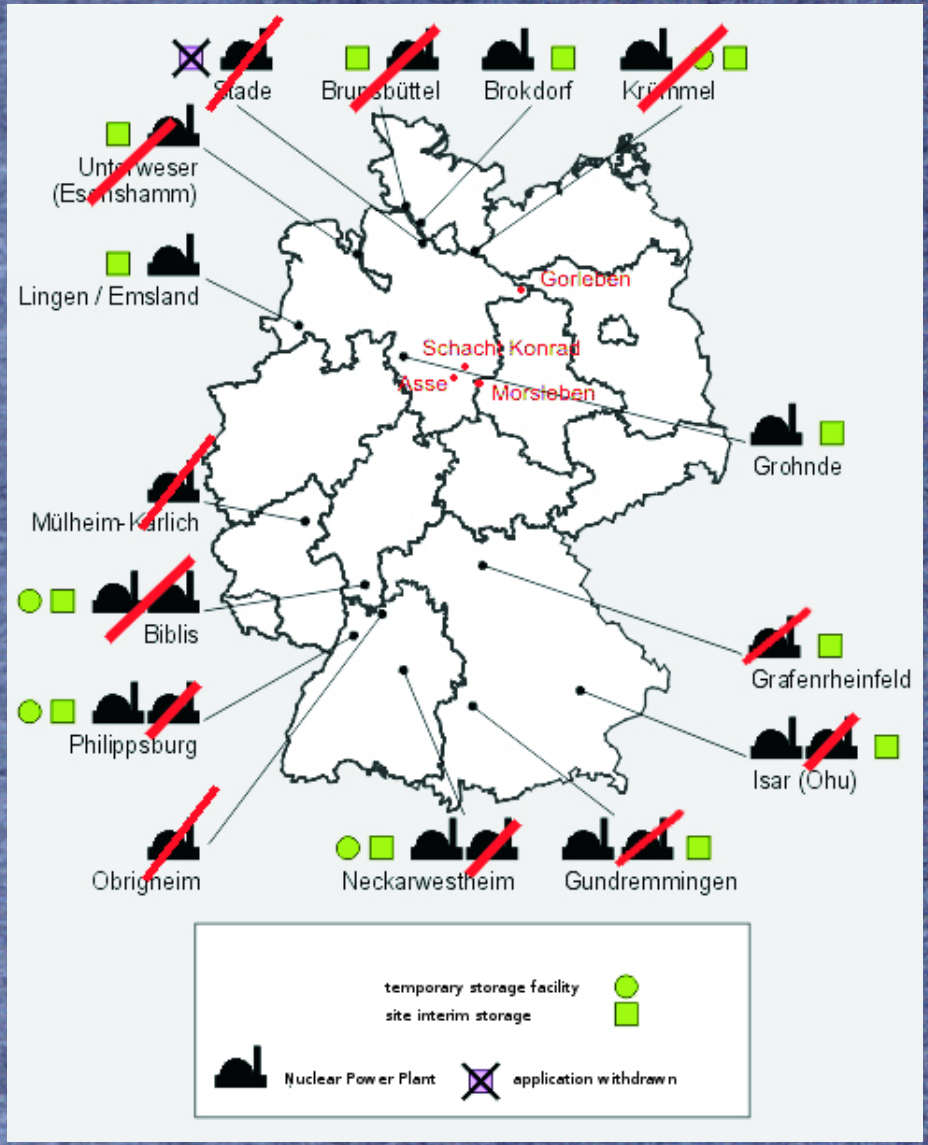
Nuclear Waste Disposal Disaster in Germany



