

A 3D Model of the North German Basin – Challenges and Approaches

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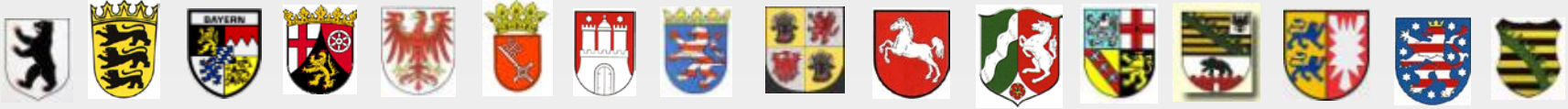
Federal Institute for Geosciences and Natural Resources (BGR)



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BGRs Interaction with Regional Geological Surveys in Germany



- **Germany** is a federal states system with **16 states**, including 3 city states (Berlin, Hamburg, Bremen). States have clearly established responsibilities.
- **Each state has its Regional Geological Survey (RGS)** with responsibility on all matters of geology, raw materials, ecology; sometimes combined with mining authority. Mapping up to 1 : 200,000 scale is done by RGSs, beyond by BGR.
- Federal Government has responsibility for nuclear waste disposal, CCS, and international matters; so has BGR. **BGR handles technical cooperation with developing countries, EuroGeoSurveys, etc.**
- Directors of RGSs and BGR as well as representatives of supervising ministries meet regularly twice a year for coordination purposes. They install and supervise ad-hoc working groups on geology, hydrogeology, raw materials, data bases etc.

Motivation

The deep subsurface is already today 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, and 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 CO₂ 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.

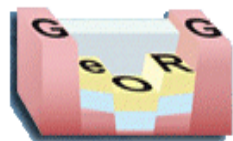
- Increased need for information of the subsurface
- Work related to German CCS Law (compilation of basic geological information)

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

A 3D Model of the North German Basin



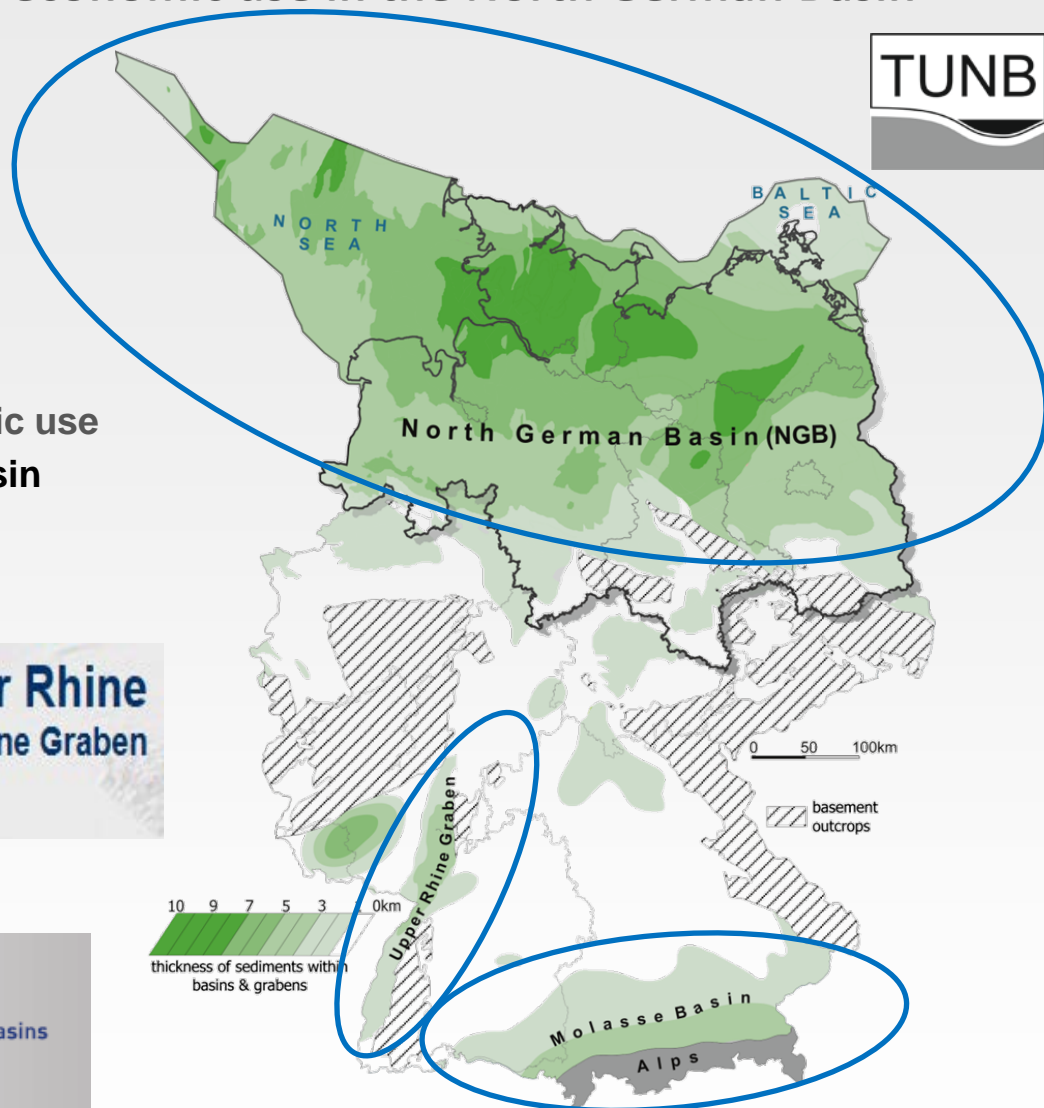
Subsurface potentials for storage and economic use in the North German Basin



