CCOP – Norway Program EPPM

P2W1: Workshop on development of natural gas resources with high CO2 & CCS in CCOP

Geological CO_2 Storage

Risks, uncertainties & the role of GS

Bali/Indonesia, March 17-20, 2009

Johannes Peter Gerling
BGR - Federal Institute of Geosciences and Natural Resources

Some characteristics of Geological Surveys

- advisory body to Government
- independant
- neutral
- broad knowledge about subsurface
- etc.

Energy demand & climate protection

- World energy demand will grow by 50 % until 2030 (e.g. IEA, WEO 2006)
- Main share from fossil fuels, mainly from coal
- Consequence: Increase of CO2 emissions

Options to react:

1. Better energy efficiency
2. Growing share of renewables
3. Cleaner fossil fuels

UNFCCC Process

Preamble of the **Bali Action Plan** (2007):

„Responding to the findings of the Fourth Assessment Report of the IPCC that warming of the climate system is unequivocal, and that delay in reducing emissions significantly constrains opportunities to achieve lower stabilization levels and increases the risk of more severe climate change impacts.“

Bali Action Plan – Mitigation

i. ***[All Developed Countries]*** *“measurable, reportable and verifiable nationally appropriate mitigation commitments or actions, (…) “comparability of efforts”*

ii. ***[Developing Countries]*** *“Nationally appropriate mitigation actions (…), supported and enabled by technology, financing and capacity building, in a measurable, reportable and verifiable way”*

iv. *“Cooperative sectoral approaches and sector-specific actions.”*

v. *“Various approaches, including opportunities for using markets”*

UNFCCC Process

Road to Kopenhagen

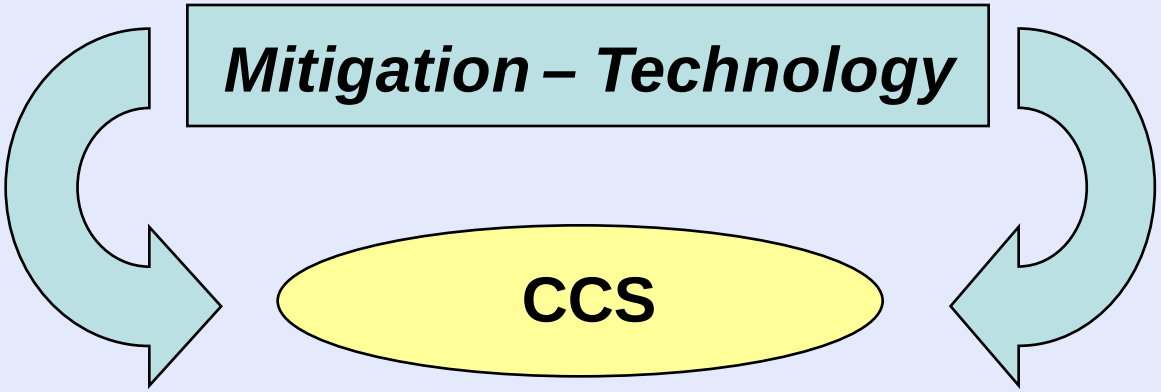
Bali Action Plan has given mandate for negotiations to Kopenhagen end of 2009

AWG LCA: Track under the convention:
Contribution of all countries (esp. developing countries and the US)

- shared vision
- **mitigation**
- adaptation
- **technology**
- finance

AWG-KP: „Kyoto-Track“
GHG reductions of industrialised countries for the second commitment period of Kyoto: **indicative corridor**: minus 25-40% by 2020 (compared to 1990 levels)

UNFCCC Process



Some of the preconditions for CCS implementation:

Input from national Geological Surveys necessary!

Availability of suitable storage sites and capacity

Regulatories in place (for approval of projects)

Knowledge in place (for design / for approval / for control of projects)

CCS in the EU

- **Legal framework: CCS Directive agreed December 2008**
  - **national governments have to implement ≤ 2 years**
- **Demonstration programme:**
  - **10-12 demo plants by 2015**
  - **Financing & incentivisation through EU ETS**
  - **Additional finance for 5 plants proposed through Economic Recovery Plan**

CCS in the EU

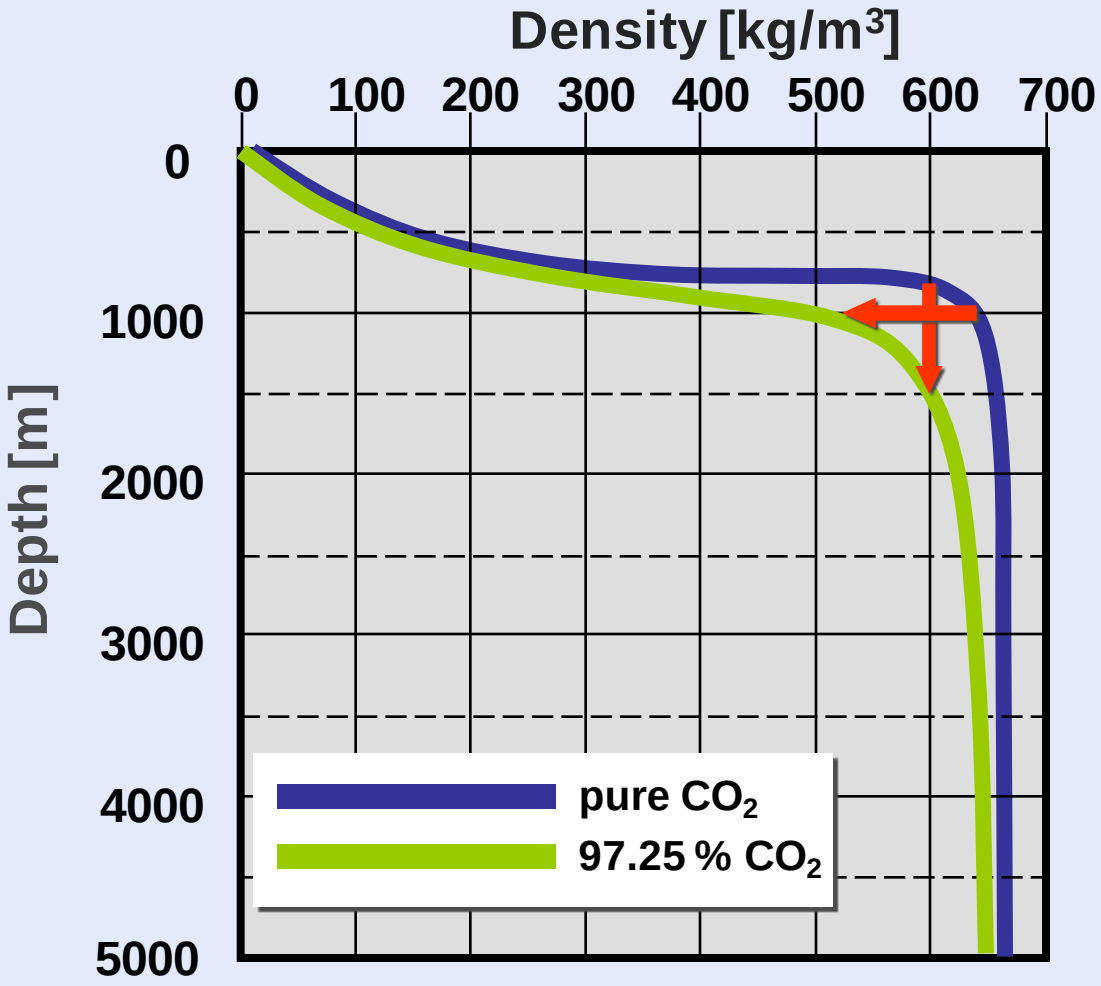
- **The importance of global demonstration: EU assistance to emerging economies and developing countries**
  - **coal to play a significant role**
  - **need to tackle emissions of fossil-fuel dependant emerging economies in order to meet 2°C objective**
  - **cooperation will be an essential element of a post-2012 agreement**
  - **<u>not to forget</u>: 1.6bn don‘t have access to electricity**