What it is NOT about

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

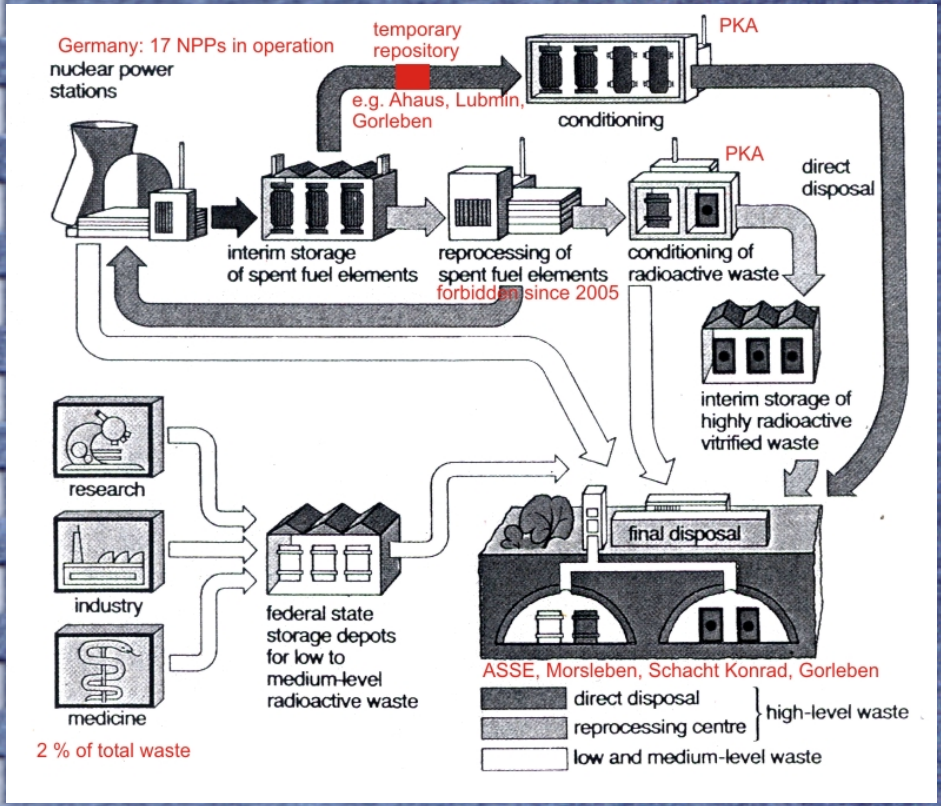
- Uranium waste (containing > 85 % of original radioactivity left in mining areas),
- Waste produced by fuel fabrication for German NPPs in other countries (conditioning, enrichment, fuel element fabrication),
- Depleted uranium sent to Russia from UAA Gronau.

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

Table of Contents

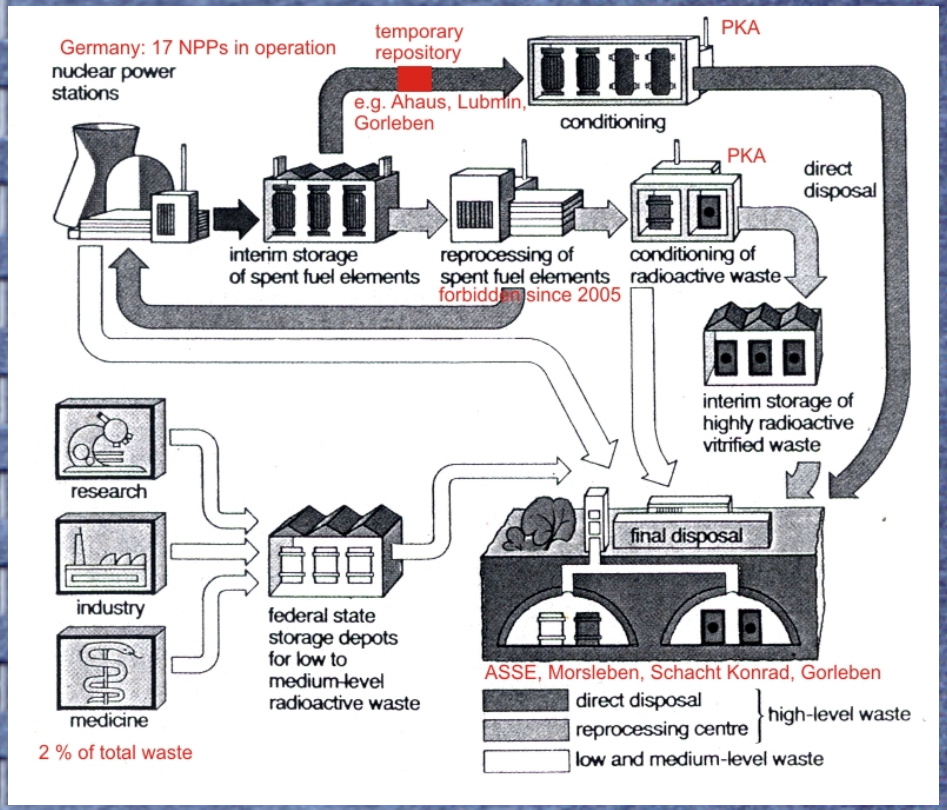
1. General Nuclear Situation in Germany
2. German Final Disposal Sites
    a) ASSE II
    b) Morsleben
    c) Schacht Konrad
    d) Gorleben
3. General Disposal Challenges
4. Special Disposal Challenges
5. Conclusions