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



Project structure & goals

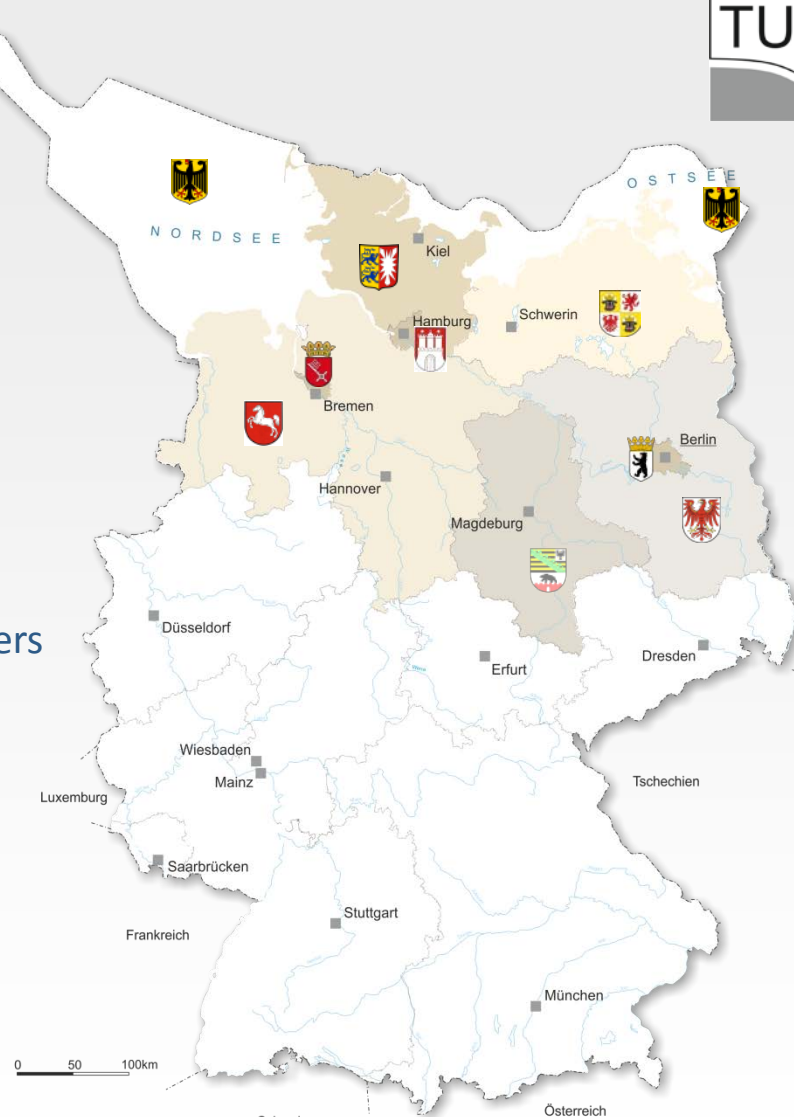
Goal: 3D model of the North German Basin