CCS in Germany

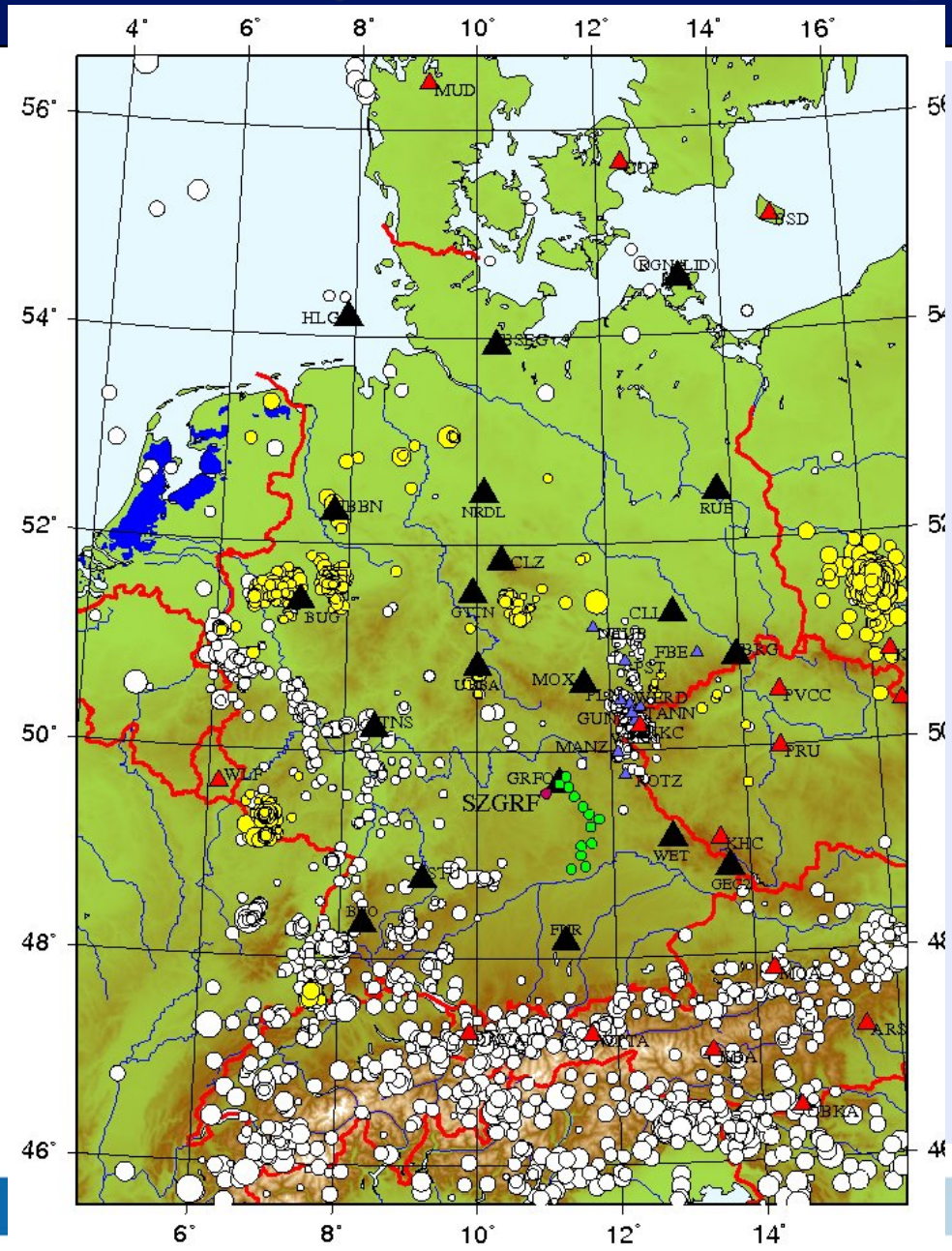
- German CO2 Storage Act
  - common draft by both ministries of economics and environment next week in Cabinet
  - Parliament readings in April to June
- proposed role for BGR
  - elaborate intensively on national storage capacities
  - set-up an national register of all CCS activities
  - approve applications for exploration, deposition and closure of CO2 storage sites

Boundary condition I: Depth beyond 800-1000 m

CO_2-behaviour underground



Boundary condition II: **Long-term safety**



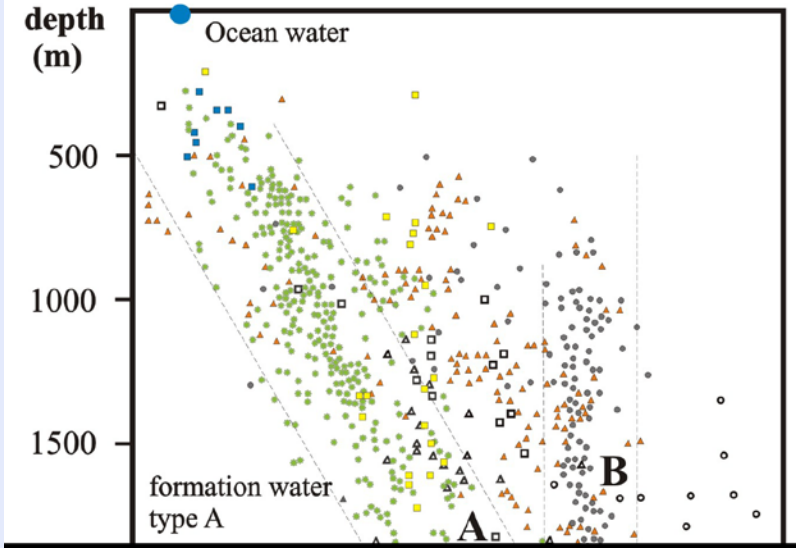
Tectonic Earthquakes in Germany since 1992 (Magnitude >2)

