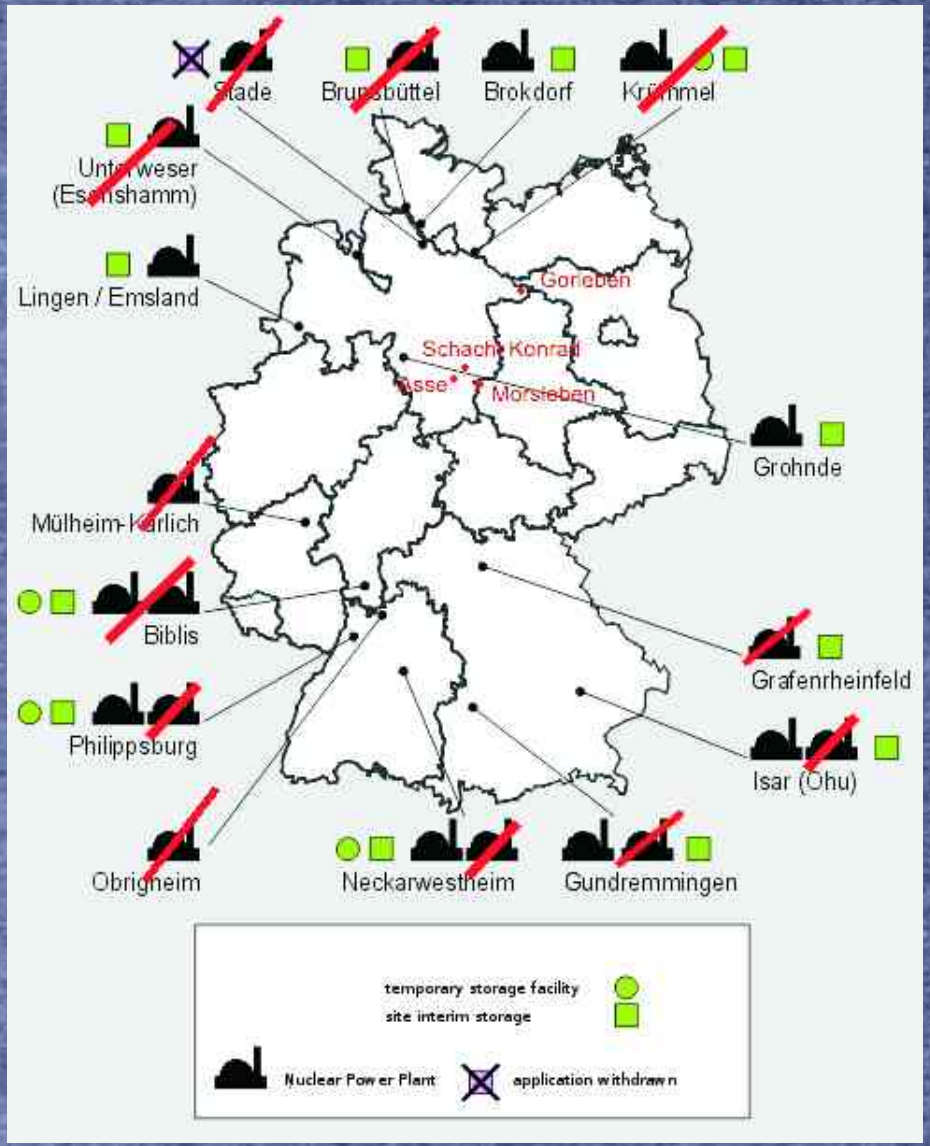
Nuclear Waste Disposal Disaster in Germany



What it is NOT about

This presentation is about nuclear waste directly produced in Germany, not:

- Uranium waste (containing > 85 % of original radioactivity left in mining areas),
- Waste produced by fuel fabrication for German NPPs in other countries (conditioning, enrichment, fuel element fabrication),
- Depleted uranium sent to Russia from UAA Gronau.

Much more nuclear waste is caused by Germany's nuclear industry than usually regarded.

