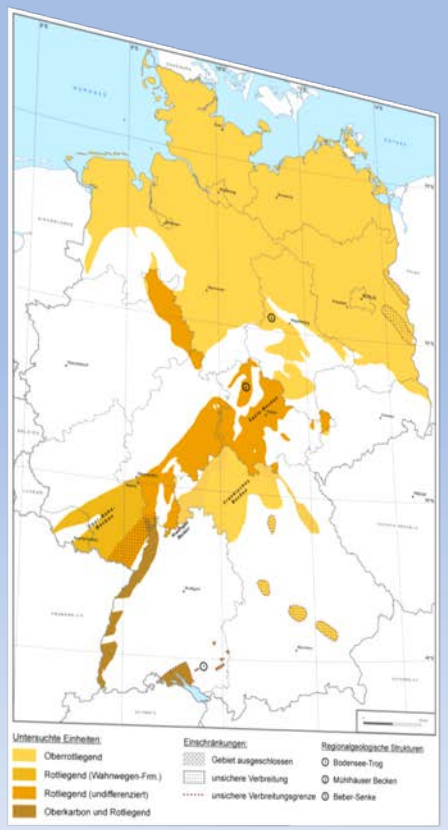
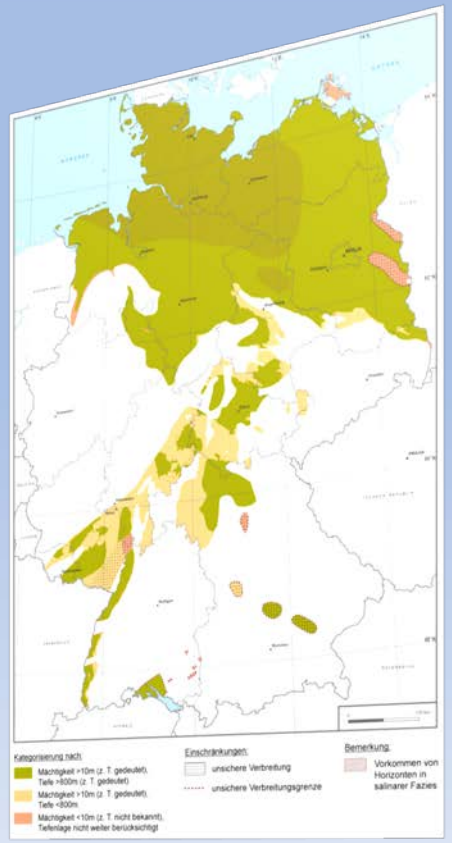
Storage Catalogue of Germany

An information system for subsurface use in Germany





Dr. Christian Müller
(Federal Institute for Geosciences and Natural Resources, BGR)

7th EUREGEO, Bologna, Italy, June 12th – 15th, 2012

Outline

- Motivation (subsurface use of deep porous reservoir rocks in Germany)
- Status of CCS legislation in Germany
- CO_2 Storage options in Germany & volumetric storage capacity estimates
- Storage Catalogue of Germany
- Atlas to visualise potential conflicts of use between geothermal energy and CCS
- Conclusions

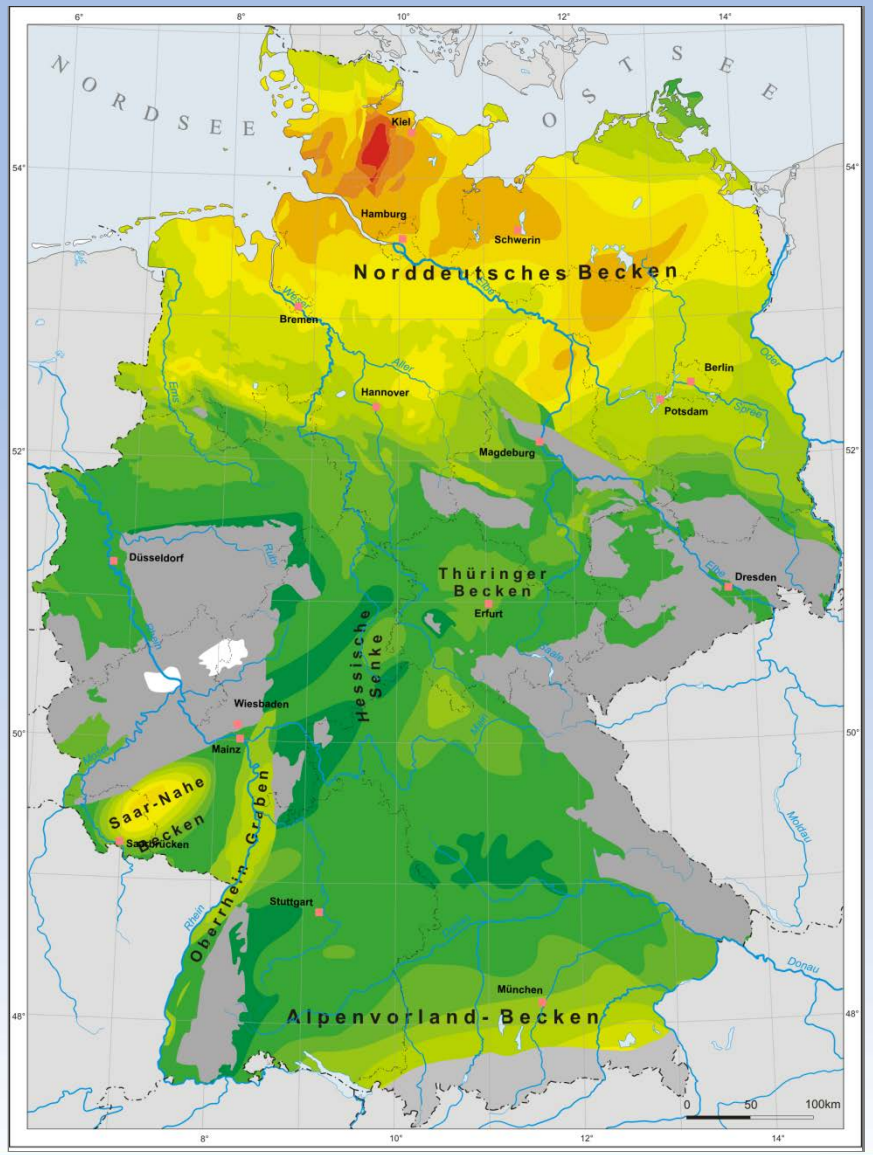
Motivation

- ~800 Mt of annual CO_2 emissions (~350 Mt from energy sector)
- Carbon dioxide emissions in Germany shall be reduced by al least 80% until 2050 (-40% until 2020)
- Nuclear power will phase out in Germany until 2022

- Ambitious goals
- Increased focus on the subsurface for storage an economic use

- Increase of potential conflicts of use (geothermal energy, CCS, gas storage)
- Increased need for information on the subsurface (subsurface planning, e.g. via information systems)