Duration: 6 years (start in 2014)

Partners:



- Phase 1 (first 3½ years)
 - 3D structural model with 13 horizons
 - harmonized across national and international borders
- Phase 2 and 3
 - „from surfaces to volume“ – selection of regions
 - parameterisation of selected regions / structures
 - 3D parameterised volume model
- Accompanying research activities
- Long-term (beyond project scope)
 - 3D model of entire area of Germany

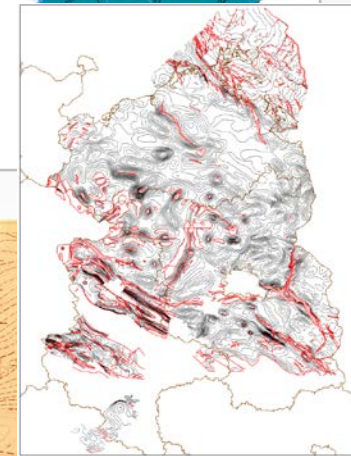
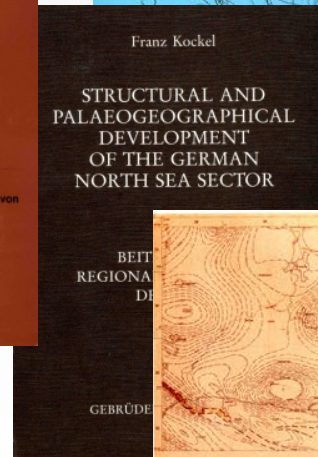
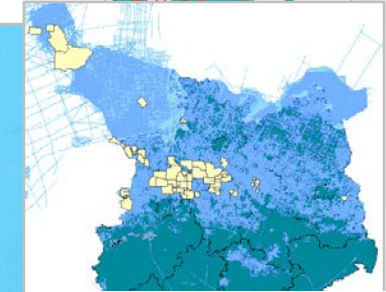
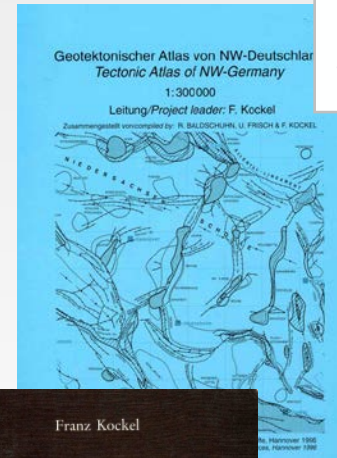
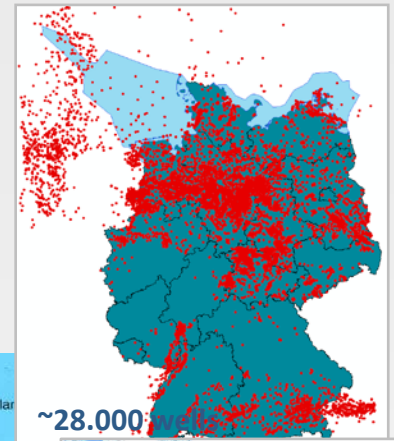


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Background information

Source of data and Information

- Seismic and well data
- Hydrocarbon well database of the federal states at the LBEG
- Well databases of the federal states
- Tectonic Atlas of NW-Germany (GTA)
- Geophysical Atlas of the GDR (GPK)
- Geothermal cartography
- Paleogeographic maps
- Reports
- ...



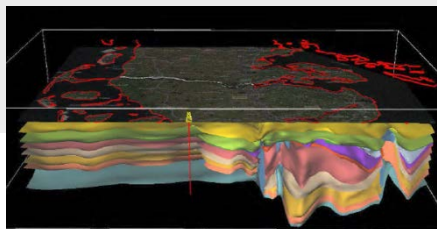
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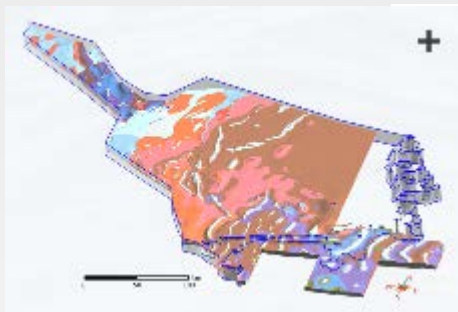
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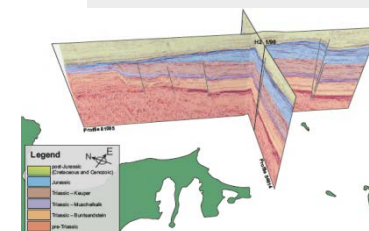
Starting points / previous work