- Tectonic earthquakes (since 1992)
- Induced earthquakes (since 1992)
- Seismometer station

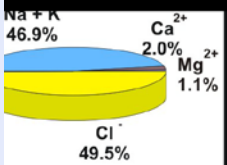
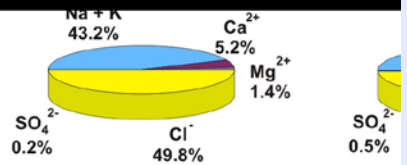
Boundary condition II: **Long-term safety**

Gas “monitoring“ in previous times

Boundary conditions III: **Protect potable water**



Chemical properties of the brines from the geothermal heating plants in Neubrandenburg and Neustadt-Glewe (Hoth&Seibt 1999)

	Neustadt-Glewe	Neubrandenburg
typ	anoxic Na-Cl-brine	
temperature [°C]	99	54
pH	5.3	6.1
density [g/cm³]	1.147	1.089
total dissolved solids [g/l]	216	137
cationics and anionics [mmol(eq)-%]		
gas-water-ratio	1:33	1:10
carbon dioxide [vol.-%]	57	94
	42	
	<1	

Quellen: Müller & Papendieck 1975, GTN, BGR, GFZ

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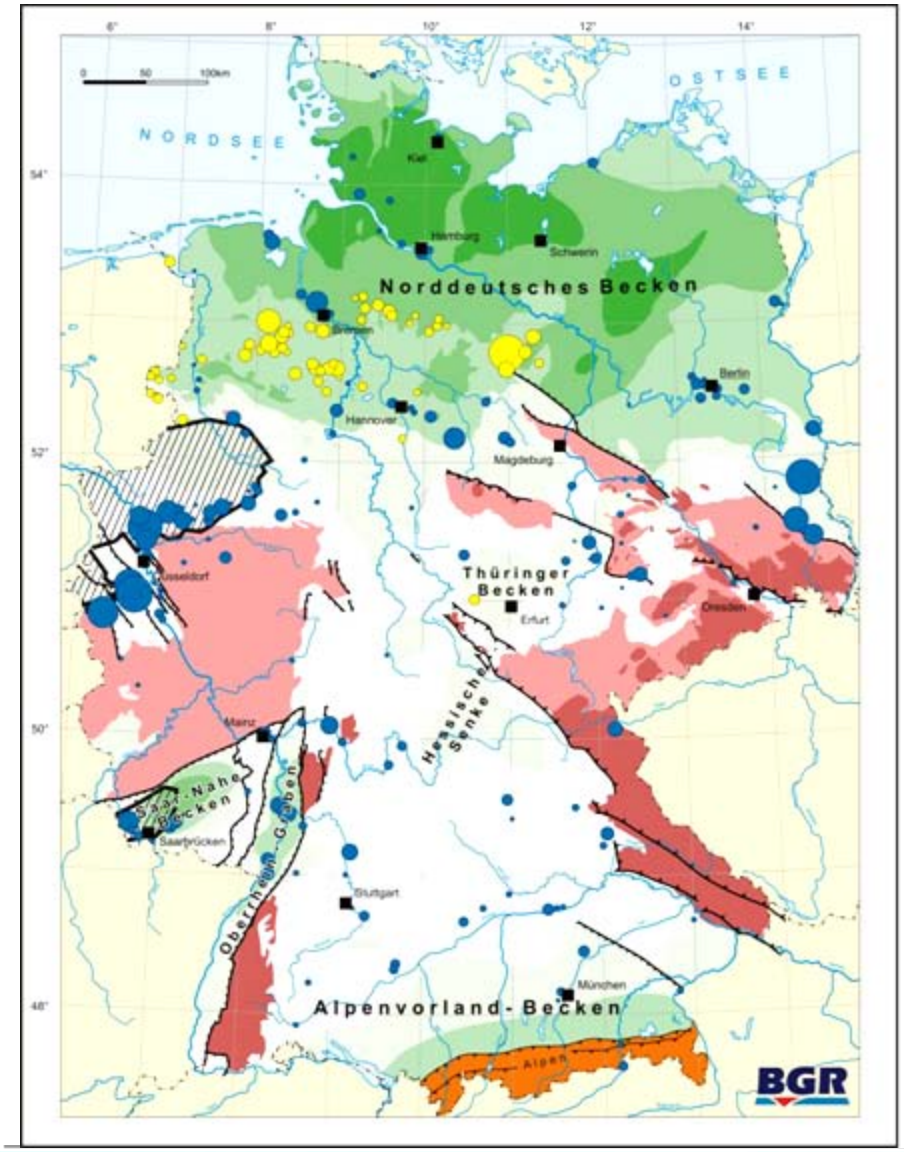
Storage Potential: current knowledge (1)



Bedeutende CO_2 - Quellen

Kraftwerke, Hütten- und Zementwerke, Raffinerien u. a.

• 0,2 → 20 Mt/a

Regionen mit Speichermöglichkeiten

20±8 Gt

zunehmende Mächtigkeit der Beckenfüllung

1km
3km
5km
9km

tiefliegende und Salzwasser führende Speichergesteine (Aquifere)