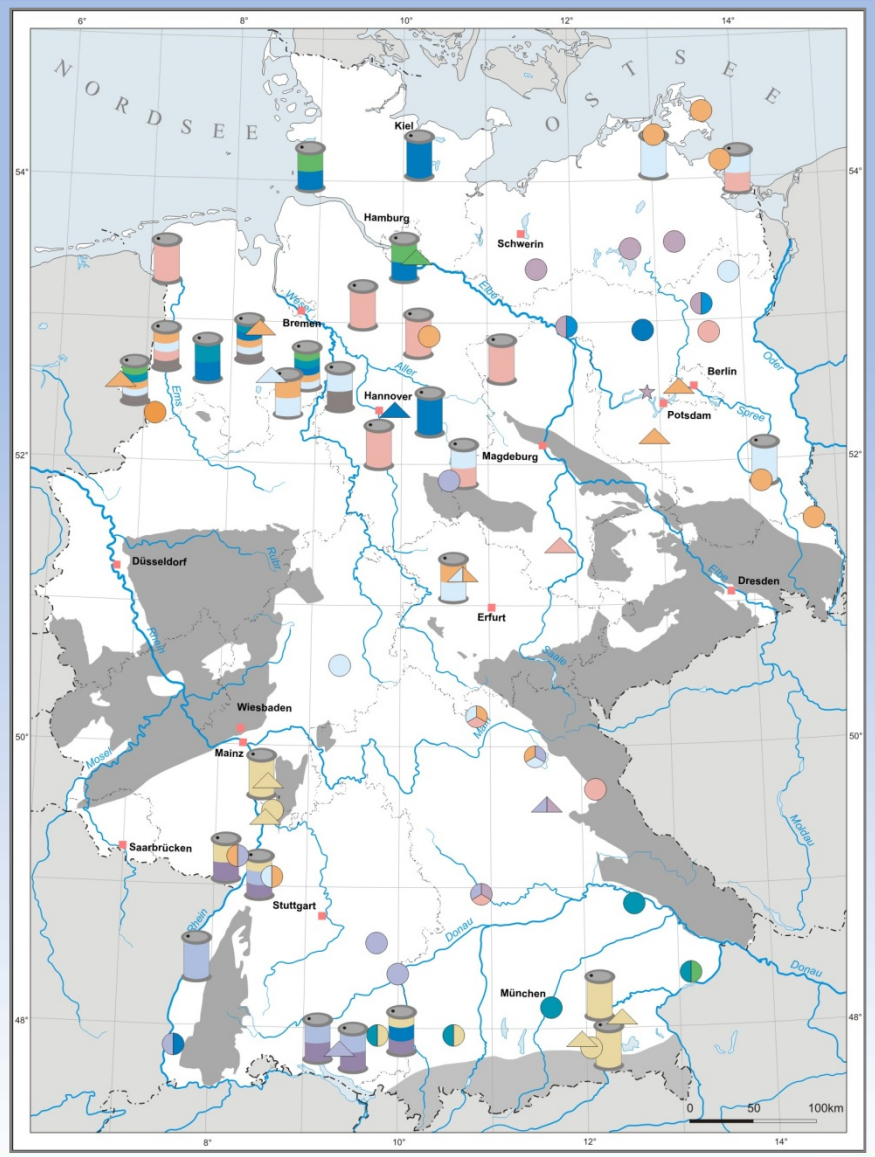
Use of deep porous rocks in Germany



Source: Reinhold & Müller (2011)

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

Use of deep porous rocks in Germany



- Hydrocarbon fields
- Underground gas storage
- Geothermal use
- ?Geological storage of CO_2
- ?Hydrogen storage
- ?compressed air storage

anstehendes magmatisches und metamorphes sowie gefaltetes sedimentäres Grundgebirge (z.T. unter känozoischer Bedeckung)

Alpen

Nutzung tiefliegender Porenspeicher

- KW-Felder
- Geothermische Nutzung
- Untertage-Erdgasspeicherung
- CO_2-Pilotspeicher Ketzin

Stratigraphische Zuordnung der Nutzhorizonte

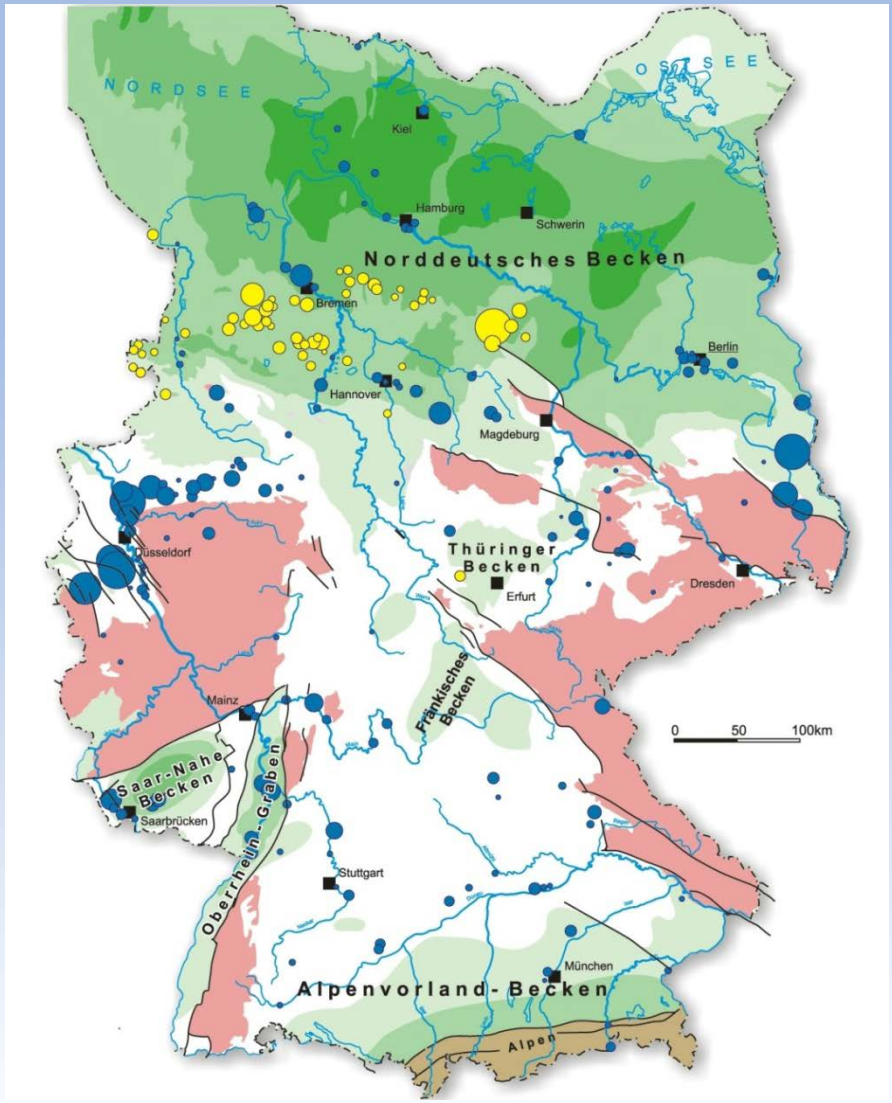
- Tertiär
- Kreide
- Jura
  - Oberjura
  - Mitteljura
  - Unterjura
- Trias
  - Keuper
  - Muschelkalk
  - Mittlerer Buntsandstein
- Perm / Karbon
  - Zechstein
  - Rotliegend
  - Karbon

Source: Reinhold & Müller (2011)

Status on CCS legislation in Germany
(Legislation on the demonstration of geological CO_2 storage)

