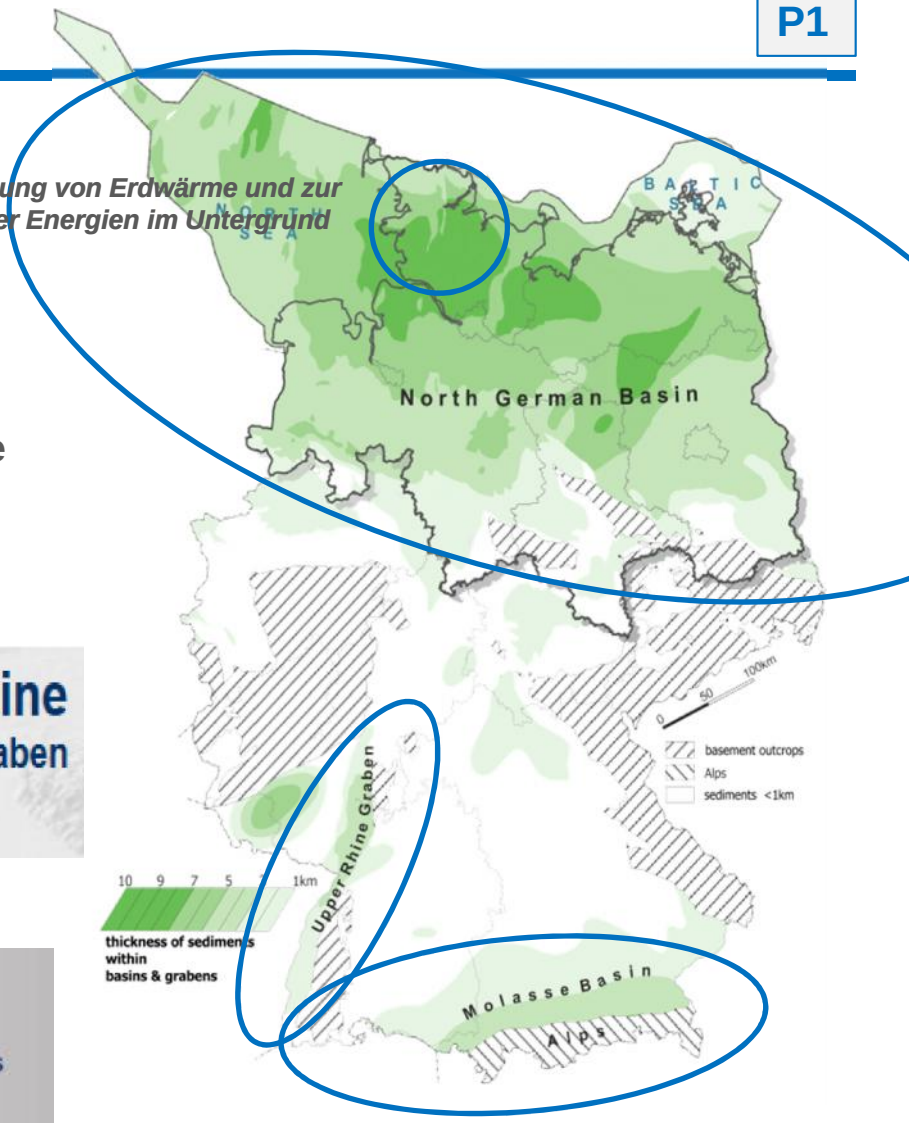
Subsurface potentials
for storage and economic use
in the North German Basin

GeoRG

INTERREG IV Upper Rhine
Geopotentials of the deep Upper Rhine Graben

GeoMol

Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources



Deep sedimentary basins and grabens in Germany (green areas).

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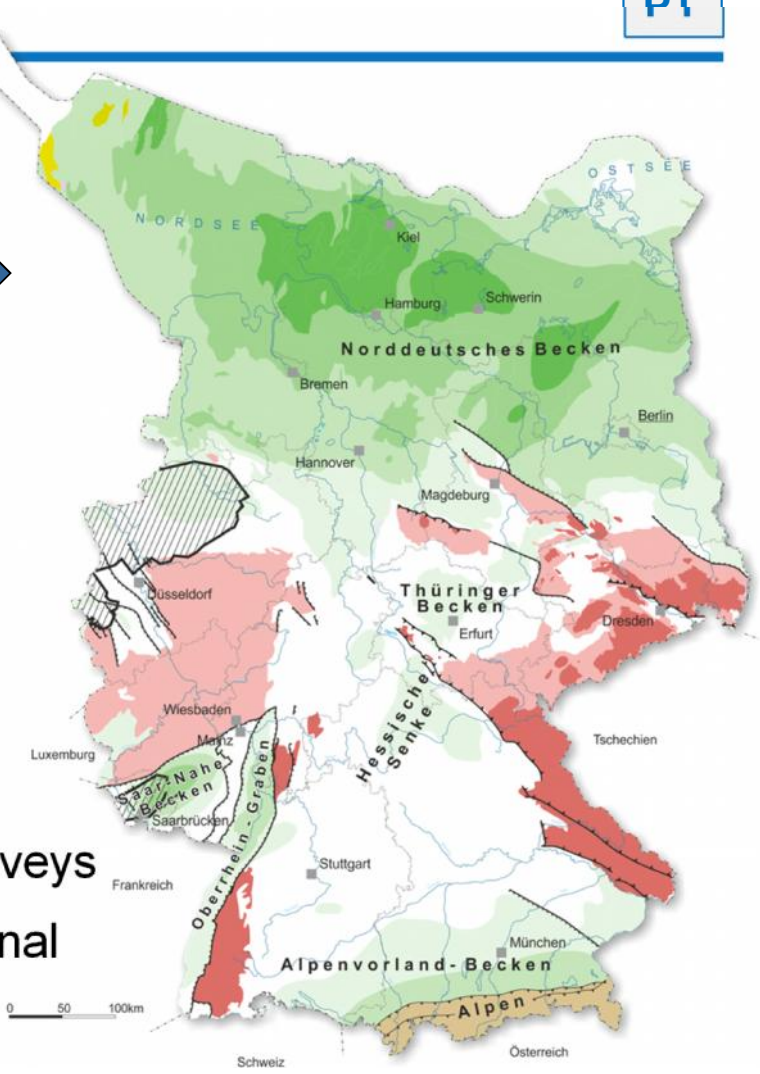
TUNB