Steinkohle - Flöze

Erdgas - Felder

2.75 Gt

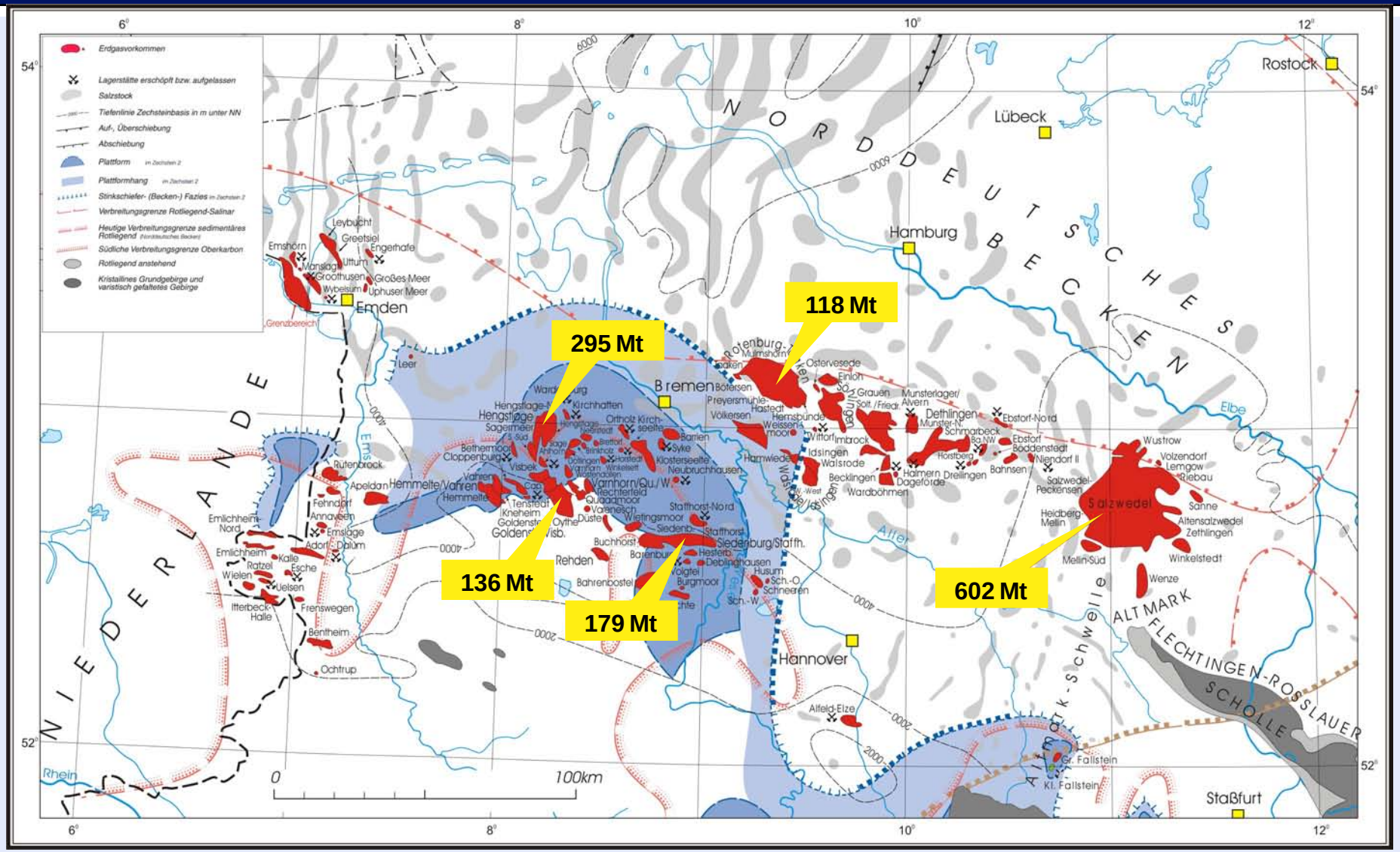
Regionen ohne bedeutende Speichermöglichkeiten

metamorphe Gesteine

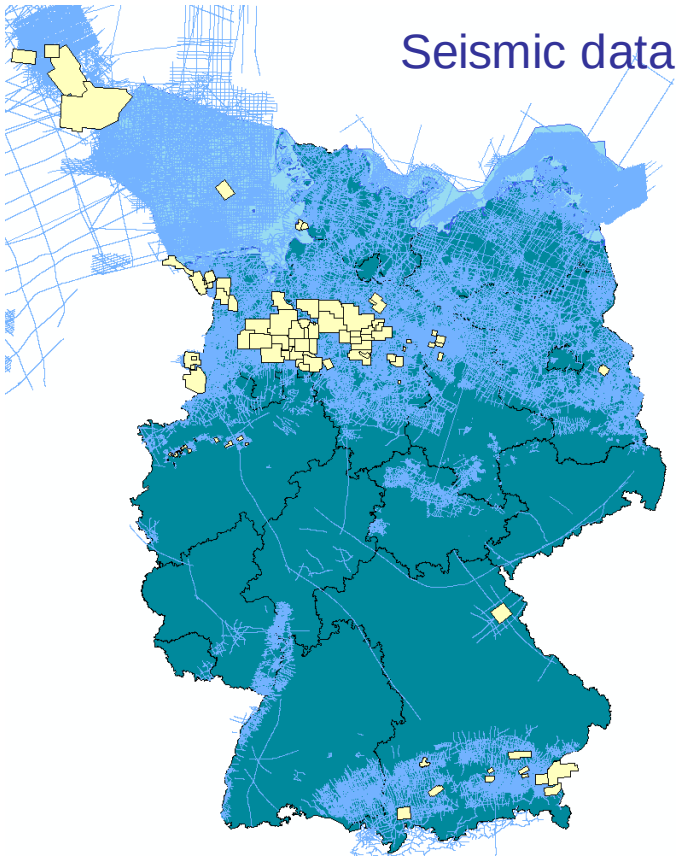
magmatische und hoch-metamorphe Gesteine

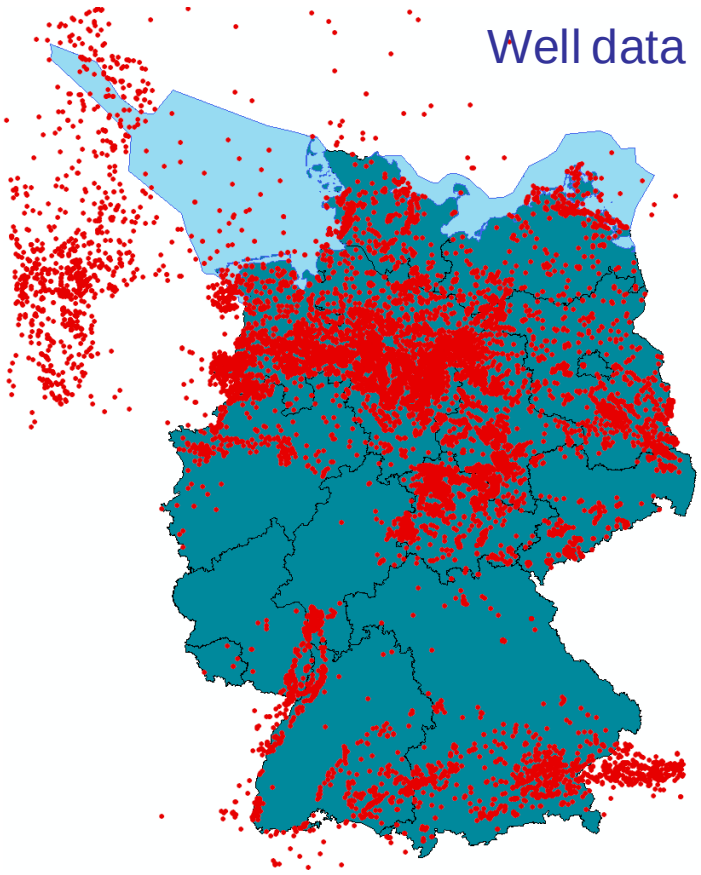
Speichergesteine nicht oder in zu geringen Tiefen vorhanden