- EU framework directive 2009/31/EC of 23 April 2009
- Joint draft by BMWi und BMU on 1. April 2009 approved by the Cabinet
- Legislation process stopped in June 2009
- According to the coalition agreement of the new government in 2009 the CCS legislation is to be implemented soon in the new legislative periode (2009-2013)
- The Cabinet approved the new draft of the CCS legislation on 13.04.11
  - including the opt-out clause for the federal states
  - max. 3 million tonnes CO_2 p. a. und storage
  - total max. 8 million tonnes CO_2 p. a.
  - applications for exploration will be limited in time until 31.12.2015
  - applications for storage concession need to be submitted until 31.12.2016
  - reporting from the German Government to German Bundestag on the application of the legislation until 31.12.2017
- The German Bundestag approved the legislation on 07.07.2011
- The German Bundesrat rejected the CCS legislation 23.09.2011
- Conciliation started 26.10.2011

CO_2 storage capacity in natural gas fields



important CO2 emission points

Natural gas fields

Regions with storage potential

Increasing thickness of sedimentary column

1km
3km
5km
7km
9km
10km

deep saline aquifers

Regions without significant storage potential

Basement

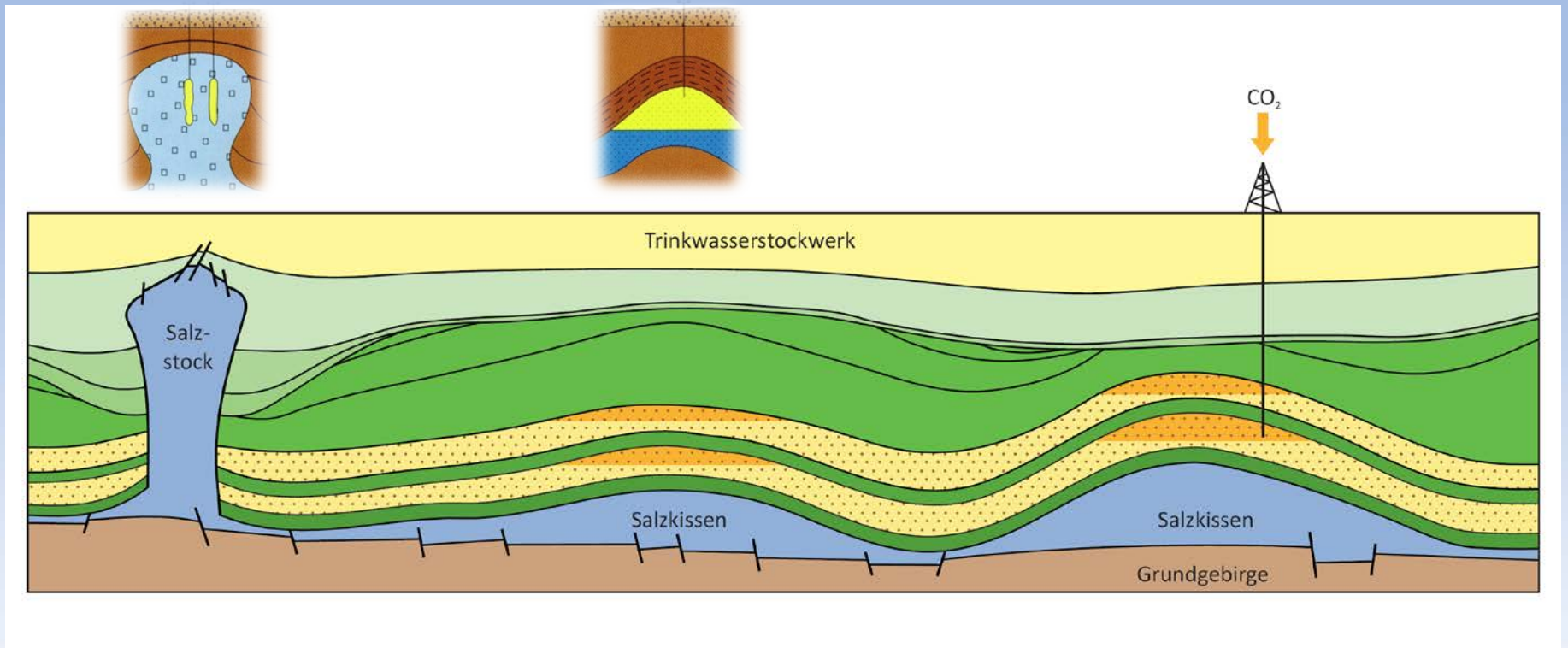
Reservoir rocks not present or not deep enough

BGRs assessment of storage capacity of selected natural gas fields

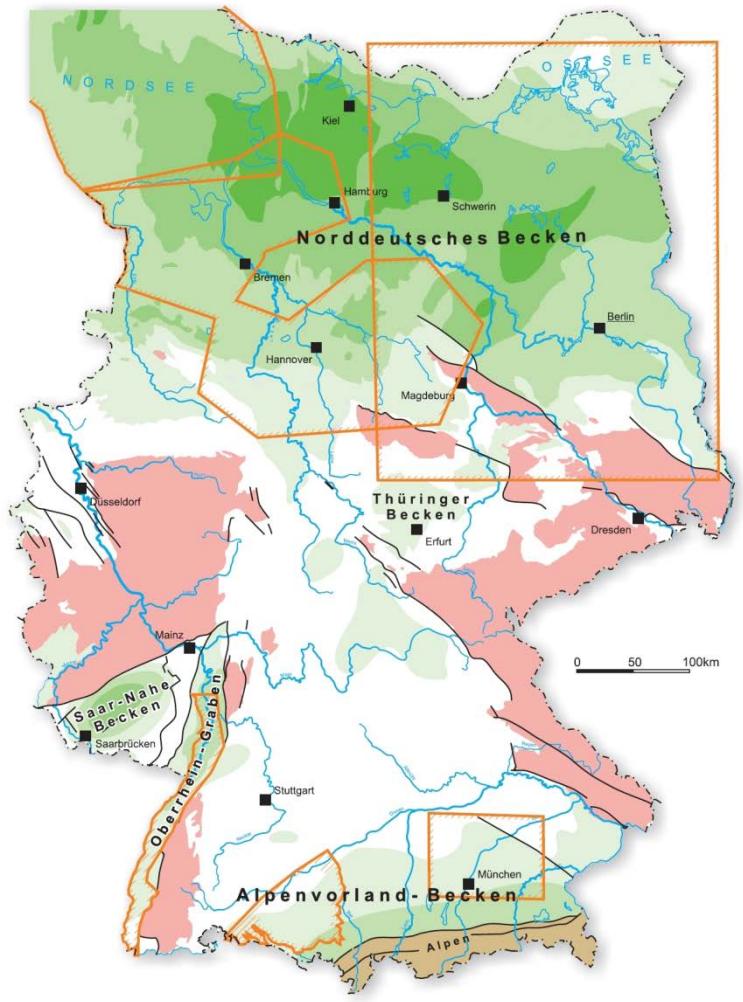
→

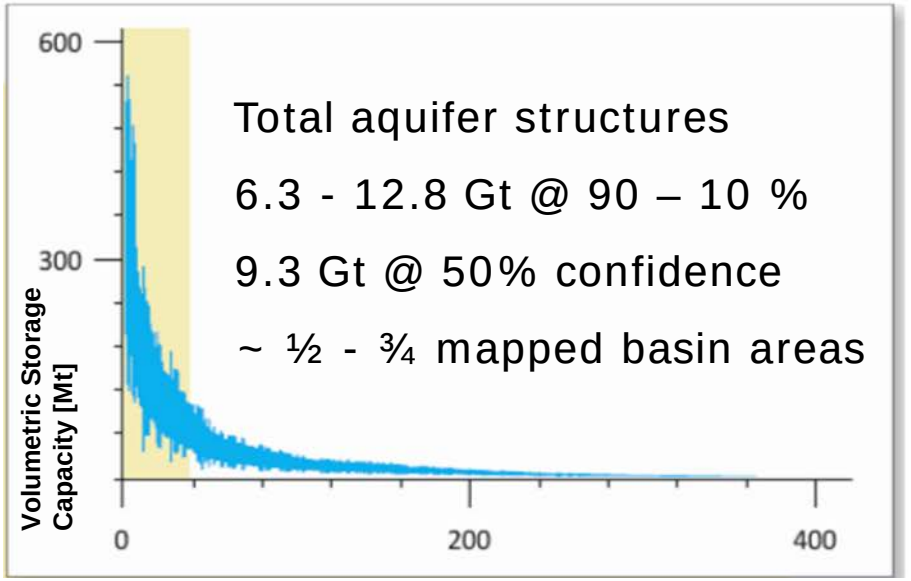
Estimated CO_2 storage capacity in natural gas fields:
2,75 Gt