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

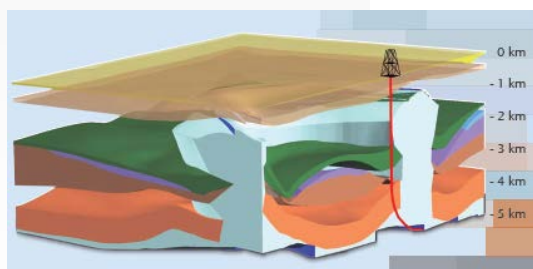


Source: GPDN



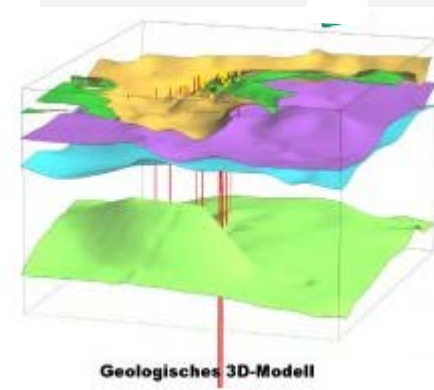
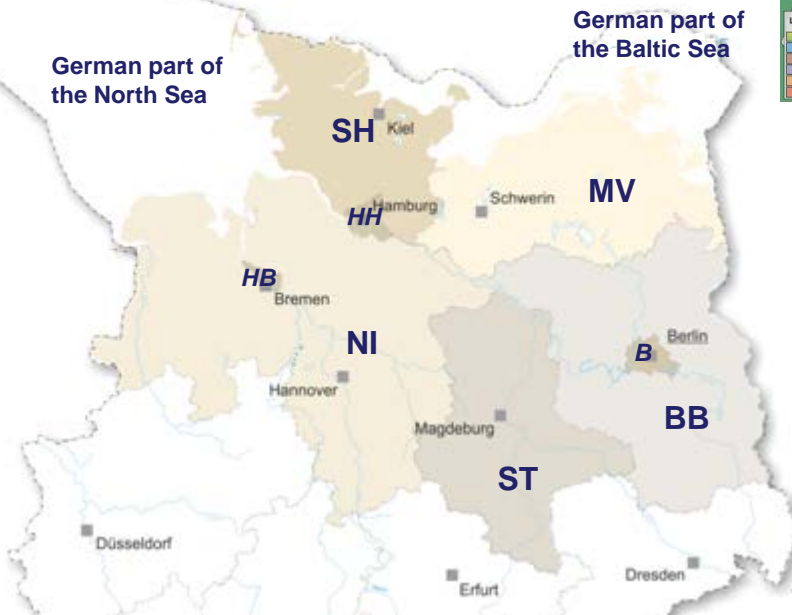
Source: Seidel E., Meschede E., Obst K.: Distribution of Triassic Sediments in the Baltic sea east of Ruegen Island based on reprocessed Petrobaltic seismic data.