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

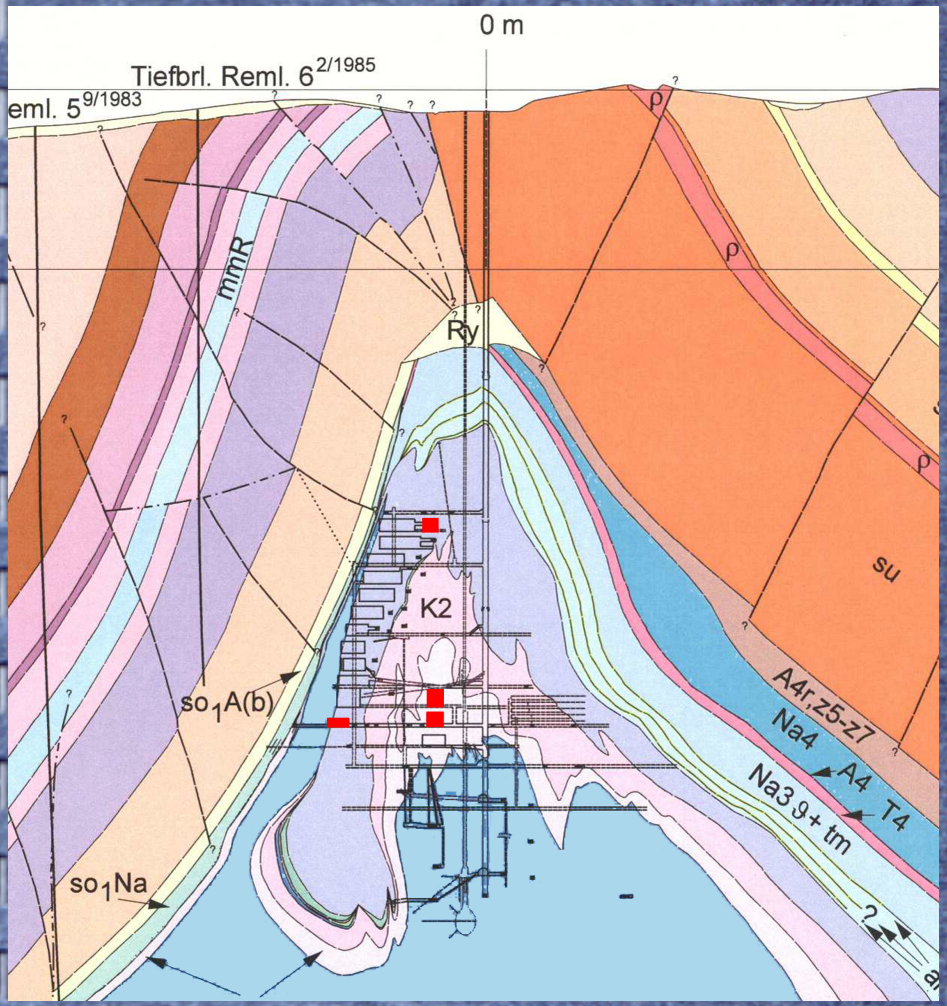
General Situation in Germany (IV)