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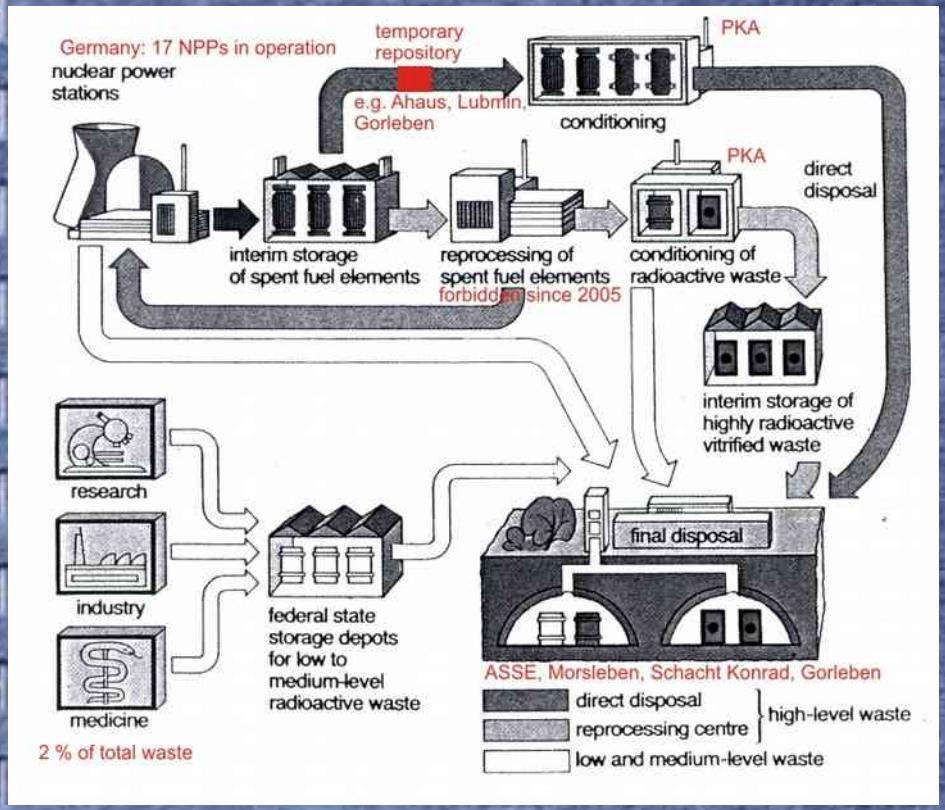
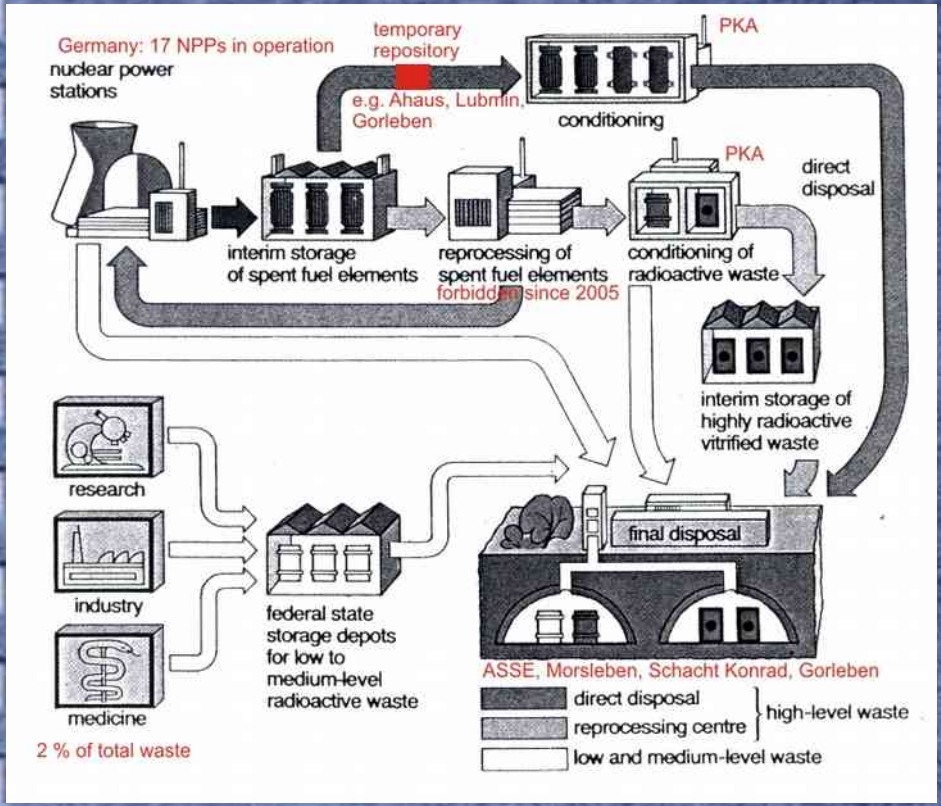
General Situation in Germany