Subsurface potentials
for storage and economic use
in the North German Basin



3D model of the subsurface

<u>Realisation of a common geological base</u>

- entire area of Germany (longterm)
- in collaboration of BGR and State Geological Surveys
- will be harmonised across national and international borders

TUNB STRUCTURE

P1

PROJECT PARTNERS

Duration of project: 6 years (start mid 2014)

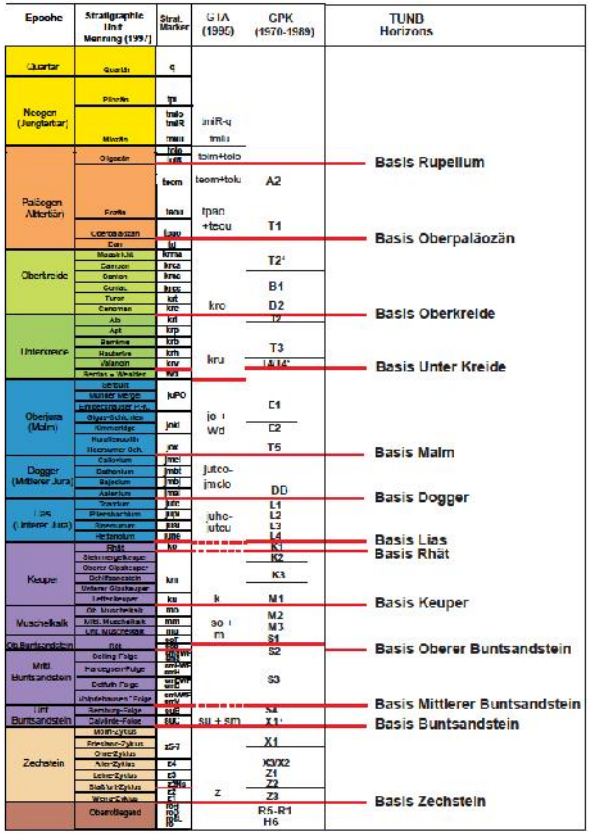
- Phase 1 (first 3½ ys)

  ⇨ 3D structural model with 13 horizons

- Phase 2 and 3

  „from surfaces to volume“ – selection of regions parametrisation of selected regions / structures

  ⇨ 3D parameterised volume model



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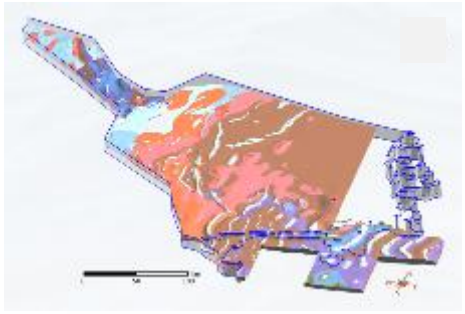
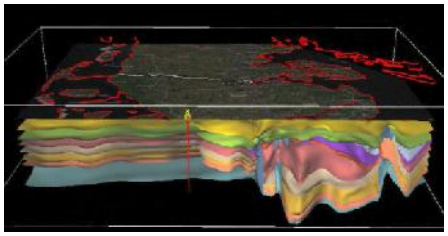
STARTING POINTS

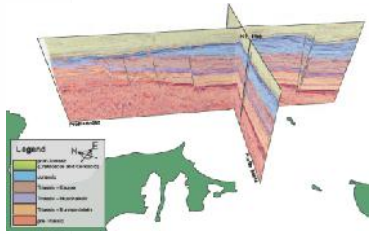
P1



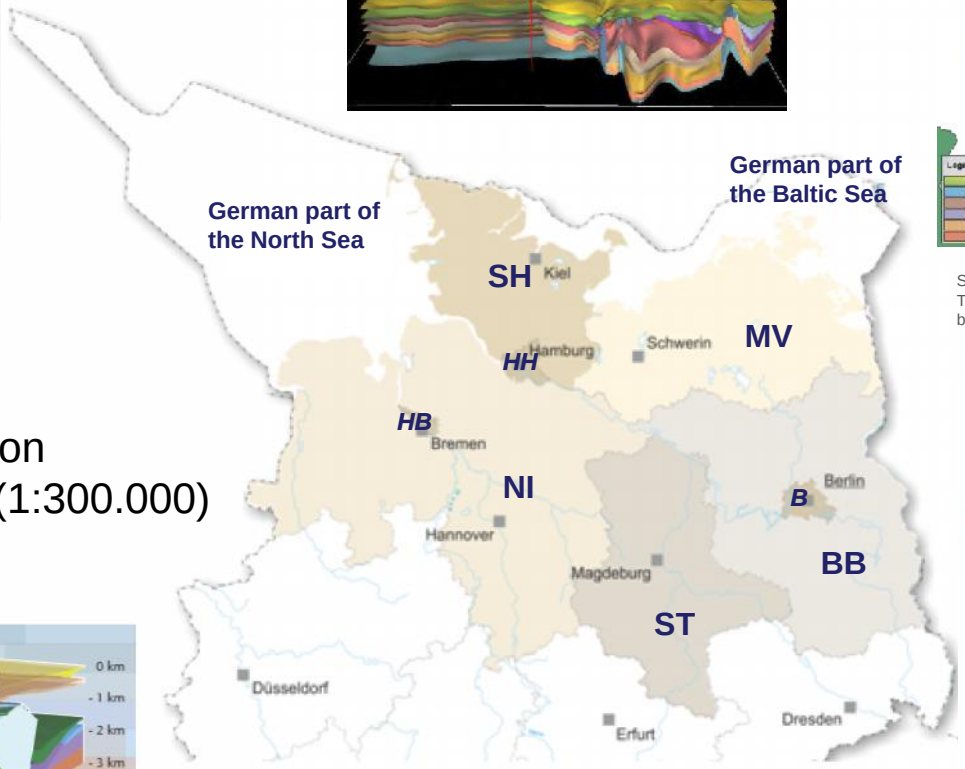
Source: GPDN



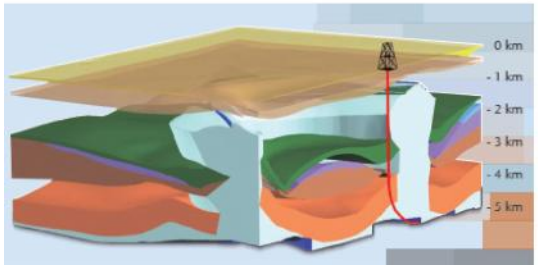
Source: Kirsch R. et al. (2014): What's new in Schleswig-Holstein? Projects and planning. Presentation at FURGY new energy Husum, 21.03.2014