- 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

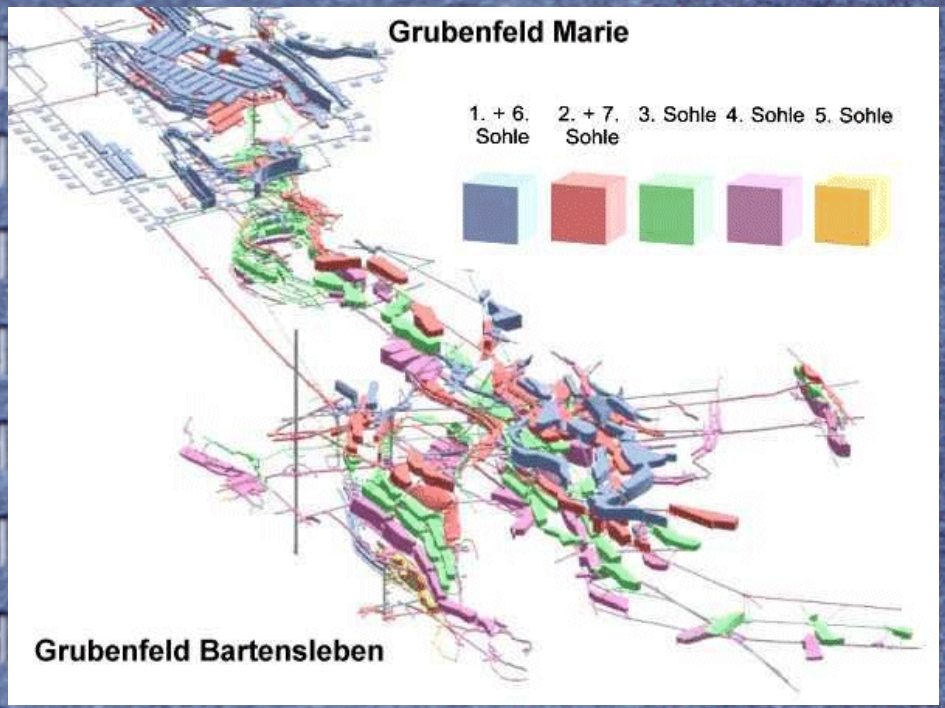
- near Wolfenbüttel / Braunschweig (Lower Saxony)
- operation started 1965; stopped 1978/1995
- old salt mine; used for L/MAW + research
- barrels dumped into reposition cavities (many damaged)

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)