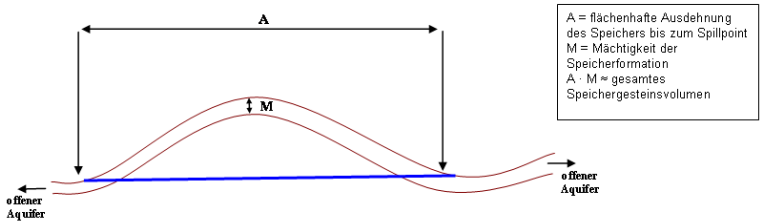
CO_2 storage capacity in aquifer structures



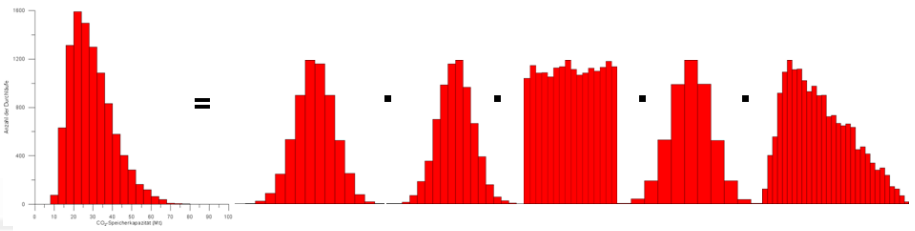
CO_2 storage capacity in aquifer structures







$$K = A \cdot M \cdot \Phi \cdot \rho \cdot E$$



Source: Knopf et al. (2010)

Storage Catalogue of Germany – project goals

Project goals:

- Characterization of reservoir and barrier rock units in Germany at a scale of 1:1.000.000 based on common criteria
- Detailed Characterization of regions with storage potential including construction of “structural” maps at a scale of 1:300.000 (not site specific)
- Development of an information system on reservoir and barrier rock units including „header data“ on wells and geophysical measurements for a wide user group from politics, industry and the general public

=> Primary focus on CO_2 storage options, but reservoir rocks may be suitable for gas storage and/or geothermal use also

Storage Catalogue of Germany – project structure

- Project structure:
  BGR (project leader) plus state geological surveys of all federal states

- Funding: BMWi (COORETEC – 1.15 M€) plus industry (EnBW, E.ON, Vattenfall Europe Mining – 300 T€)
- Duration: 04/2008 until 03/2011

Criteria for reservoir and barrier rocks

Reservoir rocks

- Depth (top of reservoir rock unit): >800 m
- Net thickness of reservoir rocks within reservoir rock unit: >10 m
- Porosity of reservoir rocks: >10 % (>20%)
- Permeability of reservoir rocks: >10 mD (>300 mD)

} point information from wells

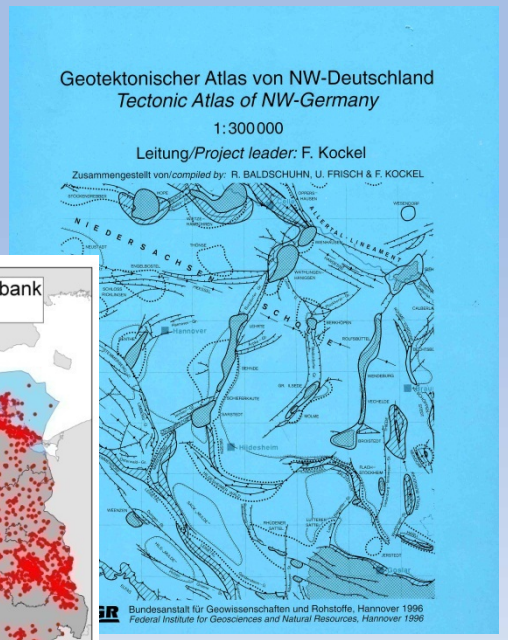
Barrier rocks (cap rocks)

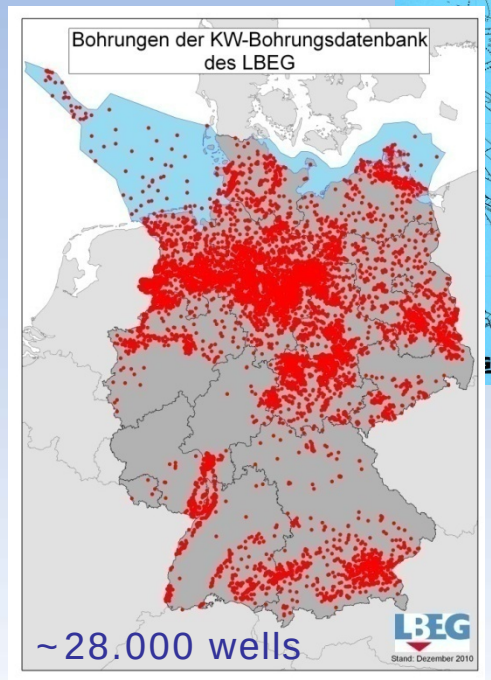
- Adequate lithology (e.g. clay stones, salt (halite))
- Depth (base of barrier rock unit): >800 m
- Thickness of adequate barrier rocks: >20 m

*Parameters derived from CO2STORE BPM

Source of data and Information

- Hydrocarbon well database of the federal states at the LBEG
- Well databases of the federal states
- Tectonic Atlas of NW-Germany
- Geophysical cartography of the GDR
- Geothermal cartography
- Paleogeographic maps
- Unpublished reports
- ...