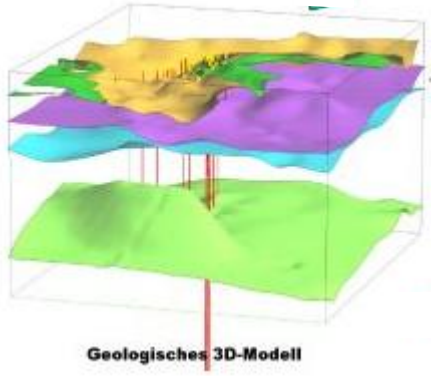
Source: Seidel E., Meschede E., Obst K.: Distribution of Triassic Sediments in the Baltic sea east of Ruegen Island based on reprocessed Petrobaltic seismic data.



Based on „GTA“:
Geotektonischer Atlas von Nordwest-Deutschland (1:300.000)



Source: LBEG *3D-Modell_2012-09.pdf*



Source: LBGR
http://www.lbgr.brandenburg.de/sixcms/detail.php/622657

Based on „GPK“:
Geophysikalisches Kartenwerk der DDR (1:200.000)

See also: www.infogeo.de

STARTING POINTS

P1

All project partners have different starting points

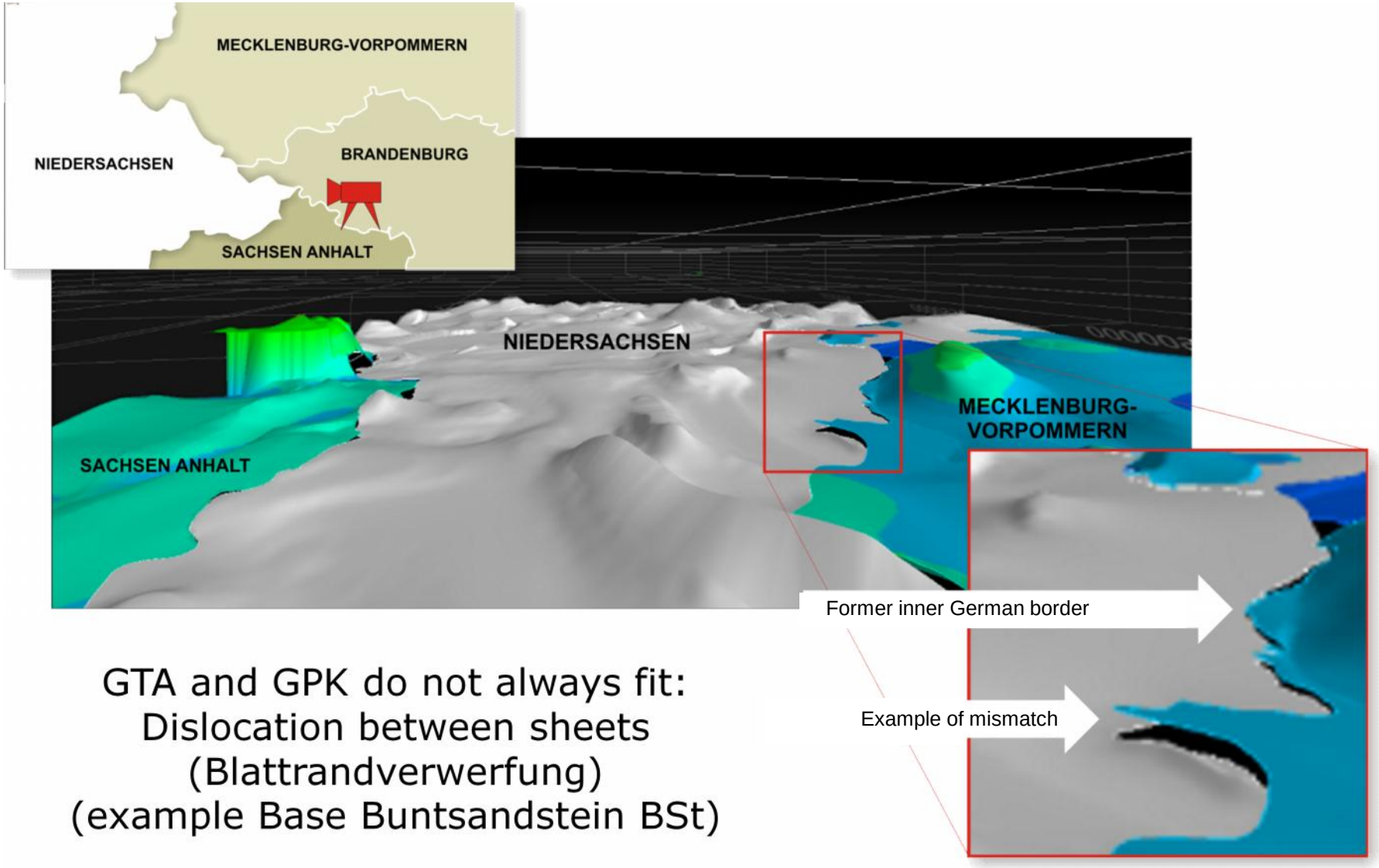
(3D model finished, partly done up to not yet started, models with different details, approaches, software used etc)

- Different starting time within project
- Different velocity models
- Varying concentrations and quality of data (e.g. from boreholes)

- GPK based on seismic reflectors
- GTA matched / fitted to stratigraphic markers

CHALLENGES

P1



GTA and GPK do not always fit:
Dislocation between sheets
(Blattrandverwerfung)
(example Base Buntsandstein BSt)