Natural gas fields are premium options



Storage Potential: current knowledge (2)





- Property of E&P-industry, with own interest
- regional geological expertise with SGD

Maps: Sedlacek 2007

Underway: Catalogue of CO2 Storage Sites

- **Partnership:**

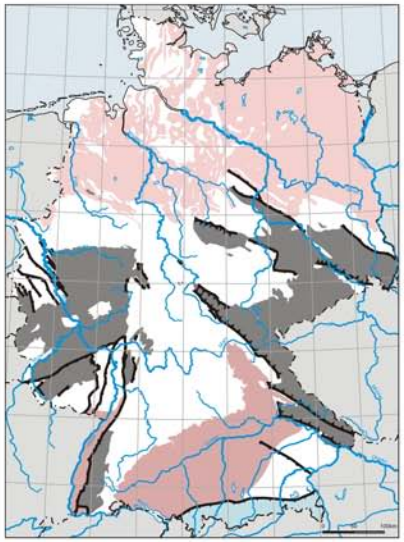
  BGR (project leader) plus Geological Surveys (SGD) of all Federal States

- **Funding: public (COORETEC) plus industry consortium (EnBW, E.ON, Vattenfall Europe Mining)**
- **Time frame: 2008 bis 2011**
- **Reference: Integrated Energy- and Climate Program of the Federal Government**

Catalogue: Work programme

Step 1

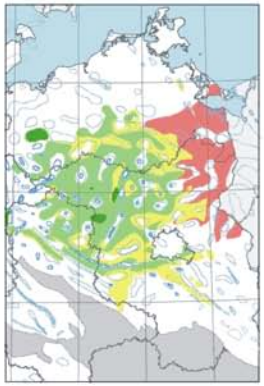
Distribution of Reservoir and Barrier Rocks



Jurassic clay formations 1 : 1. 000.000

Step 2

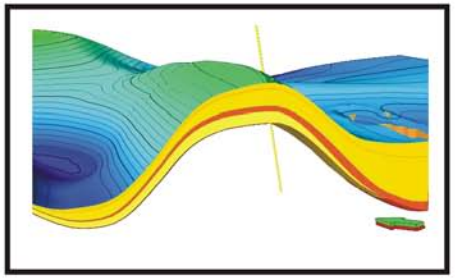
Classification of Reservoir and Barrier Rocks



Aalenium stage 1: 300.000

Step 3

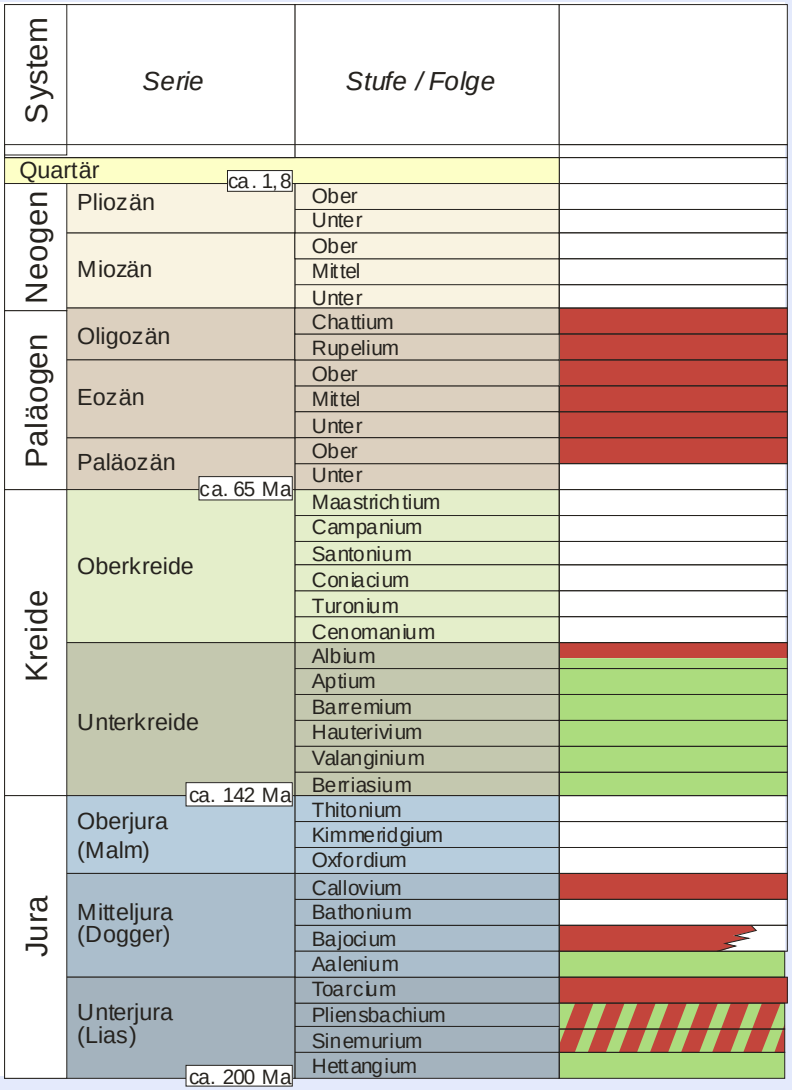
Evaluation and Documentation of Individual Structures