- 7 reactors in operation
- by 2005 most HAW to La Hague & Sellafield
  - return transports from La Hague and from Sellafield 2018 expected
- later „reprocessing“ prohibited (only new contracts concerned)
  - waste for ~15 years

General Situation in Germany (II)



- since 2005: <u>direct final disposal required</u>
  - but: NO final repository exists
- only ~2 % of total radioactive waste comes from medicine, research + other industries

General Situation in Germany (III)

- waste facilities:
  - temporary repositories at several NPPs & nuclear factories
  - PKA Gorleben (not in operation)
  - temporary HAW repositories, e.g. Ahaus, Gorleben, Lubmin
  - final disposal sites: Asse II, Morsleben, Schacht Konrad, Gorleben

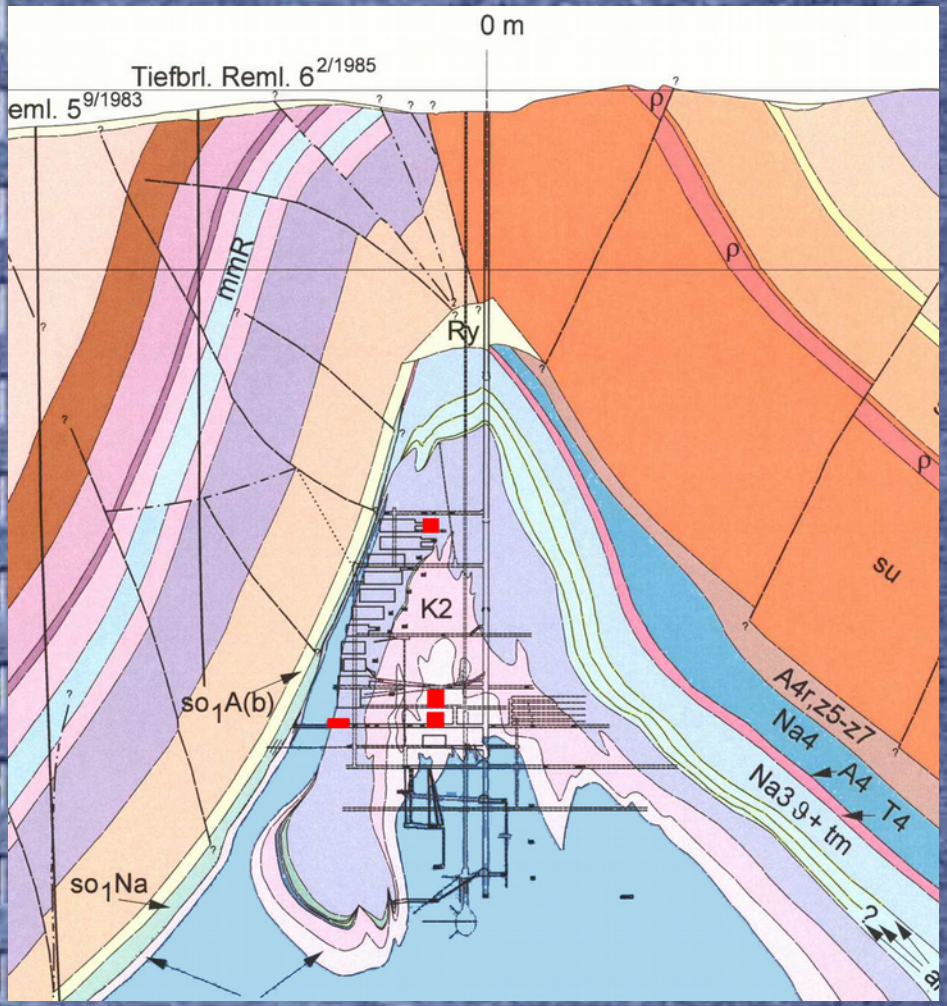
General Situation in Germany (IV)