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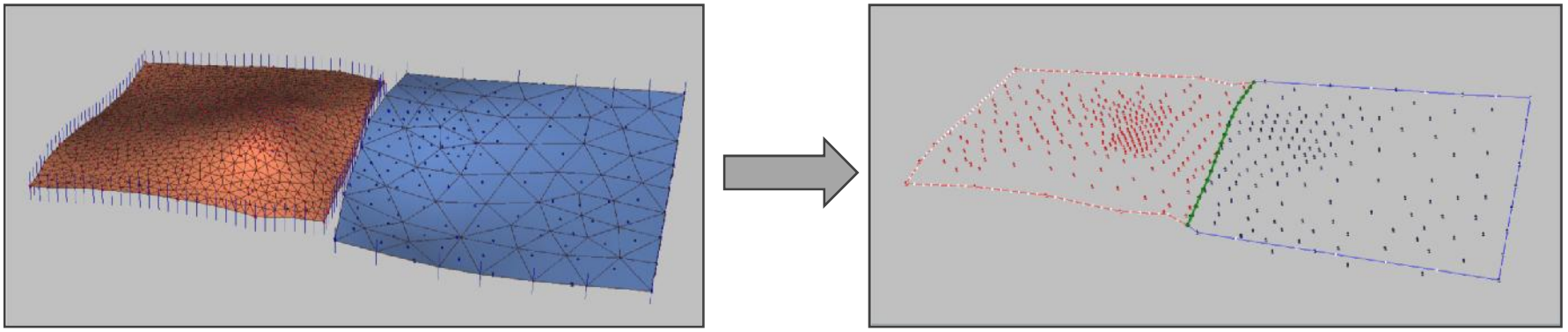
WAY FORWARD

Develop a harmonisation procedure

- We start in a „pilot area“ to
- develop and test workflows for e.g. fault modelling, modelling of salt structures, etc.

As best practice for modelling work in the remaining area
and help adjustment across national borders (to NL, DK, PL)



OUTLOOK

Our goal is to end up with a geological 3D model that: (i) is nationally and transnationally consistent, (ii) well documented, (iii) reflects uncertainties and (iv) is prepared to be improved in terms of detail and regions.

A-CAES
Source: DLR

H_2
CH_4

Geothermal
Energy

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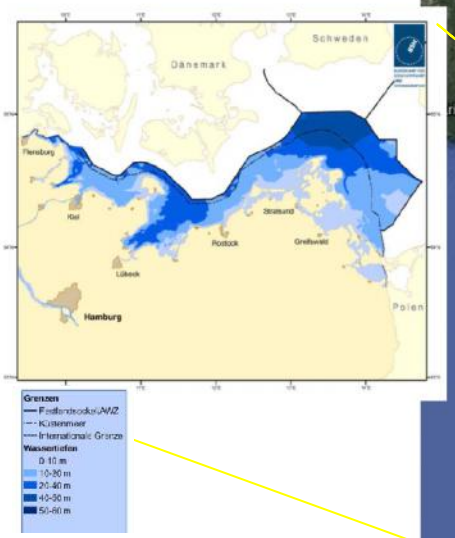
BALTIC SEA

P2



Source: Google maps (right), and (top) http://www.bsh.de/de/Meeresnutzung/Wirtschaft/CONTISInformationssystem/index.jsp)

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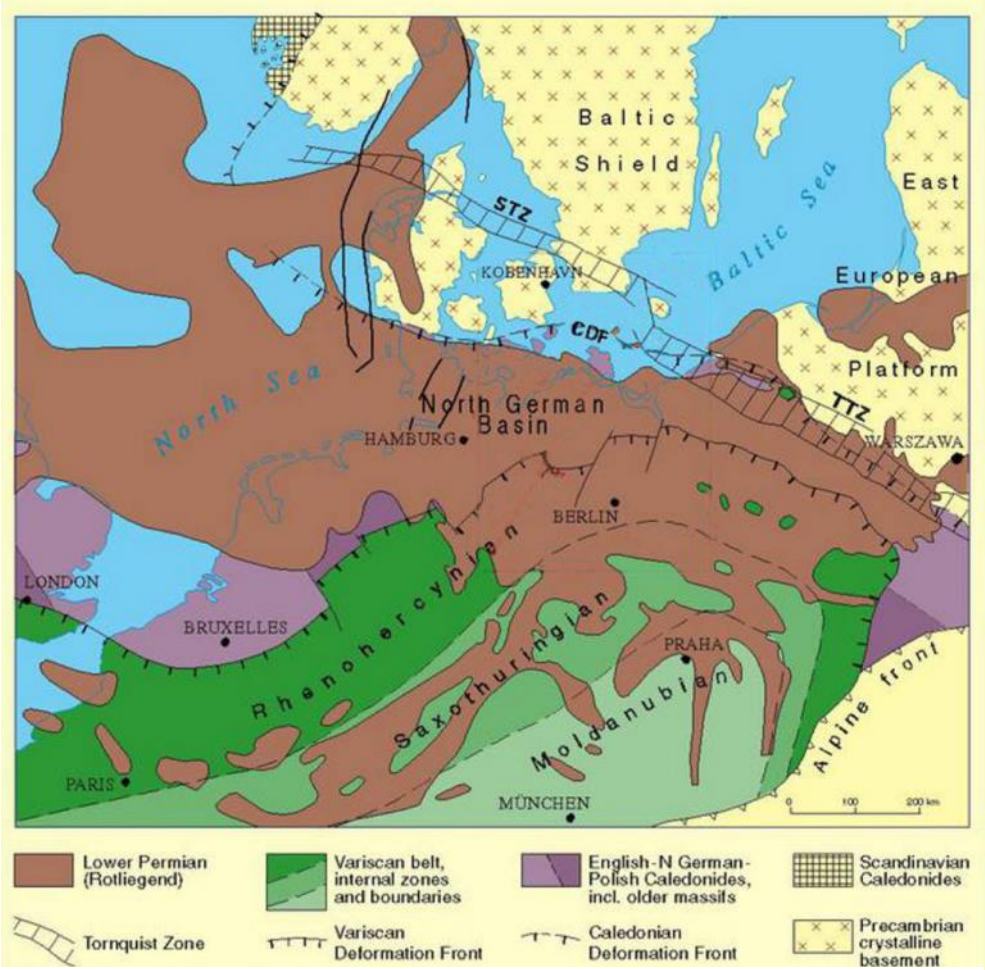


Modified map from © Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences

Location of the North German Basin related to regional structures of North Europe

STZ = Sorgenfrei-Tornquist-Zone
TTZ = Tornquist-Tesseyre-Zone
CDF = Caledonian Deformation Front

Baltic Sea NE of STZ/TTZ:

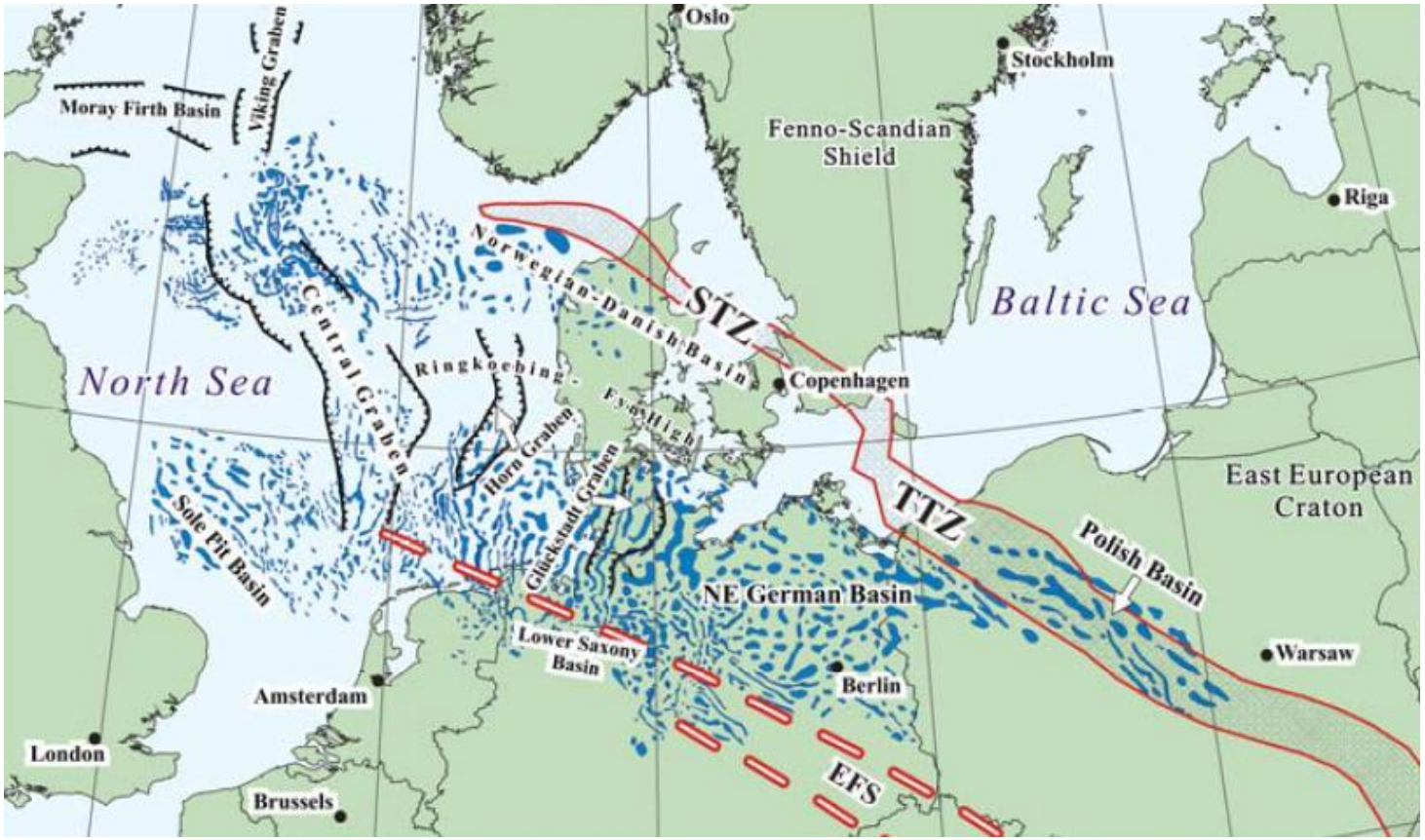
- Palaeozoic rocks underlain by Proterozoic crystalline basement

Baltic Sea SW of STZ/TTZ:

- Northern rim of the Southern Permian Basin (and its North German Basin)
- thick Mesozoic sediment filling
- complex tectonic structures

SALT STRUCTURES

P2



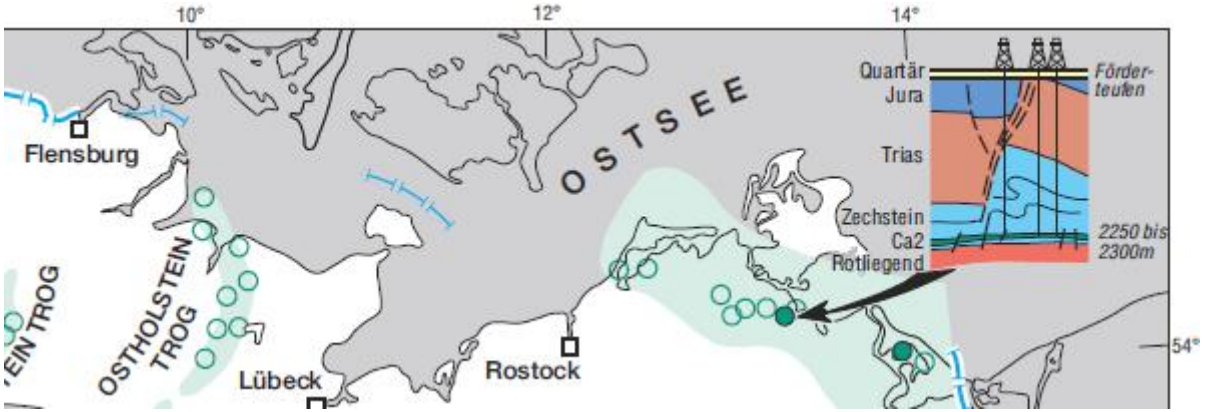
Source: Cacace M. (2008): Stress and strain modelling of the central European Basin. Dissertation

Distribution of salt structures in the North German Basin /German Baltic Sea

STZ = Sorgenfrei-Tornquist-Zone
TTZ = Tornquist-Tesseyre-Zone
EFS = Elbe Fault System