Based on „GTA“: Tectonic Atlas of NW-Germany



Source: LBEG 3D-Modell_2012-09.pdf

See also: www.infogeo.de



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

Based on „GPK“: Geophysical Atlas of the GDR



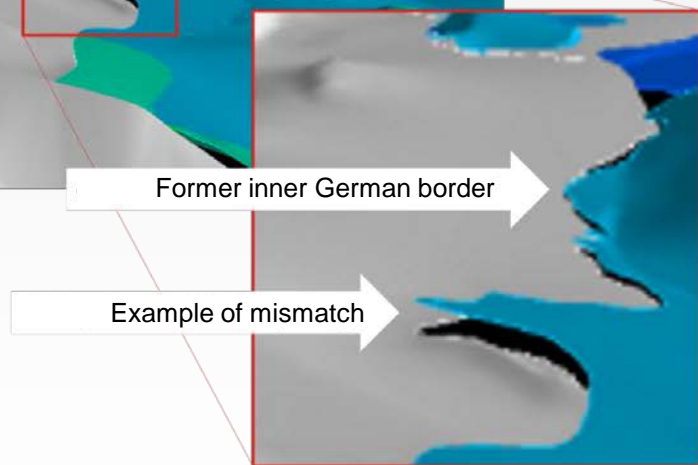
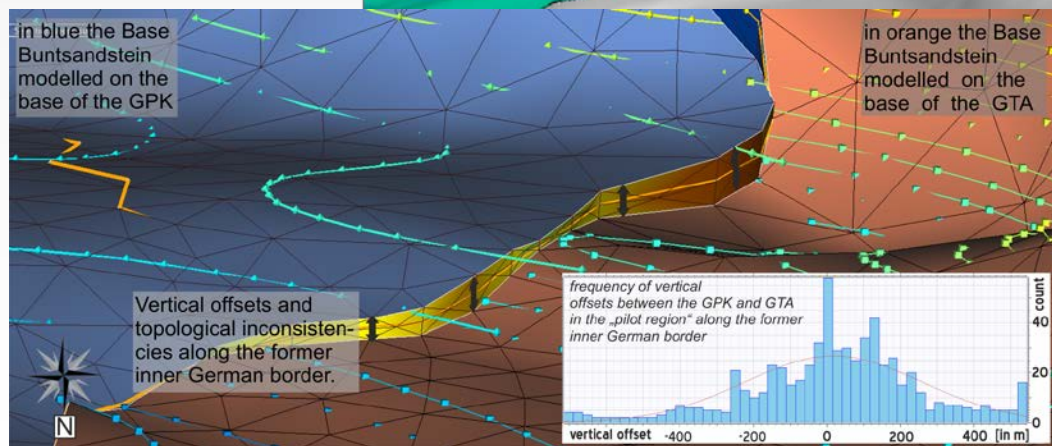
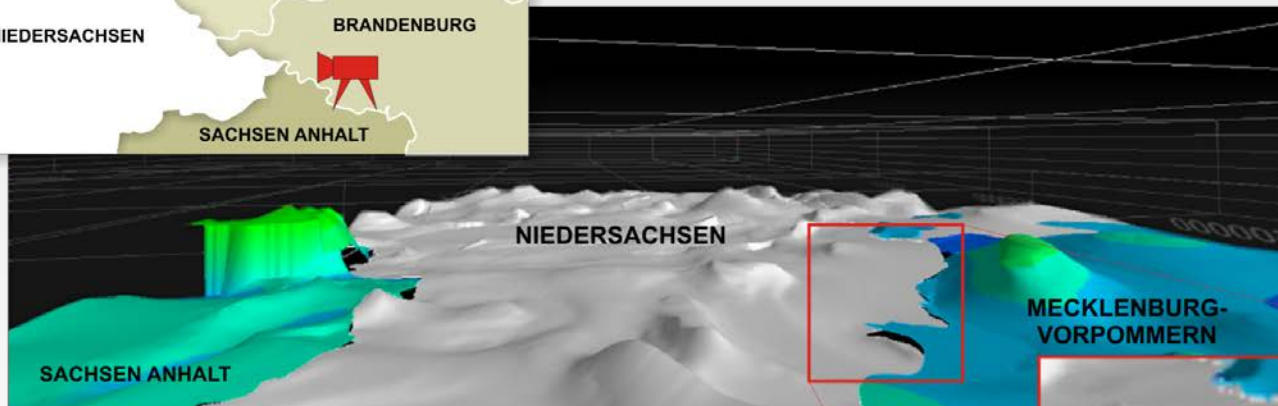
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Subsurface potentials for storage and economic use in the North German Basin



Challenges: Inconsistencies along the former inner German border (GTA vs. GPK)

Example Base Buntsandstein



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Challenge: Agreement on model horizons (stratigraphy)

Tectonic Atlas of NW-Germany (GTA)
(Baldschuhn et al. 2001)

Scale:

- developed @ 1:25 000
- maps @ 1:100 000
- maps @ 1:300 000

Base of lithostratigraphic units:

- Tertiary
- Cretaceous
- Jurassic
- Triassic
- Permian

fault traces, salt structures etc.