- final disposal concepts:
  - salt rock + other geological formations
  - deep mine (more difficult: access, attacks, natural catastrophes, pristine=safety)
  - geological barrier provides safety
  - non-retrievable final disposal (costs, proliferation, safety)

German Final Disposal Sites: Asse II

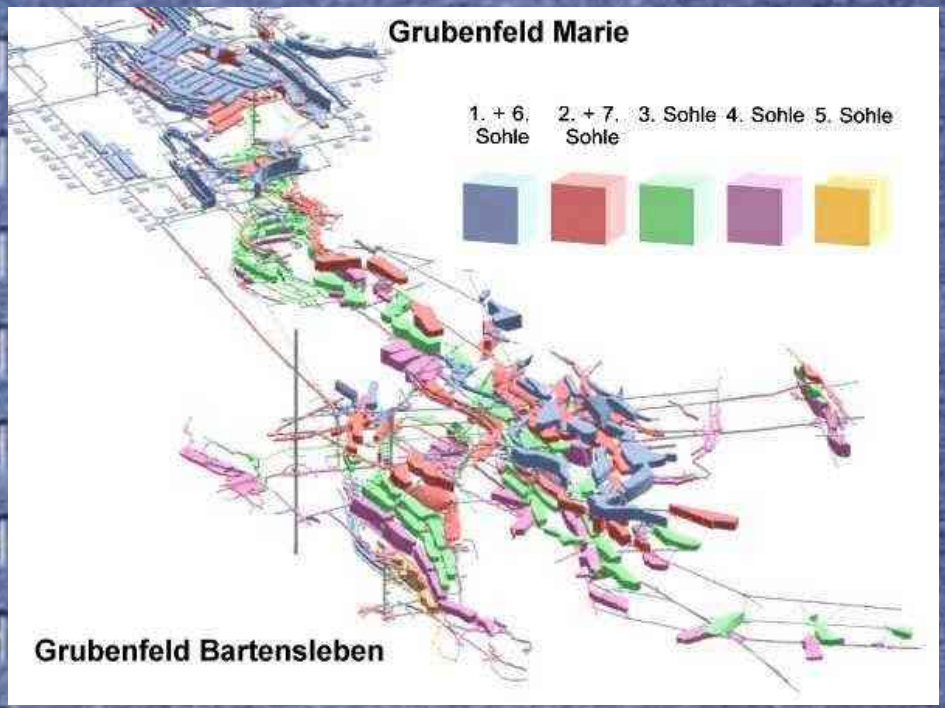
- near Wolfenbüttel / Braunschweig (Lower Saxony)
- operation started 1965; stopped 1978/1995
- old salt mine; used for L/MAW + research
- barrels dumped into reposition cavities (many damaged)

Asse II (II)



- safety issues: <u>water influx</u> (~11,500 litres/day), <u>collapse</u>
  - acute danger of complete flooding
- doesn't meet requirements of nuclear law / no public consultation
- continuously new scandals become public

Morsleben



- between Braunschweig and Magdeburg (Sachsen-Anhalt)
- formerly GDR's central final repository for L/MAW + planned HAW final repository
- operation started 1971; stopped 1998
- old salt mine

Morsleben (II)