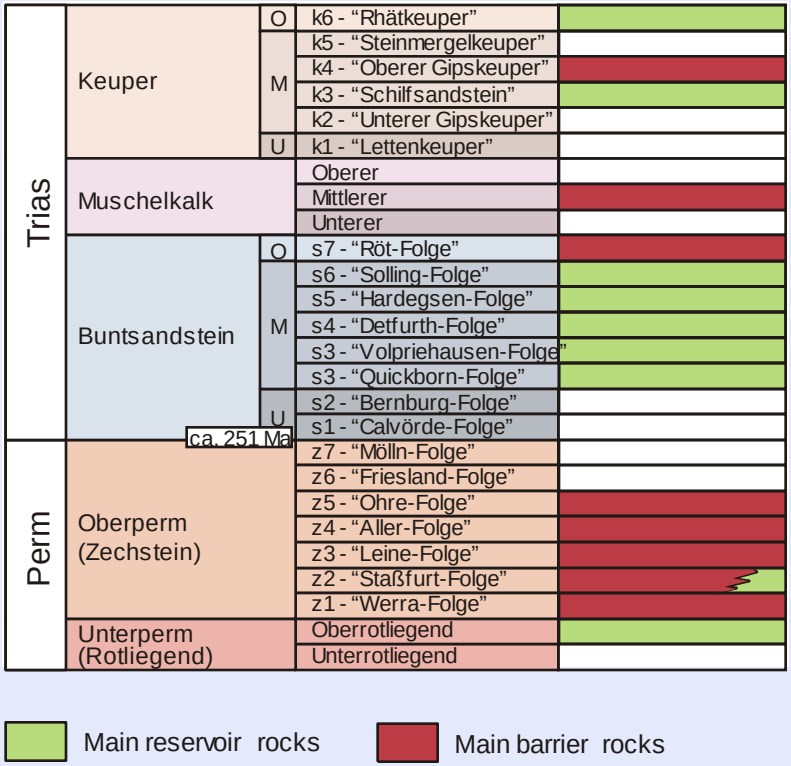


Increasing Incorporation of Data

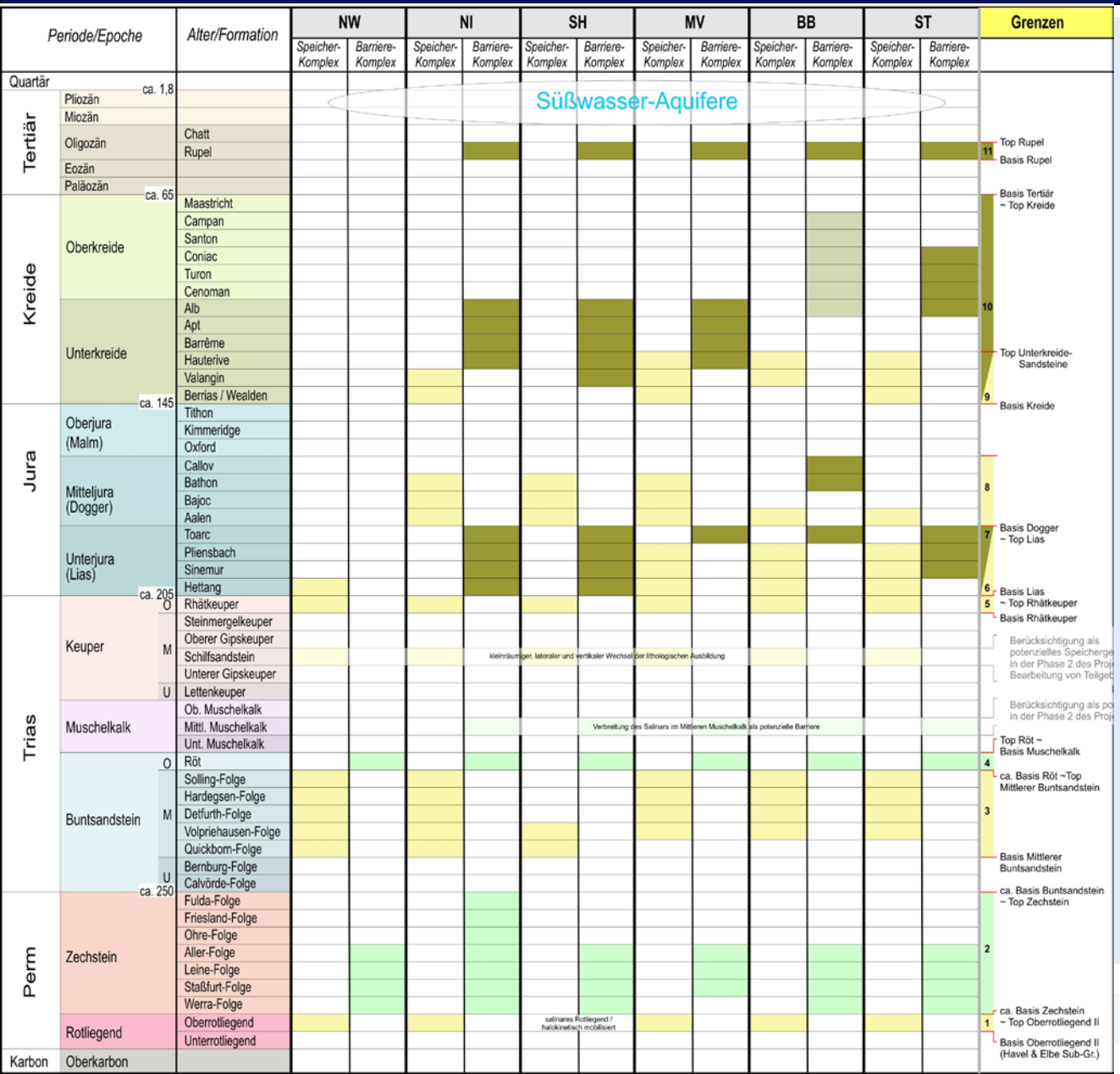
Qualification → Quantification

Major Reservoir & Barrier Rocks





Storage and Barrier Rocks in NGB: correlation



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Key criteria for reservoir/barrier rocks have to be defined …