Epoche	Stratigraphic Unit Menning (1997)	Strat. Marker	GTA (1995)	GPK (1970-1989)	TUNB Horizons
Quartär	Quatr	q			
Neogen (Jungtertiär)	Pliozän	tpi			
	Miozän	tmio	tmiR-q		
	Oligozän	to	tmiu		
Paläogen (Alttertiär)	teom	teom	teom+to	A2	Basis Rupelium
	teou	tpao	+teou	T1	
	Oberpaläozän	tpao			Basis Oberpaläozän
	Oberrhein	kr			
Oberkreide	kr		kro	B2	Basis Oberkreide
	kr				
	kr				
	kr				
	kr				
Unterkreide	kr		kru	T3	Basis Unter Kreide
	kr				
	kr				
	kr				
Oberjura (Malm)	jo		jo + Wd	E1	Basis Malm
	jo				
	jo				
	jo				
Dogger (Mittlerer Jura)	dm		jutco	T5	Basis Dogger
	dm				
Lias (Unterer Jura)	li		jutco	DB	Basis Lias
	li				
	li				
	li				
Keuper	ke			K1	Basis Rhät
	ke			K2	
	ke			K3	
Muschelkalk	mk		k	M1	Basis Keuper
	mk				
Ob. Buntsandstein	bs		so + m	M2	Basis Oberer Buntsandstein
	bs			M3	
	bs			S1	
Mittl. Buntsandstein	bs			S2	Basis Mittlerer Buntsandstein
	bs				
	bs				
Unt. Buntsandstein	bs			S3	Basis Buntsandstein
	bs				
Zechstein	z		z	X1	Basis Zechstein
	z			X1'	
	z			X3/X2	
	z			Z1	
Oberoligozän	ro		R5-R1	H6	
	ro				

Geophysical Atlas of the GDR (GPK)
(Reinhardt et al 1960-1991)

Scale:

- developed @ 1:25 000
- maps @ 1:100 000, 1:200 000
- maps @ 1:500 000 (generalised)

Seismic reflection horizons:

- Quaternary
- Tertiary
- Cretaceous
- Jurassic
- Triassic
- Permian

fault traces, salt structures etc.



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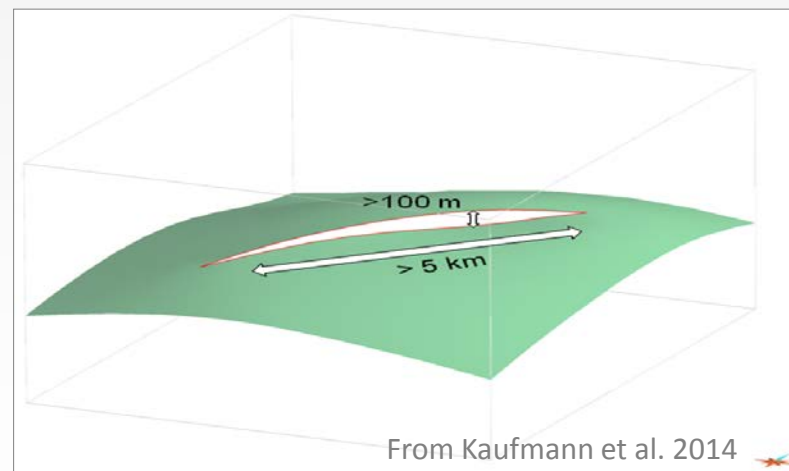
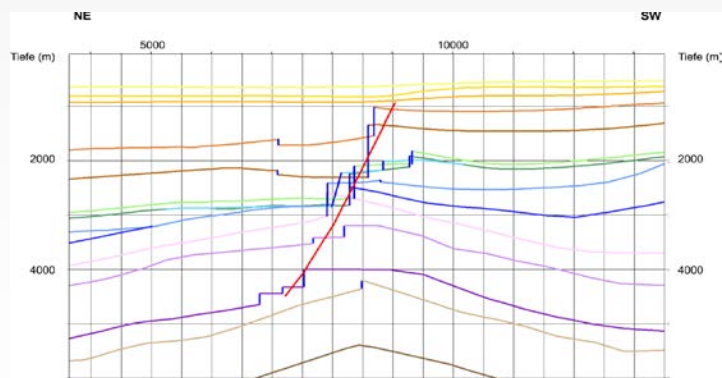
Challenge: Harmonised interpretation and generalisation