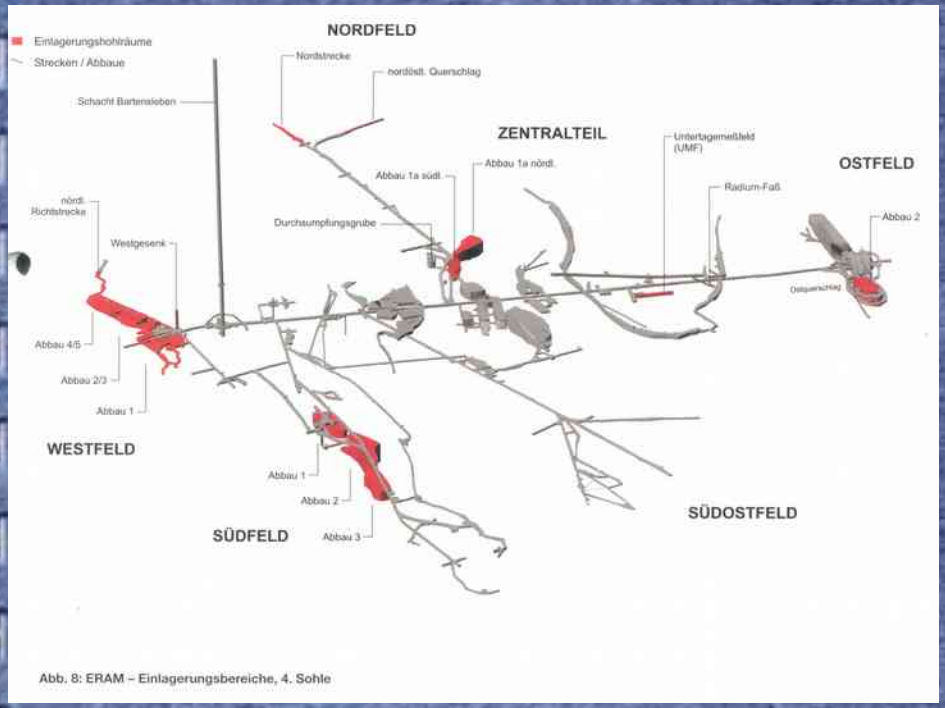


Abb. 8: ERAM – Einlagerungsbereiche, 4. Sohle

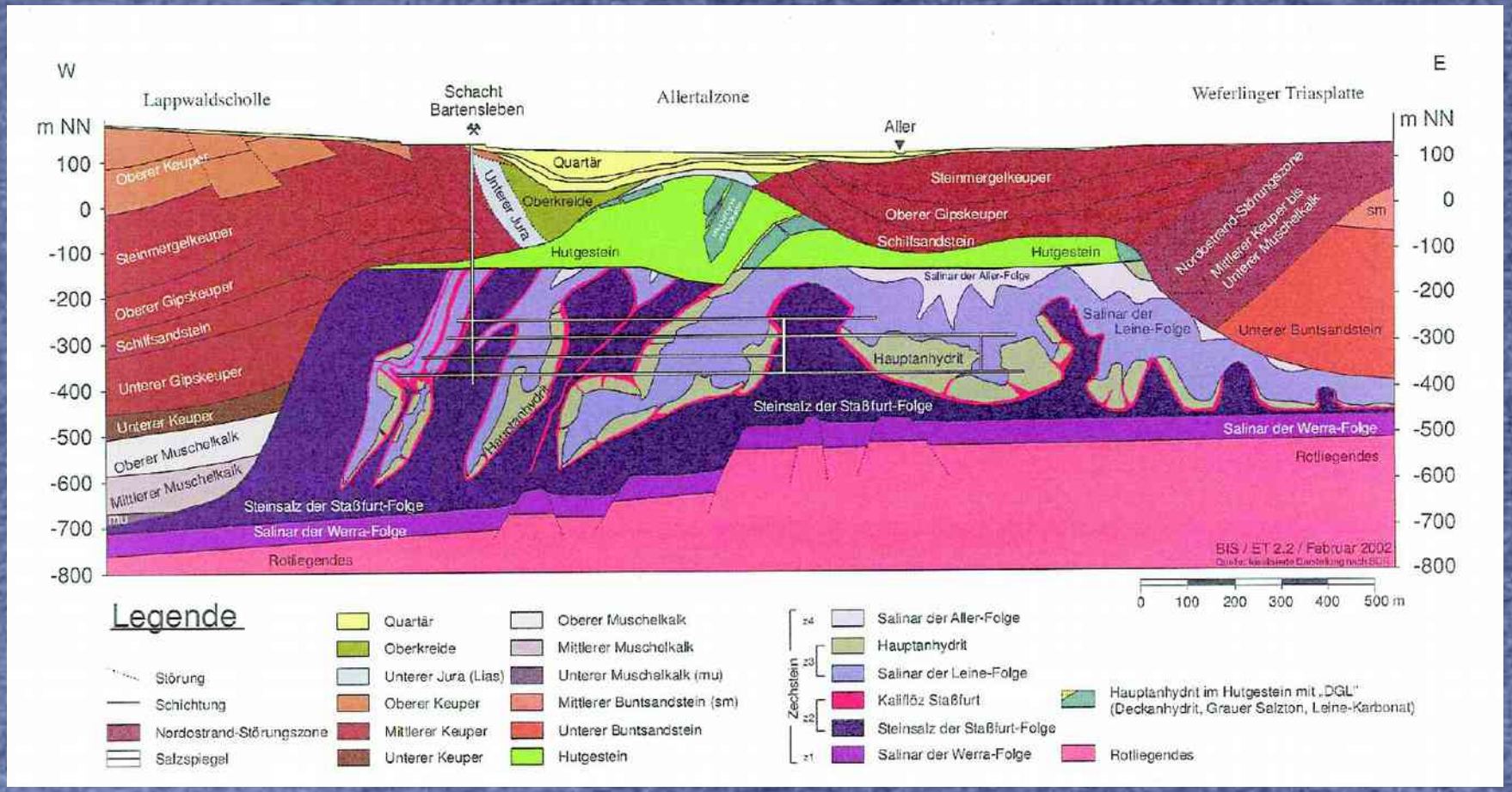
- solid waste in barrels stacked or dumped in barrels or loosely into reposition cavities
- liquids sprayed onto layer of lignite ashes (assuming mixture would solidify)
- total amount L/MAW: ~36,000 m³