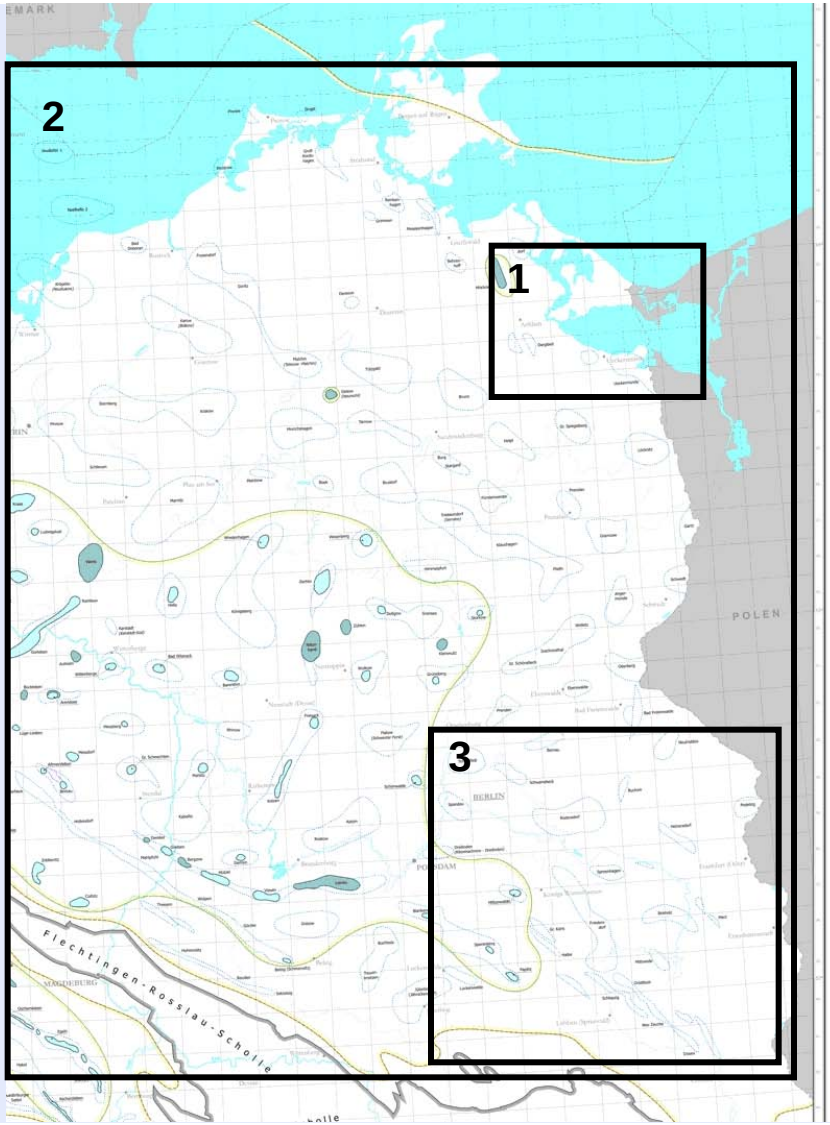
- distribution
- thickness (>10m)
- depth (>800m)
- reservoir/barrier properties (Poro; Perm; geochemistry)
- lithofacies
- spatial characteristics
- etc.

Potential Storage Sites across the border

Poland

Source: http://www.pgi.gov.pl

CO2-studies in NE Germany



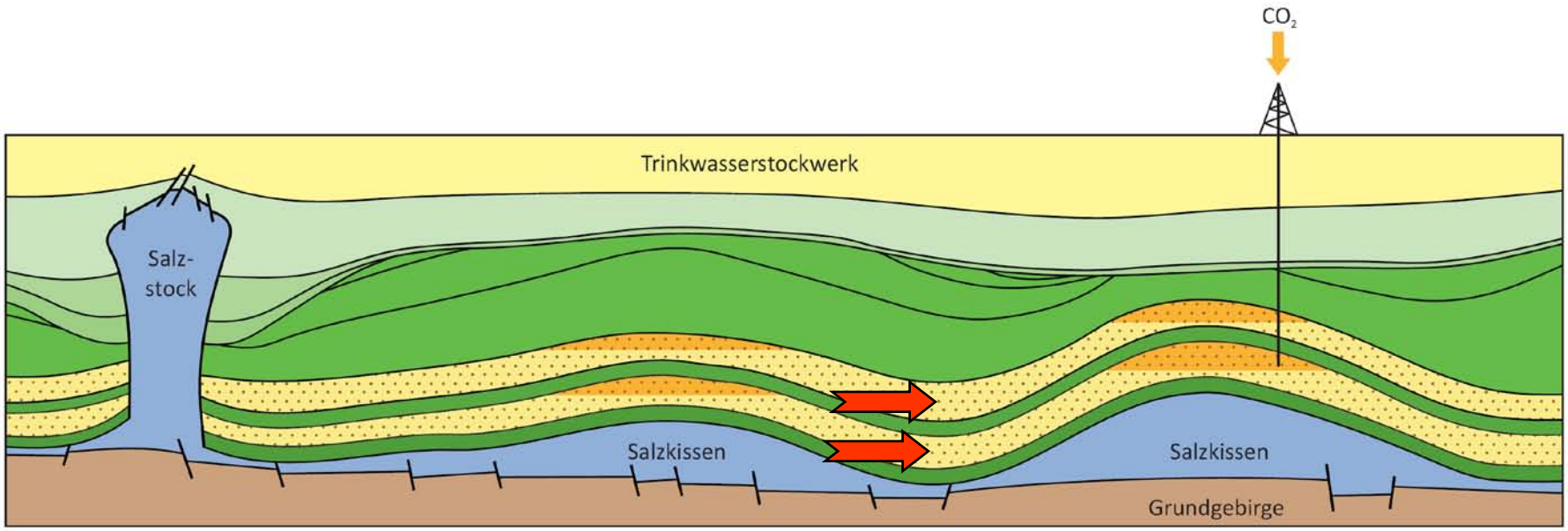
Different CO2-storage capacity studies in East Germany:

1. **GESTCO project (2004)**
2. **CO2Store study (2003)***
3. **Other industry studies (2007/2008)***

***unpublished**

Different injection strategies:

- **in anticlines**
- **in synclines**



Competing interests on deep subsurface targets

- Mining: coal, salt, oil, gas
  - formation water from HC-production
  - waste from salt mining / processing
- Nuclear waste
- Gas storage (natural gas, compressed air?, hydrogen?)
- Deep geothermal energy
- Geological CO2 storage

Site-specific national R&D projects
(GEOTECHNOLOGIEN/BMBF)

- **CLEAN – CO2 storage in a gas field (Altmark) :**
  - **Bundle of projects; national partners only; started in late summer 2008**
  - **R&D Coordinator: GFZ Potsdam**
  - **Industry: Gaz de France Suez + Vattenfall**

- **COAST – CO2 storage in a saline aquifer :**
  - **Bundle of projects; national partners only; will probably start in August 2009**
  - **R&D Coordinator: BGR**
  - **Industry: RWE**

What else is missing ?