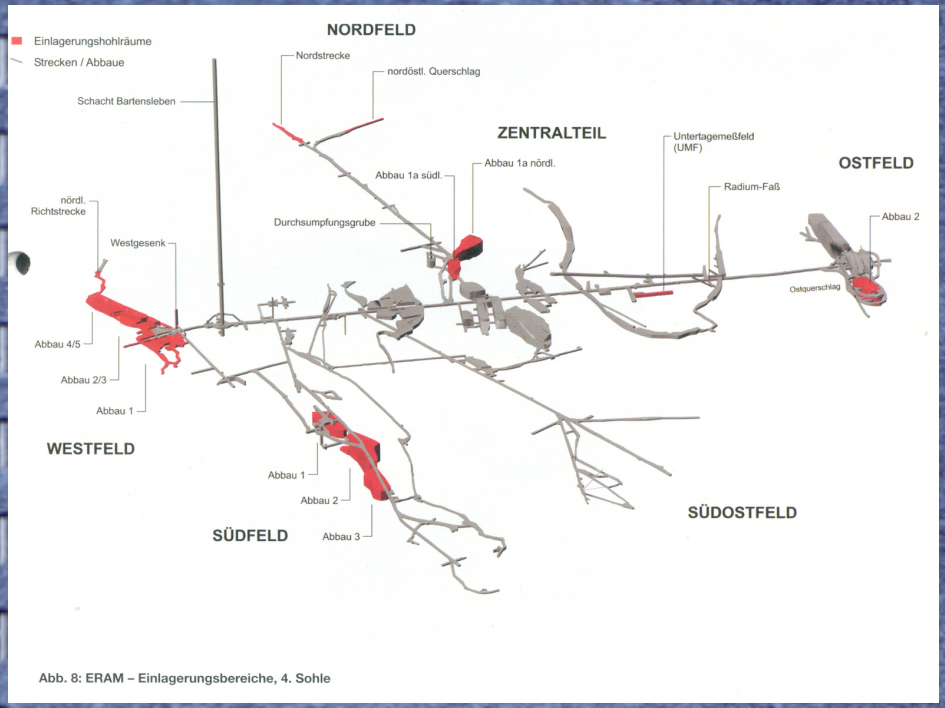
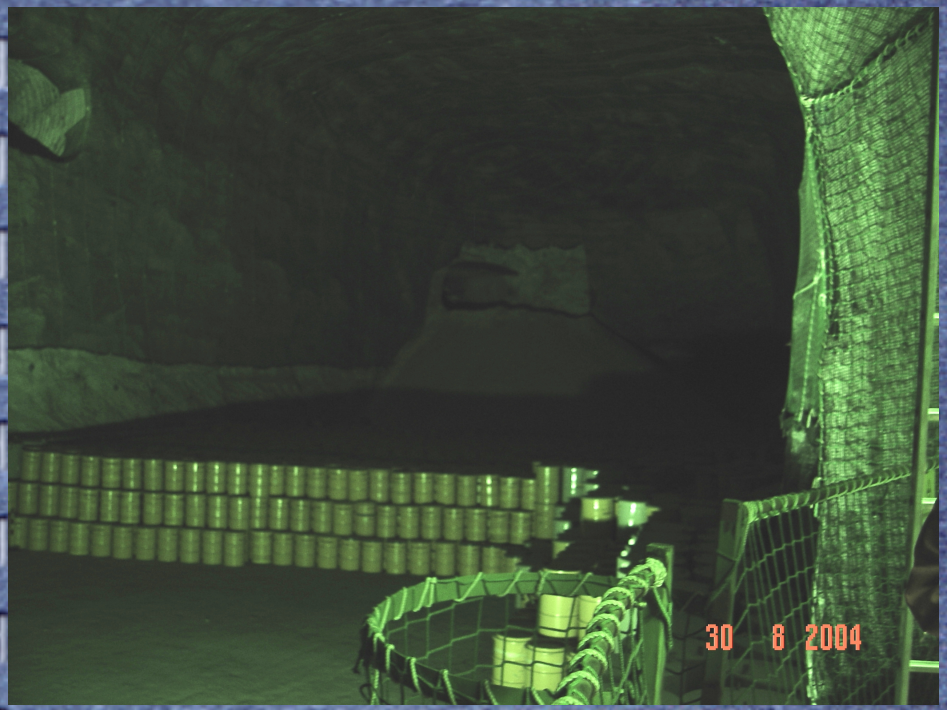