Morsleben (III)

- >6,000 radiation sources (partly HAW) sunk in drill holes
- safety issues:
  - water influx: >20 known locations; at least one has connection to biosphere
  - collapse: >4,000 t cave-in 2001; 500 t cave-in early 2009; 20,000 t cave-in expected soon by operator

Morsleben (IV)

- unsuitable geological conditions (potassium salt layers, main anhydrite)



Asse II & Morsleben: Operator's Failures

Both Asse II and Morsleben are affected by problems caused by the operator of the repositories:

- inventory unknown
- public cheated about inventory & safety issues
- safety issues wellknown from the very beginning
- no public consultations in site selection
- old mines (over 100 years) not suitable for final disposal of nuclear waste
- extension & situation of cavities not completely and not in detail known

Asse II & Morsleben: Operator's Failures (II)

- Morsleben: operator increased threat of collapse by backfilling higher levels almost 1,000,000 m³ of „salt-concrete“ onto deposition cavities of deeper levels
- Asse II: to prevent complete collapse operator wants to flood with 1.200.000 m³ $MgCl_2$-solution

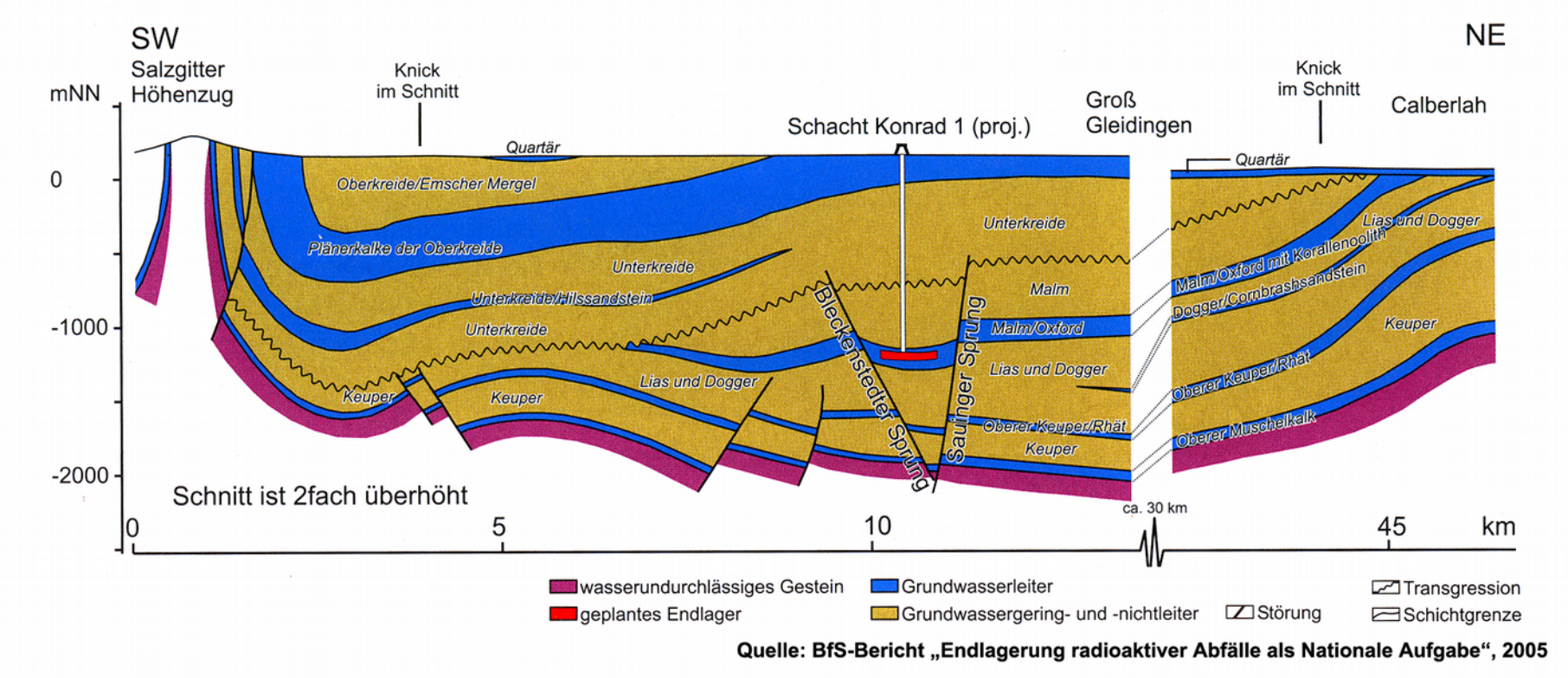
  -> radioactivity would quickly escape the repository
  -> recovery of atomic waste would be impossible