- Harmonized concept of horizon interpretation (seism. Reflector → horizon)
- Harmonized concept of fault generalisation

Uniform criteria for incorporating faults in the model

- minimum length of the fault (5 km)
- minimum offset of 3 horizons
- a fault must not change its character (orientation, dip,...) across state borders

A lot of coordination between the RGS is required



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

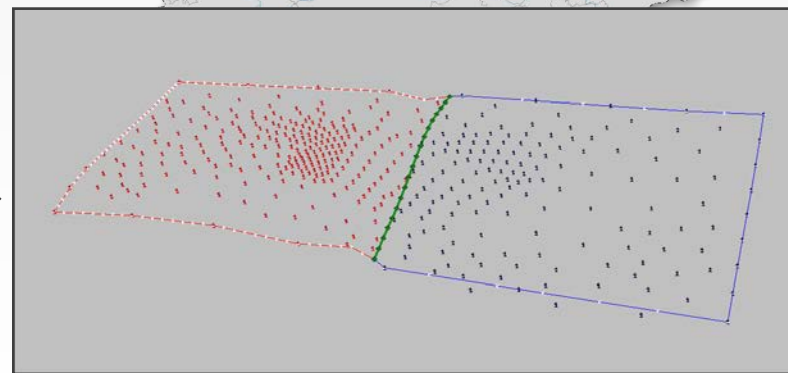
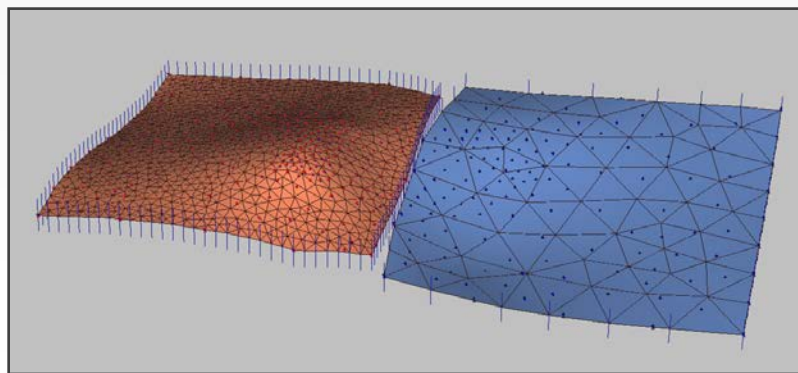
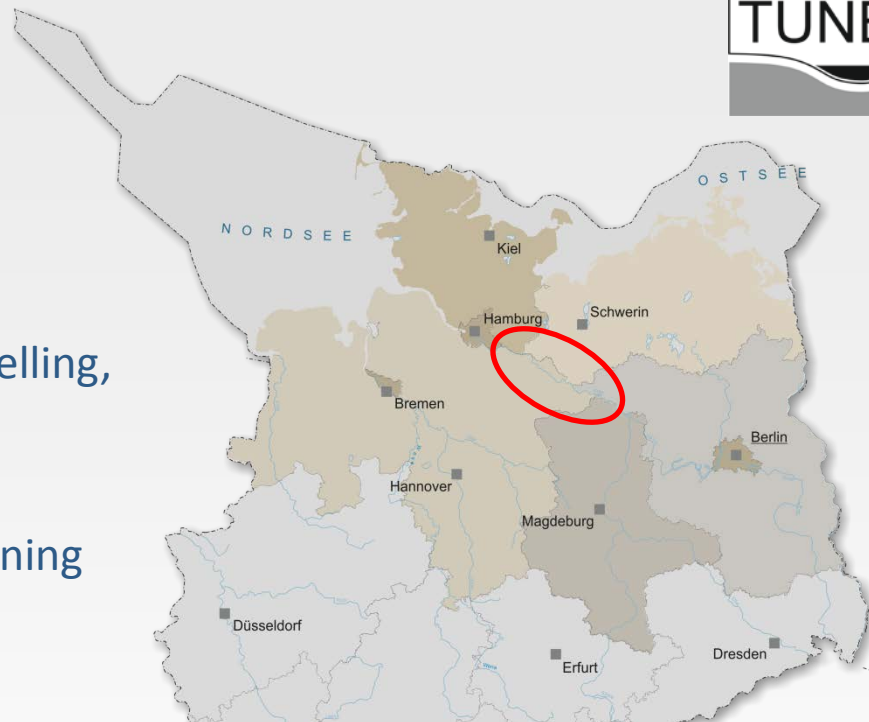