- Legal framework → EU, national: on the road
- Technical regulation

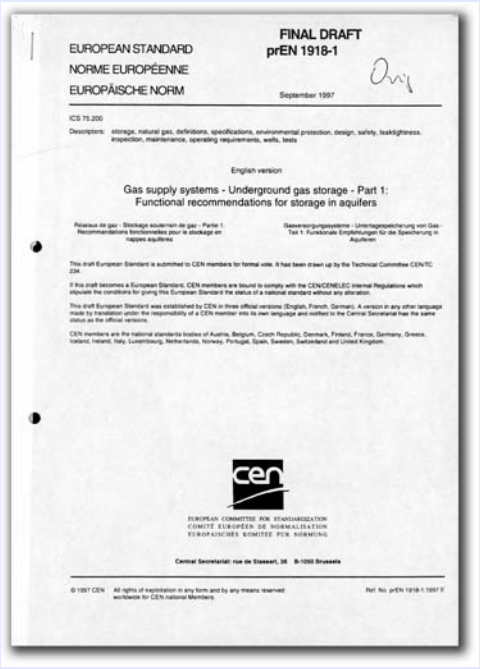
- STABILITY:
  - two persons (4/2008), continuously
  - goal: development of concepts & criteria regarding site selection, abandoned wells, longterm security, and monitoring

- TF „CO2 storage in geological formations“:
  - under the auspicies of DGG and DGGT (geo-scientific organisations)
  - goal: define reg framework with all actively involved stakeholders
  - UGS as „quarry“
  - STABILITY is „backoffice“

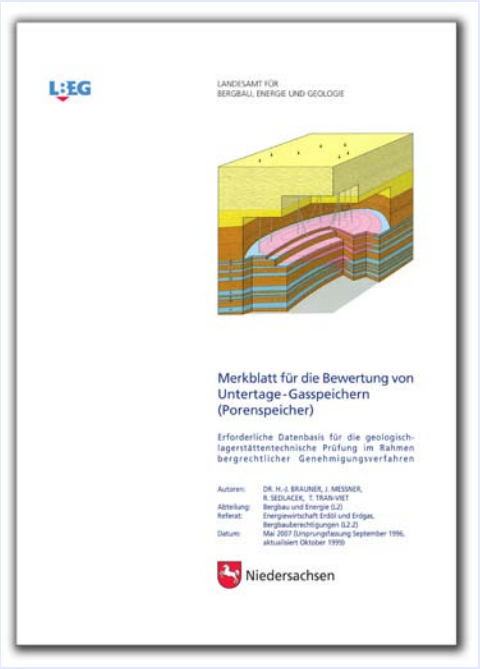
Transfer of regulation from UGS

Federal Mining Act

EU/DIN standard UGS



Handouts from Mining Authorities



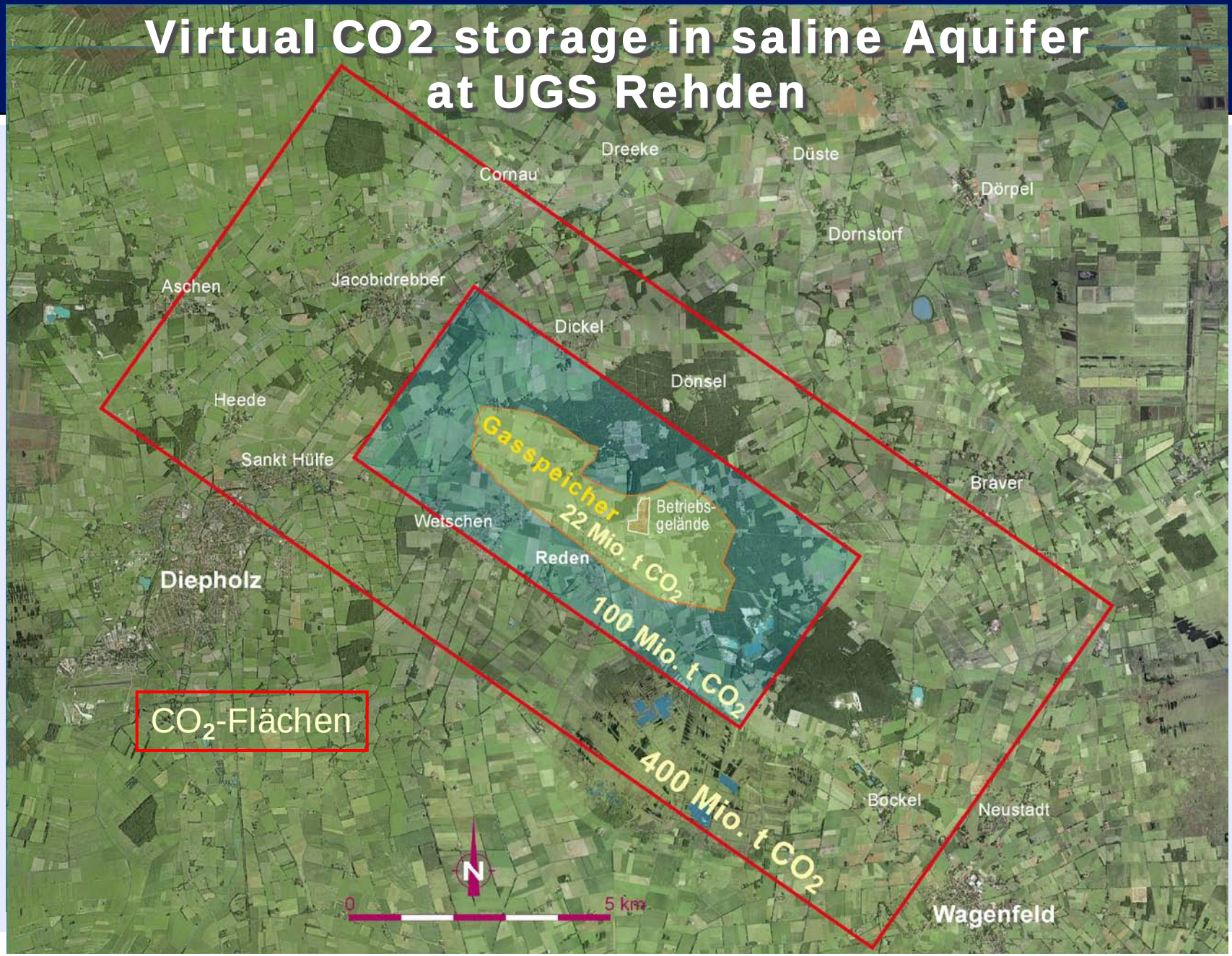
- Federal Mining Act (BBergGesetz) only relevant in case of enhanced oil/gas recovery

CCOP workshop on „Geological storage of CO2“

- time : June 2009
- duration : 5 days (Monday til Friday)
- location : Bangkok
- sponsor : German government
- lectures : BGR, CO2GeoNet,
- input : national perspectives from participants

	Morning	Afternoon	Evening
Monday	Opening/ Intro	WS T1	Icebreaker-Party
Tuesday	WS T2	Input 1	
Wednesday	WS T3	Social Programme	
Thursday	WS T4	Input 2	
Friday	WS "Road Map"		

Virtual CO2 storage in saline Aquifer at UGS Rehden



Quelle: Sedlacek 2007

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Thank you for your attention !