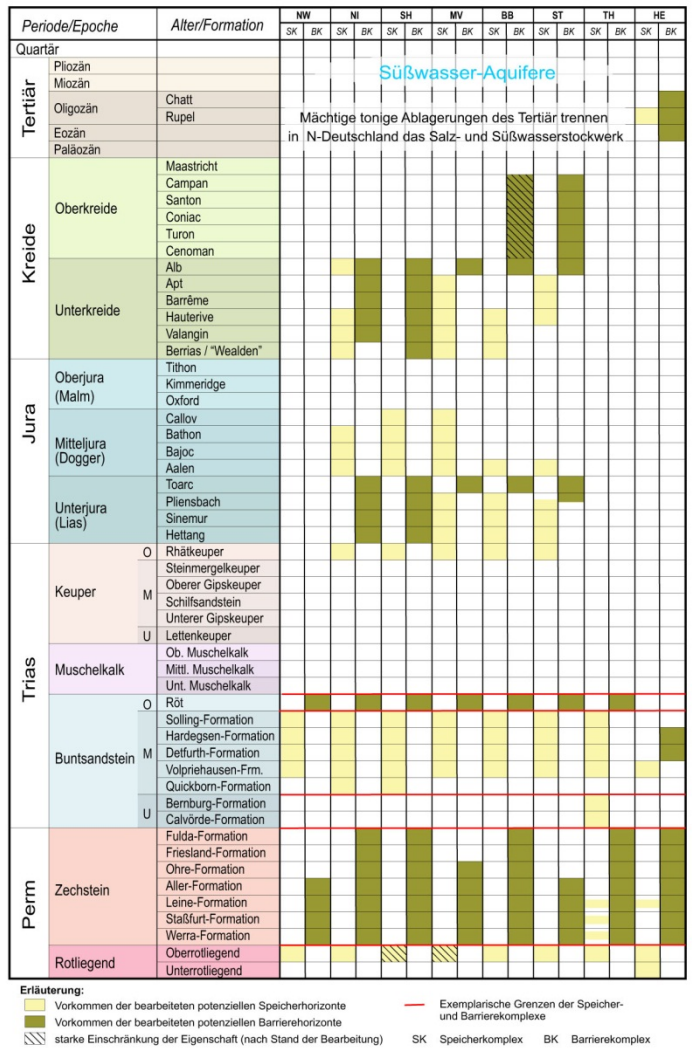




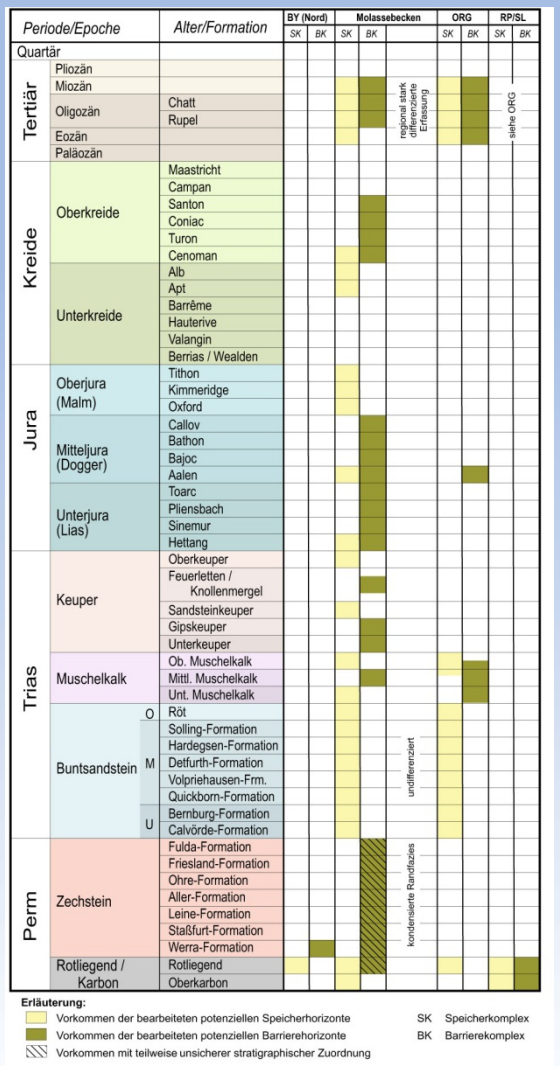
! No collection of new data!
! No laboratory analyses!