OIL and GAS

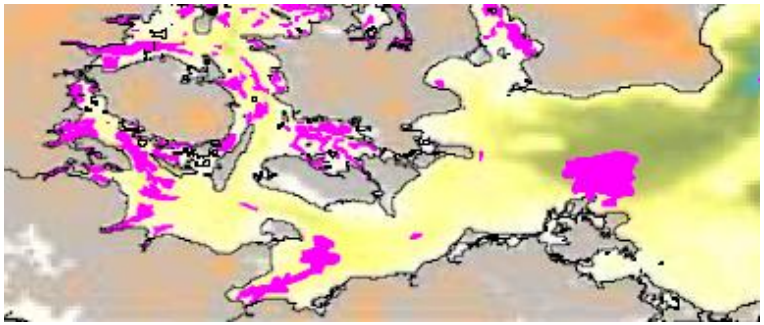
P2



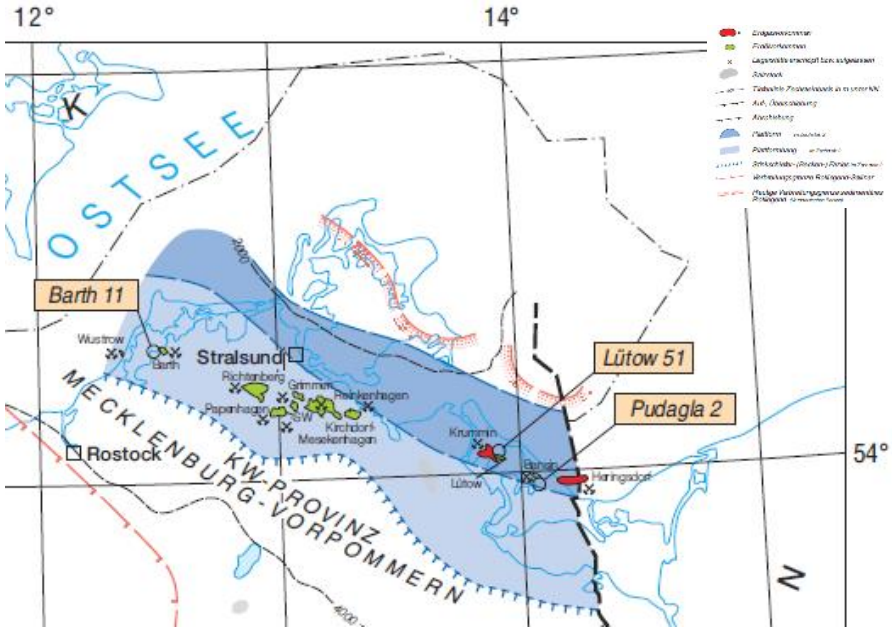
- Oil reserves < 1.5 mio. t
- Oil exploration (ceased - depleted)
- Prospective area

Source: Erdöl und Erdgas in der Bundesrepublik Deutschland 2013 (LBEG)

Shallow gas occurrences (purple areas) in Baltic Sea bottom sediments



Source: Endler R. et al. (2010) : Acustic imaging of shallow gas in Baltic Sea sediments. HYDRO 2010, 02.-05. November, Rostock-Warnemünde, Germany



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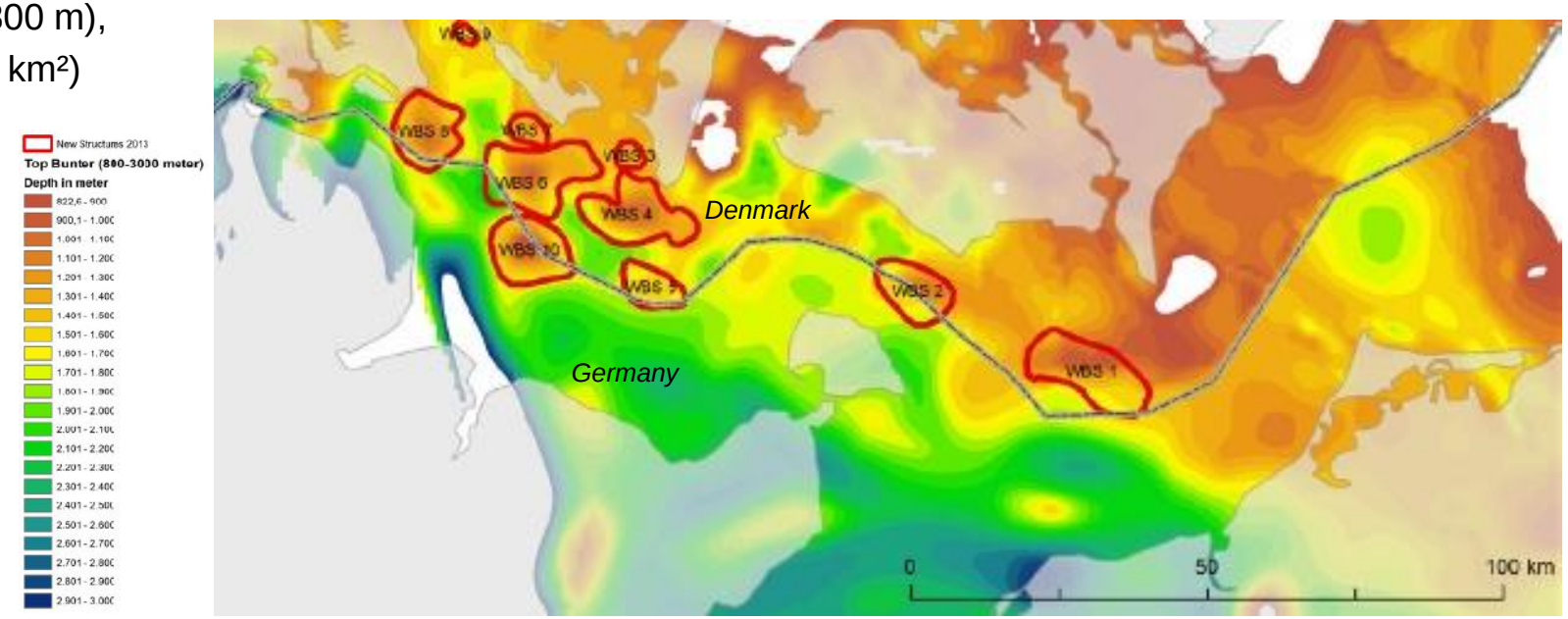
CO_2 STORAGE POTENTIAL

Latest investigation of Southwest Baltic Sea (Denmark and Germany) (Anthonsen et al., 2014):

Identification of 10 structures in Bunter Sandstone / Gassum Formation.

selection criteria:

- depth (> 800 m),
- size (> 10 km²)



Source: Anthonsen K.L., Bernstone C., Feldrappe H. (2014): Screening for CO2 storage sites in Southeast North Sea and Southwest Baltic Sea. Energy Procedia 63, 5083-5092