Approach: Pilot area

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 and international borders (to NL, DK, PL)



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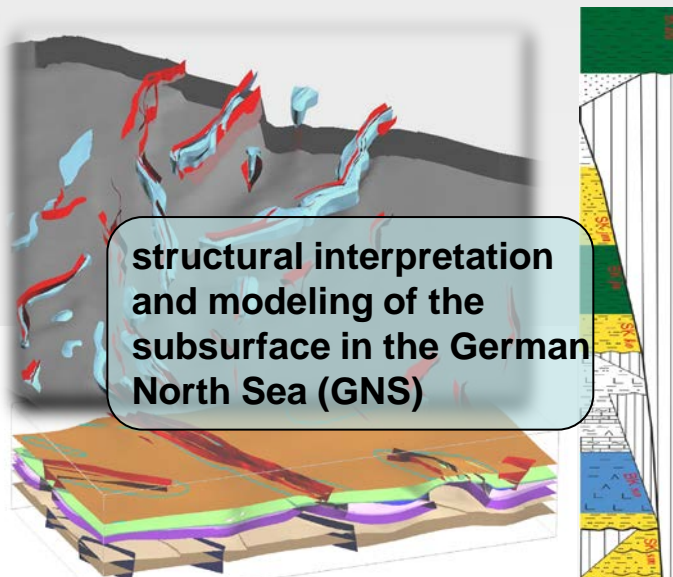
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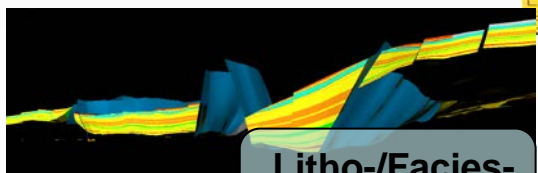
Examples of accompanying research activities (GNS)

Seismic mapping study



structural interpretation and modeling of the subsurface in the German North Sea (GNS)

detailed seismostratigraphic and lithological analysis of Mesozoic rock units

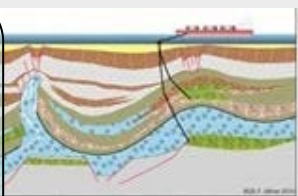


Litho-/Facies-modeling

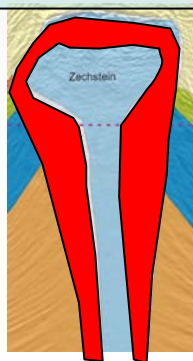
Seismic velocity modeling

Time-Depth migration

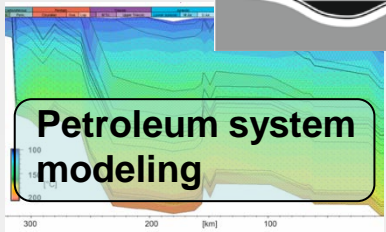
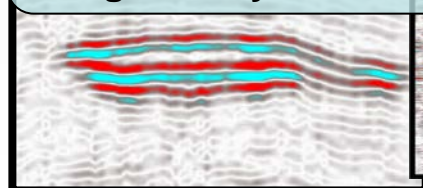
barrier and storage rocks in the GNS. Estimation of storage potentials in saline aquifers



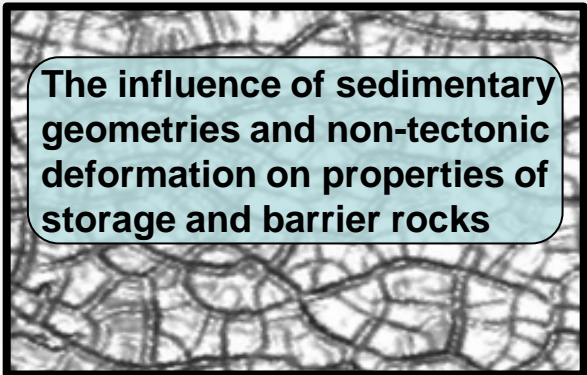
Aspects of uncertainties in geological models



shallow gas and relationship to Neogene Delta evolution and geometry



Petroleum system modeling



The influence of sedimentary geometries and non-tectonic deformation on properties of storage and barrier rocks



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



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.