Reservoir and barrier rock units

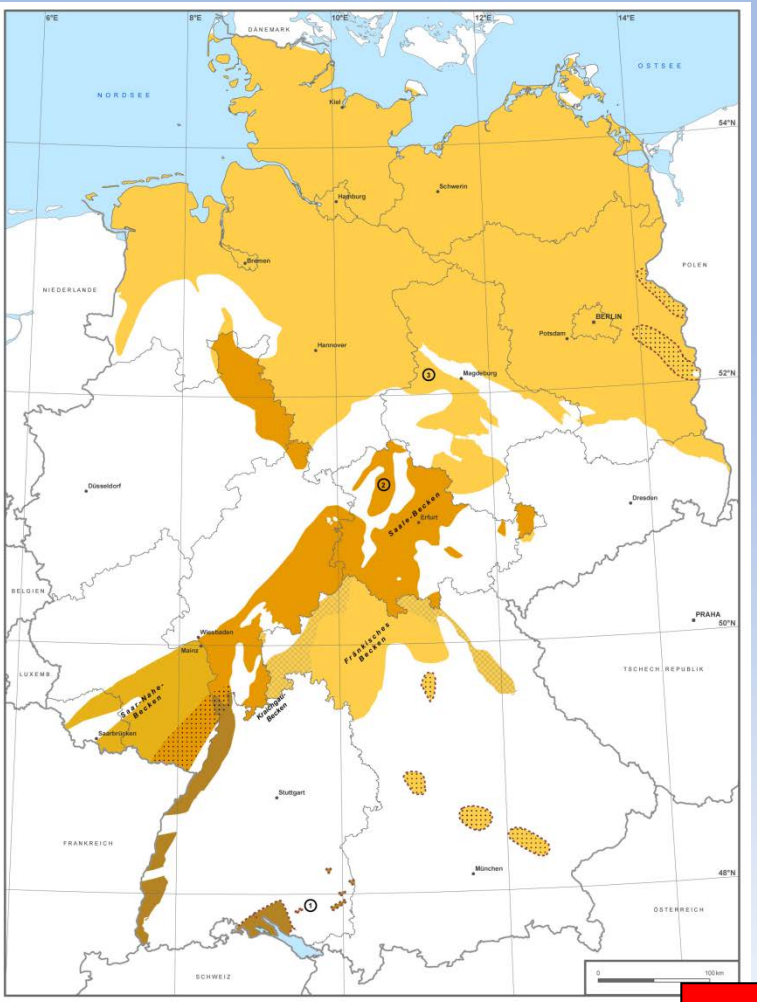
N-Germany



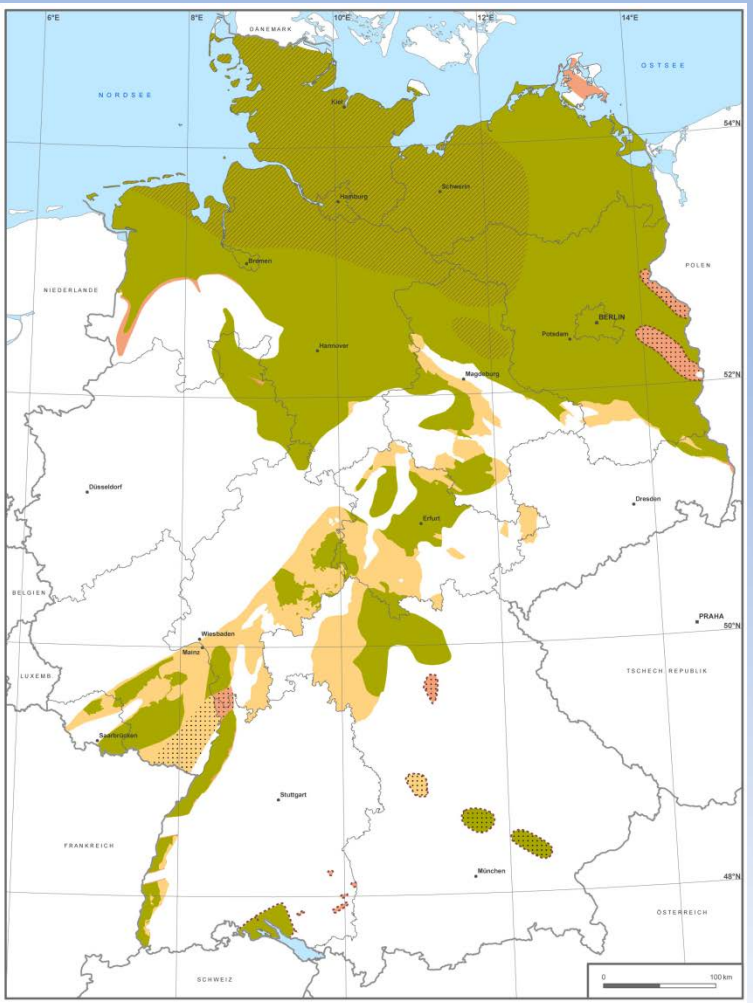
S-Germany



Permo-Carboniferous deposits
as potential reservoir rock unit



Periode/Epoche		Alter/Formation	
Quartär			
Tertiär	Pliozän		
	Miozän		
	Oligozän		Chatt
			Rupel
	Eozän		
	Paläozän		
Kreide	Oberkreide		Maastricht
			Campan
			Santon
			Coniac
			Turon
			Cenoman
	Unterkreide		Alb
			Apt
			Barrême
			Hauterive
			Valangin
			Berrias / "Wealden"
Jura	Oberjura (Malm)		Tithon
			Kimmeridge
			Oxford
	Mitteljura (Dogger)		Callov
			Bathon
			Bajoc
			Aalen
	Unterjura (Lias)		Toarc
			Pliensbach
			Sinemur
			Hettang
Trias	Keuper	O	Rhätkeuper
		M	Steinmergelkeuper
			Oberer Gipskeuper
			Schilfsandstein
			Unterer Gipskeuper
		U	Lettenkeuper
	Muschelkalk		Ob. Muschelkalk
			Mittl. Muschelkalk
			Unt. Muschelkalk
	Buntsandstein	O	Röt
		M	Solling-Formation
			Hardegsen-Formation
			Detfurth-Formation
			Volpriehausen-Frm.
			Quickborn-Formation
		U	Bernburg-Formation
			Calvörde-Formation
Perm	Zechstein		Fulda-Formation
			Friesland-Formation
			Ohre-Formation
			Aller-Formation
			Leine-Formation
			Staßfurt-Formation
			Werra-Formation
	Rotliegend		Oberrotliegend
			Unterrotliegend



Untersuchte Einheiten:
- Oberrotliegend
- Rotliegend (Wahnwegen-Frm.)
- Rotliegend (undifferenziert)
- Oberkarbon und Rotliegend

Einschränkungen:
- Gebiet ausgeschlossen
- unsichere Verbreitung
- unsichere Verbreitungsgrenze

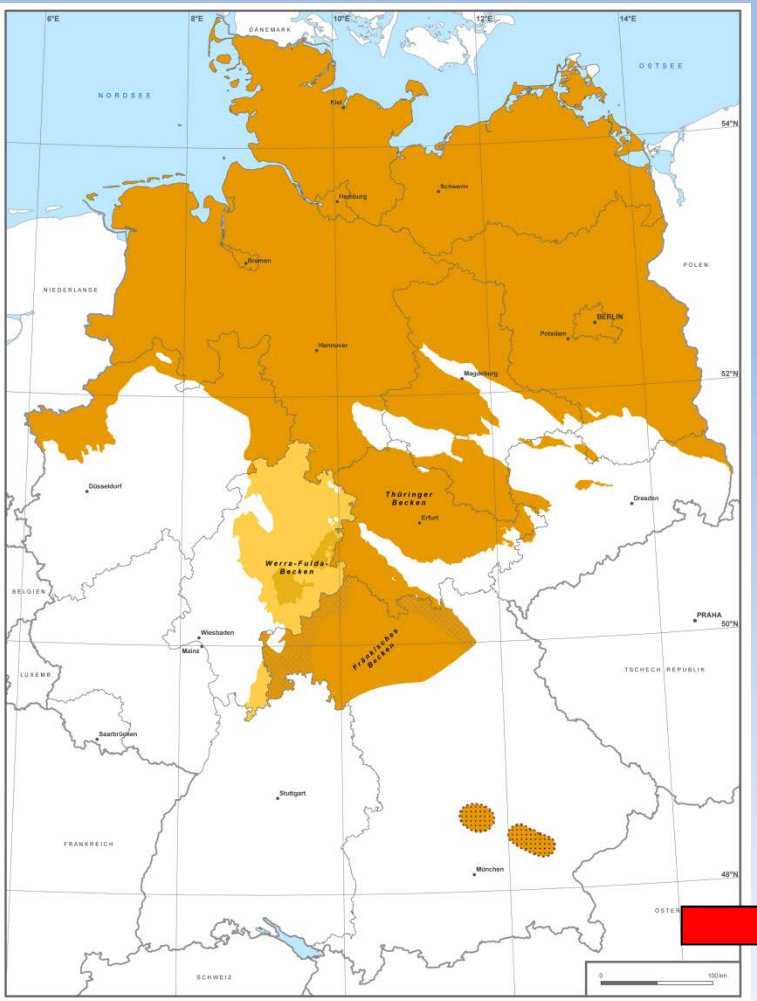
Regionalgeologische Strukturen:
- ① Bodensee-Trog
- ② Mühlhäuser Becken
- ③ Beber-Senke

Kategorisierung nach:
- Mächtigkeit >10m (z. T. gedeutet), Tiefe >800m (z. T. gedeutet)
- Mächtigkeit >10m (z. T. gedeutet), Tiefe <800m
- Mächtigkeit <10m (z. T. nicht bekannt), Tiefenlage nicht weiter berücksichtigt