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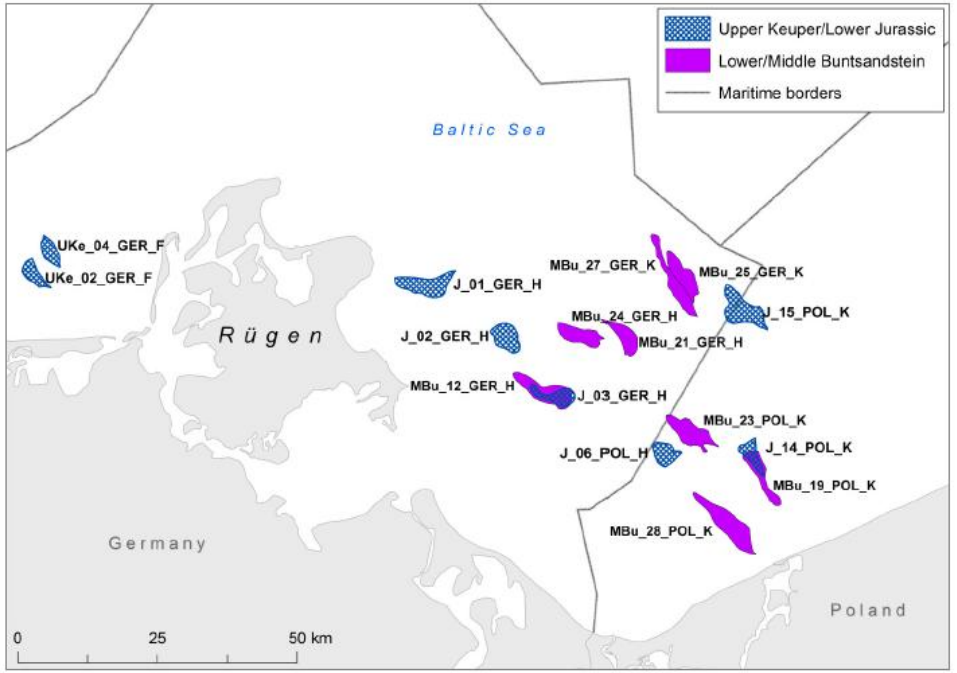
CO_2 STORAGE POTENTIAL

Latest investigation of East German (and West Polish) Baltic shelf area (Anthonsen et al., 2014):

Identification of 16 structures at the bases of the Jurassic/ Upper Keuper and the Middle Bunter.

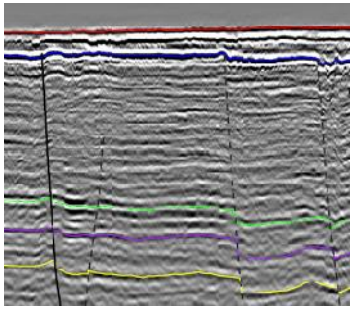
selection criteria:
- depth (> 800 m),
- size (> 10 km²),
- thickness of storage complex (> 10 m)

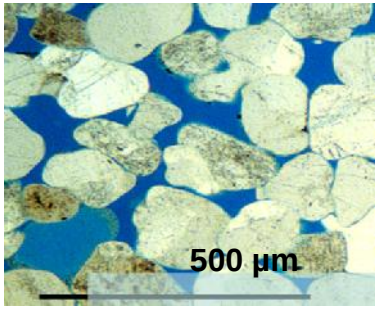


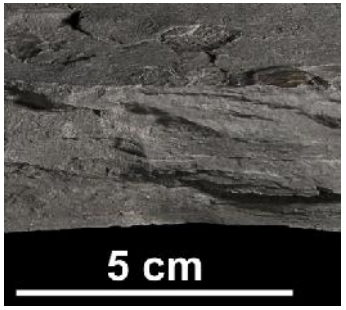
Source: Anthonsen K.L., Bernstone C., Feldrappe H. (2014): Screening for CO2 storage sites in Southeast North Sea and Southwest Baltic Sea. Energy Procedia 63, 5083-5092