Schacht Konrad

- near Salzgitter / Braunschweig (Lower Saxony)
- operation approval: 2002 (still offline)
- old iron ore mine; L/MAW disposal
- known safety issues: water-carrying layers with connection to biosphere

Schacht Konrad (II)

- Known safety issues:
  - water-carrying layers with connection to biosphere
  - unsuitable rock formations

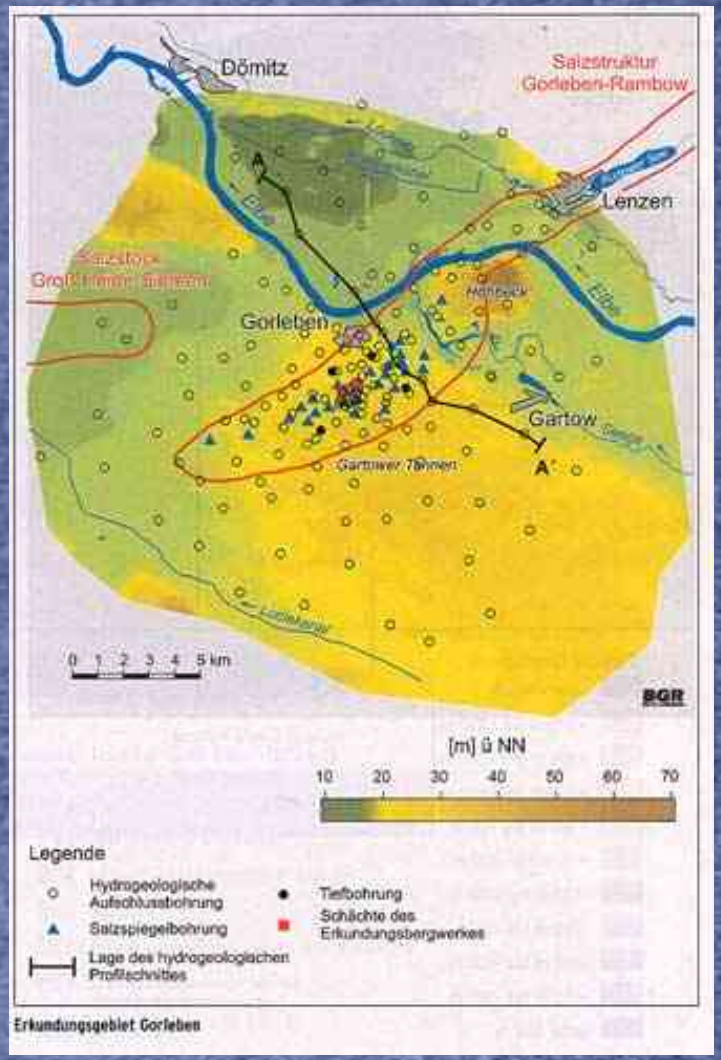


Quelle: BfS-Bericht „Endlagerung radioaktiver Abfälle als Nationale Aufgabe“, 2005