Einschränkungen:
- unsichere Verbreitung
- unsichere Verbreitungsgrenze

Bemerkung:
- Vorkommen von Horizonten in salinarer Fazies

Zechstein deposits
as potential barrier rock unit



Periode/Epoche			Alter/Formation
Quartär			
Tertiär	Pliozän		
	Miozän		
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			Rupel
	Eozän		
	Paläozän		
Kreide	Oberkreide		Maastricht
			Campan
			Santon
			Coniac
			Turon
			Cenoman
	Unterkreide		Alb
			Apt
			Barrême
			Hauterive
			Valangin
			Berrias / "Wealden"
Jura	Oberjura (Malm)		Tithon
			Kimmeridge
			Oxford
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			Bajoc
			Aalen
	Unterjura (Lias)		Toarc
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Trias	Keuper	O	Rhätkeuper
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	Muschelkalk		Ob. Muschelkalk
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			Solling-Formation
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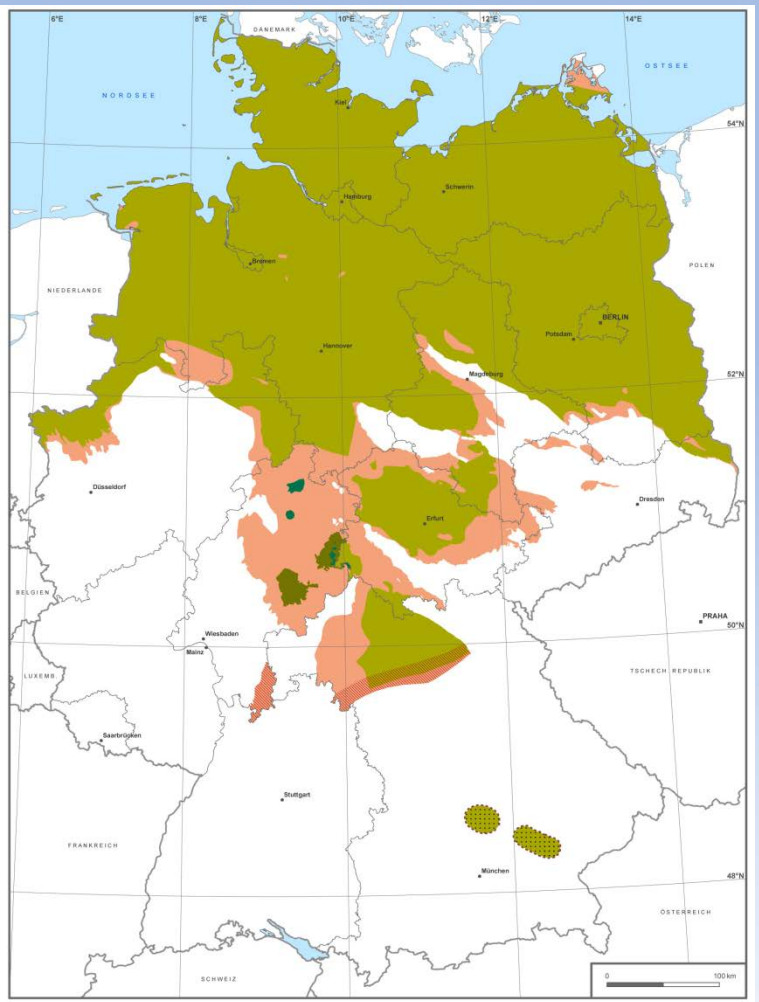
			Volpriehausen-Frm.
			Quickborn-Formation
			Bernburg-Formation
		U	Calvörde-Formation
Perm	Zechstein		Fulda-Formation
			Friesland-Formation
			Ohre-Formation
			Aller-Formation
			Leine-Formation
			Staßfurt-Formation
			Werra-Formation
	Rotliegend		Oberrotliegend
			Unterrotliegend



Untersuchte Einheiten:
- Zechstein oberhalb Plattendolomit (z4 - z7)
- Zechstein unterhalb Plattendolomit (z1 - z3)
- Zechstein (undifferenziert)

Einschränkungen:
- Gebiet ausgeschlossen
- unsichere Verbreitung
- unsichere Verbreitungsgrenze

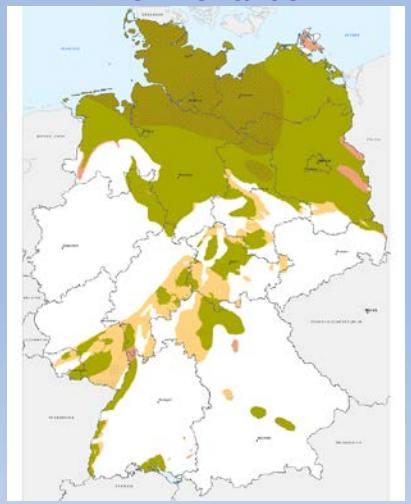
Kategorisierung nach:
- Mächtigkeit >20m (z. T. gedeutet) und Tiefe >800m
- Mächtigkeit <20m (z. T. nicht bekannt) und/oder Tiefe <800m

Anmerkungen:
- Barriere-Einh. z1 - z3
- Barriere-Einh. z4 - z7

Einschränkungen:
- sandige Randfazies
- unsichere Verbreitung
- unsichere Verbreitungsgrenze