CO_2 STORAGE POTENTIAL

P2





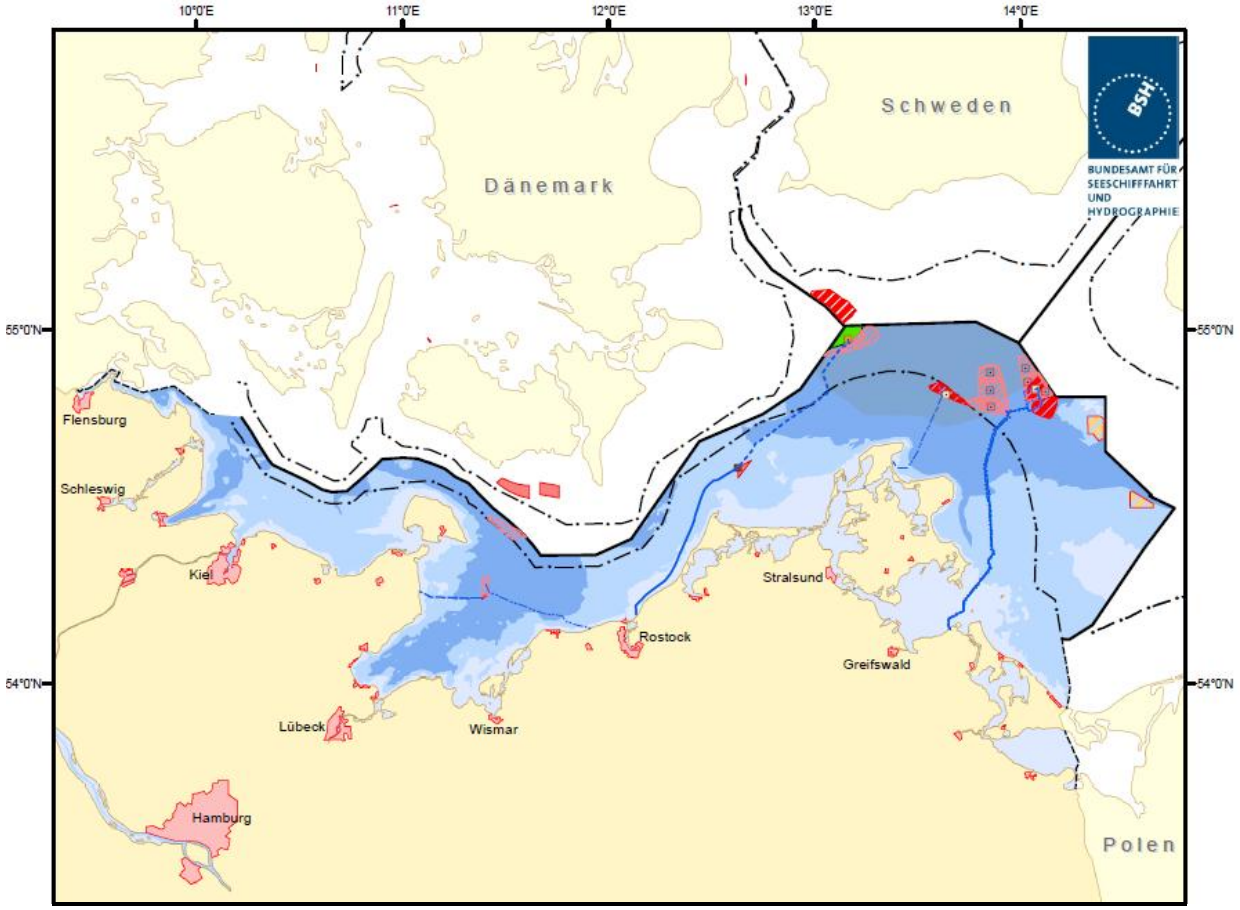
Storage potential: Great uncertainty

- lack of precise data and consequently lack of relevant reservoir parameters
- small number of bore-holes and consequentially a small amount of data
- extrapolation of the few data to the whole area has been difficult because of the complex structural geology of the East German Baltic shelf area

Authors* come to the conclusion that the suitability of the identified underground structures has to be investigated by a more comprehensive exploration program including the sealing formations on top of the storage complexes.

* Anthonsen K.L., Bernstone C., Feldrappe H. (2014)

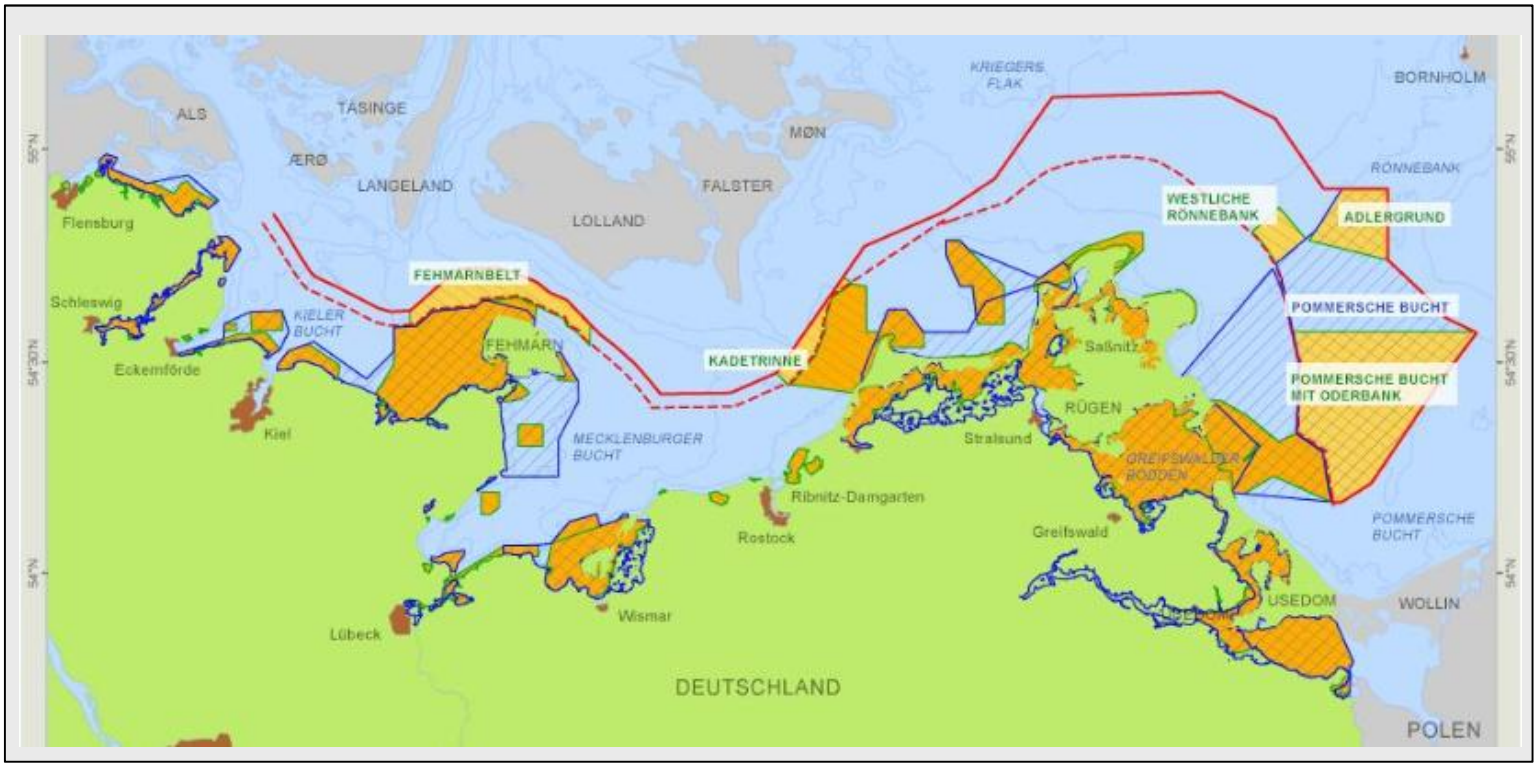
OFFSHORE WIND PARKS



Source: *www.bsh.de/de/.../CONTIS.../OstseeOffshoreWindparksPilotgebiete.pdf*

NATURE CONSERVATION

P2



Source: BfN Bundesamt für Naturschutz, Fachgebiet Meeres- und Küstenschutz, Stand 2011

FFH area *Bird protection area*

Natura 2000: Conservation of natural habitats and of wild fauna and flora (EU guideline 92/43/EEC)

SUMMARY

German sector of the Baltic Sea has something to offer in terms of

- Resources (renewables as well as hydrocarbons)
- Subsurface storage potential (although presumably small)
- Natural reserve

Need to avoid conflicts of interest and conflicts of use.

A geological 3D model can support the identification of potential conflicts and help provide solutions.

Thank you very much for your attention.