Gorleben

- in Wendland (Lower Saxony)
- „research mine“
- no public consultation yet
- salt rock formation

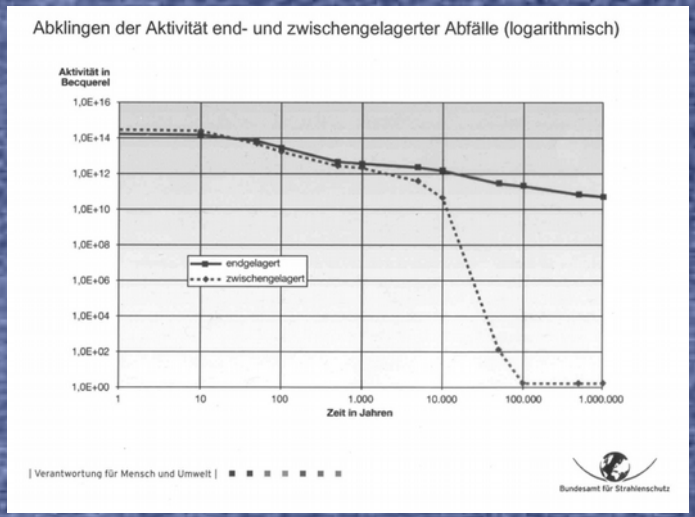
Gorleben (II)



- Known safety issues:
  - water-carrying layers
  - no mighty & gapless layer of clay
  - saltdome not at rest and still rises
  - running salt-dissolution

General Disposal Challenges

- Estimated <u>longterm safety necessary</u> for at least 1,000,000 years
  - no-one knows how *society & technology* will look like
  - no-one knows how *geological formations* will develop by that time (at least not in detail)



General Disposal Challenges (II)

- No complete knowledge about geological rock formations & layers possible
  - destructive methods (e.g. drilling) create *knowledge only about small areas* -> remaining parts only estimated
  - non-destructive methods can't show everything – especially *not details of rock layers / water ways*
- Chemical reactions of waste / materials of container / surrounding rock formations / water not really known
  - every few years new knowledge about *unexpected complications* found in labority experiments

General Disposal Challenges (III)

- No container is longterm safe against corrosion / damages
  - maybe some 5-70 years
  - copper (Scandinavian KBS model): threats by oxygen and pressure
  - steal (German Pollux model): threats by water and pressure

General Disposal Challenges (IV)

- No technical barrier (bentonite, salt-concrete) is longterm safe
  - *water will always find ways at the seams* between natural rock formations and technical barrier
  - *reactions* between water / barrier material / rock formation material *unknown*
  - *Pressure of surrounding rock formations* will form & damage technical barriers
- No experimental proof of safety possible (millions of years necessary)
  - *only* small labority experiments for some years with *longterm estimation* possible

Special Disposal Challenges

- Certain rock formation layers offer points for attacks of water influx (e.g. potassium salt)
- Historical water inclusions can damage rock formations
  - increase *risk of escaping* radioactive particles
- Cave-ins can cause further damages in rock formations
  - increase *risk of escaping* radioactive particles
  - *complete backfilling impossible* – at least 10 % - 20 % will be kept open

Special Disposal Challenges (II)

- Even a pure, not fissured rock formation will become damaged by drilling / exploration & construction of the repository
  - *can't* completely *be repaired* again
- All risk models only assumptions
  - *no experience* with longterm disposal
- Additional problem: climate change effects

Special Disposal Challenges (III)

- How to keep knowledge of radioactive threat?
  - human experience with longterm knowledge only by religions: e.g. Christianity shows *several changes in interpretation & translation* within 2,000 years
  - even today former *understanding* of warnings about dangerous places (e.g. Australia – uranium) got *lost or people don't care* about it anymore

Conclusions

- Longterm safe storage of radioactive waste is impossible
- Knowledge about dangerous reactions & developments remains uncertain
- Operators of repositories & authorities often unreliable

Conclusions (II)

Nowhere in the world a *safe solution* for the longterm radioactive waste has been found for certain reasons.

And it is *not possible* to do safe final disposal as well for general reasons.

Nuclear *waste must not be produced* – all NPPs have to be *shut down immediately* and worldwide.