Reservoir rock units - overview

Permokarbon

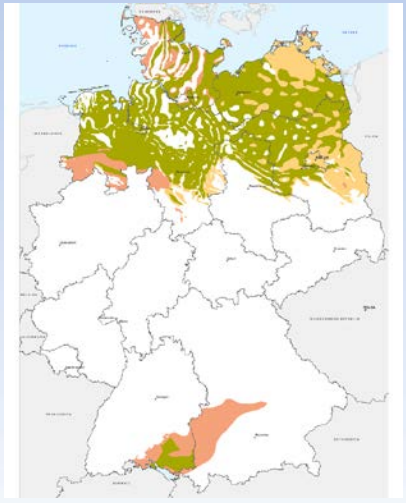


Zechstein

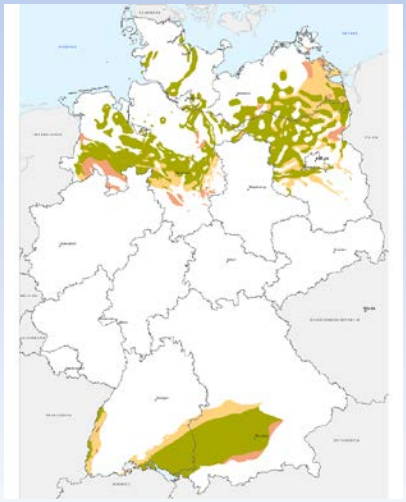
Buntsandstein

Muschelkalk

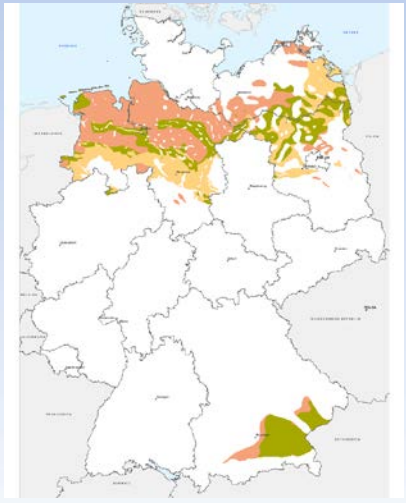
Mittlerer Keuper



Oberer Keuper / Unterjura

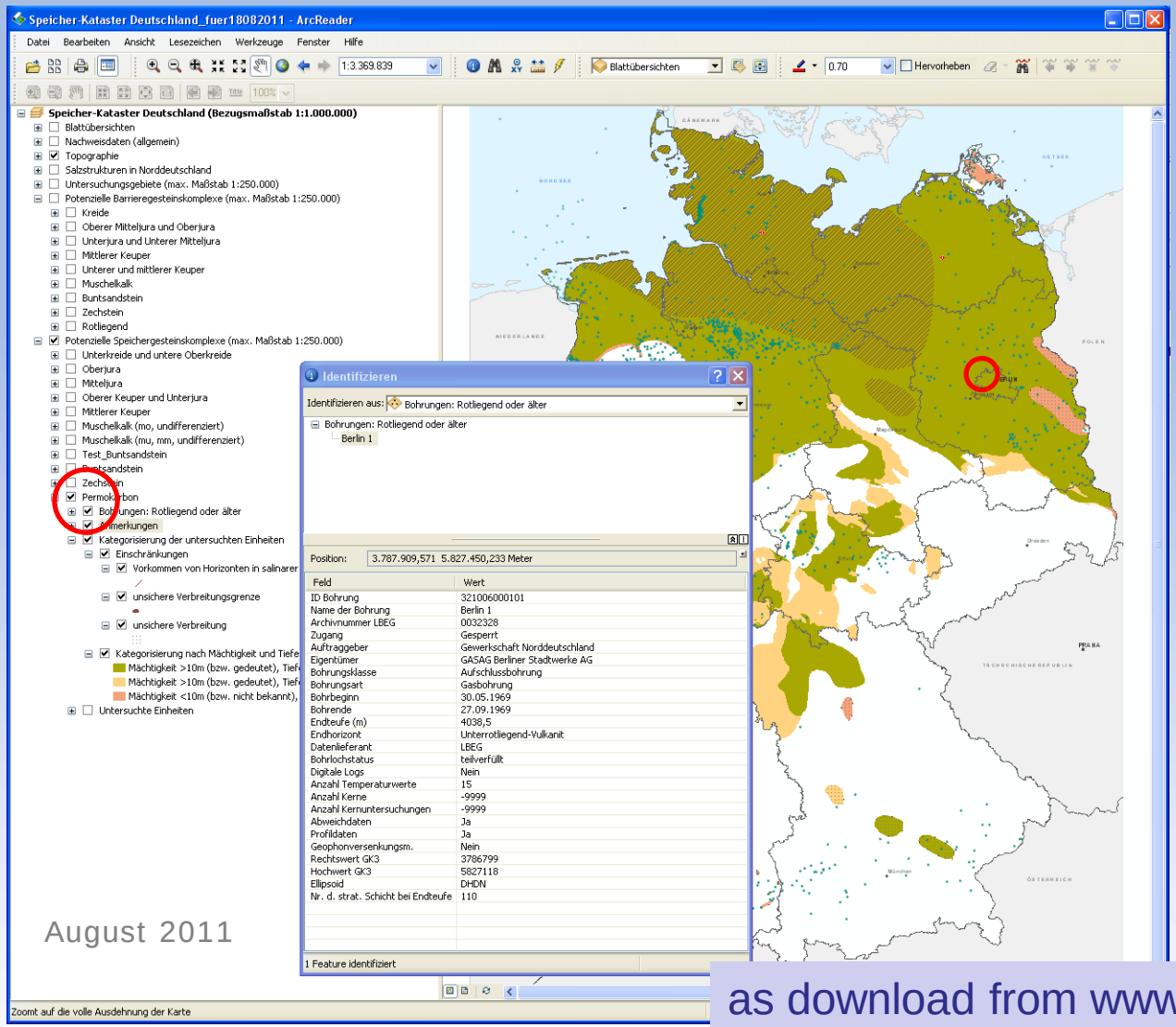


Mitteljura



Unterkreide / u. Oberkreide

GIS based map application
(Example reservoir rock unit permo-carboniferous)



August 2011

as download from www.bgr.bund.de

Reports & publications

Reports (German language)

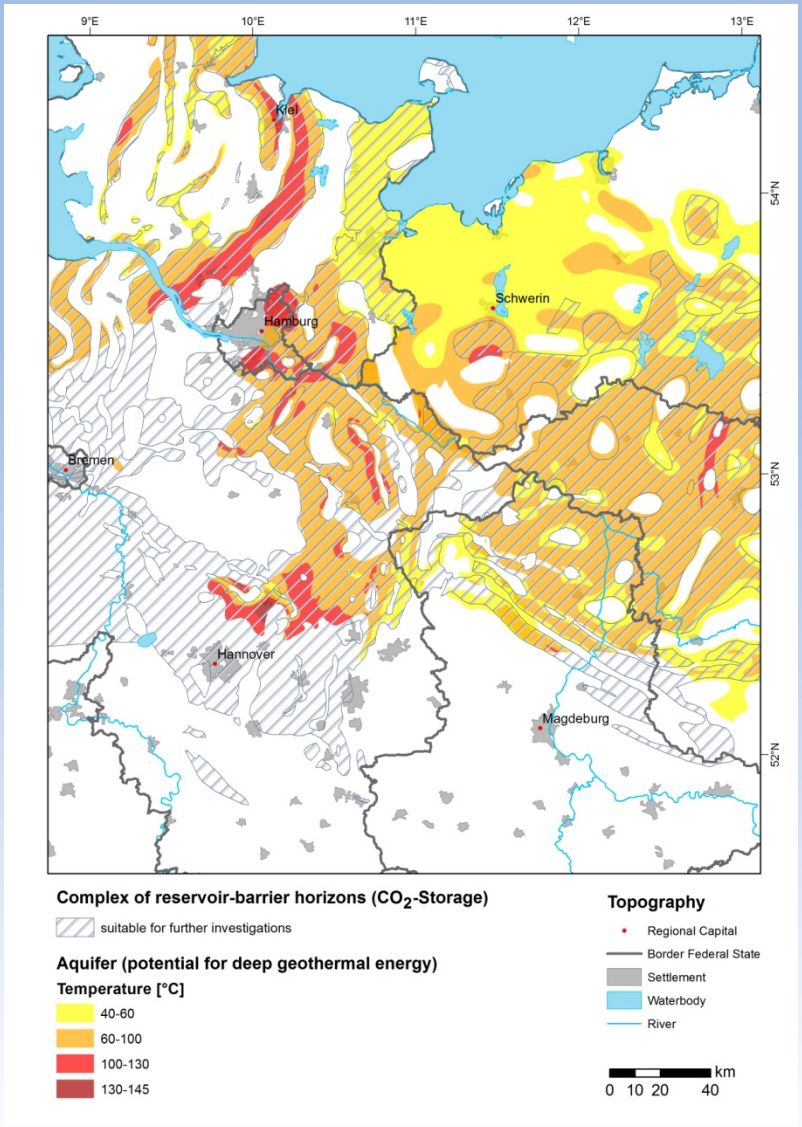
- 12 reports from sub-projects + 1 synthesis report

  (~1200 pages incl. detailed characterization of regions at federal state level)

Publications (German language + abstracts in English)

- Publication of project results in the special publication series of the Deutsche Gesellschaft für Geowissenschaften (Schriftenreihe SDGG)
- all 12 sub-projects (federal states) have contributed with own articles
- + 1 introduction/summary article
- Available since November 2011

Potential conflicts of use (geothermal energy and CCS)



New project: Atlas to visualise potential conflicts of interest between CO_2 storage (CCS) and deep geothermal energy (Geothermie-Atlas)

Project duration: 2011-2012

Project partners: LIAG & BGR

Funding: BMU

Main goals:

- visualise areas with potential conflicts of use between CO_2 storage and deep geothermal energy
- visualise areas with occurrence of deep reaching faults via GIS database

Summary

- Phase out of nuclear energy and CO_2 reduction targets in Germany results in an increased focus on the subsurface for storage an economic use (incl. potential conflicts of use)
- First volumetric storage capacity estimates for Germany indicate >10 Gt of storage capacity (2.75 Gt in natural gas fields and 6,3-12,8 Gt in saline aquifers)
- The project Storage Catalogue of Germany is a first step to create a nationwide database and to identify areas for further investigations on the basis of geological criteria
- The storage catalogue project provides an information system with categorized maps on 18 potential reservoir and barrier rock units (based depth an thickness criteria)
- A detailed characterization of regions with storage potential is available at federal state level and includes structural maps and reservoir properties (not site specific)
- Results are available as reports, a GIS based map application (visit BGRs website), and a special publication in SDGG
- The storage catalogue of Germany (information system) provides a powerful tool to support a regional assessment of e.g. the CO_2 storage potential. But, it will not make site specific & regional exploration work indispensable
- A new project aim to visualise potential conflicts of interest between CO_2 storage (CCS) and deep geothermal energy

Thank you

(Förderkennzeichen: 0327765)

Gefördert durch:

Bundesministerium für Wirtschaft und Technologie

aufgrund eines Beschlusses des Deutschen Bundestages

Projektträger Jülich
Forschungszentrum Jülich