Abb. 8: ERAM – Einlagerungsbereiche, 4. Sohle

- 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

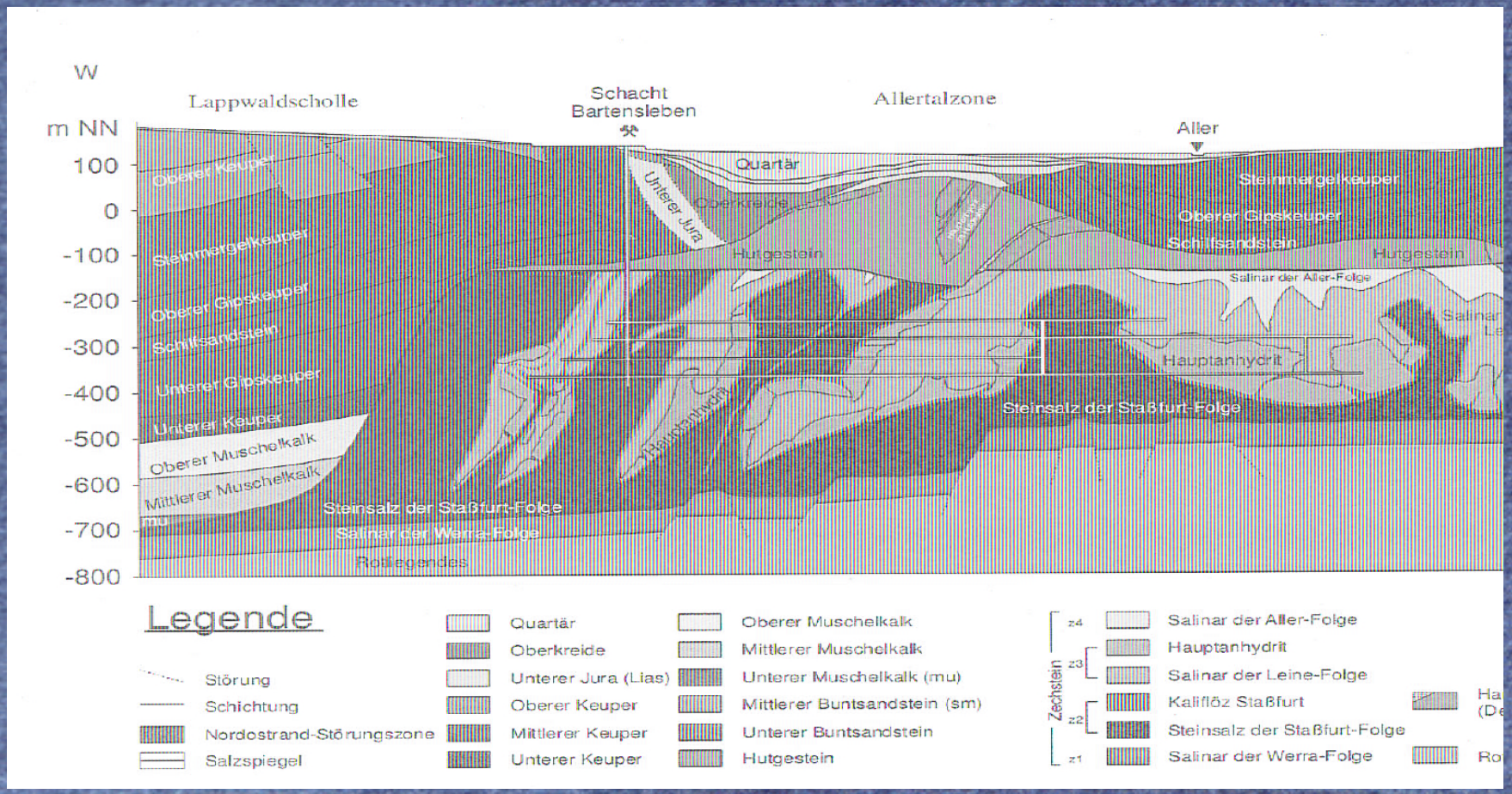
Morsleben (III)



- >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

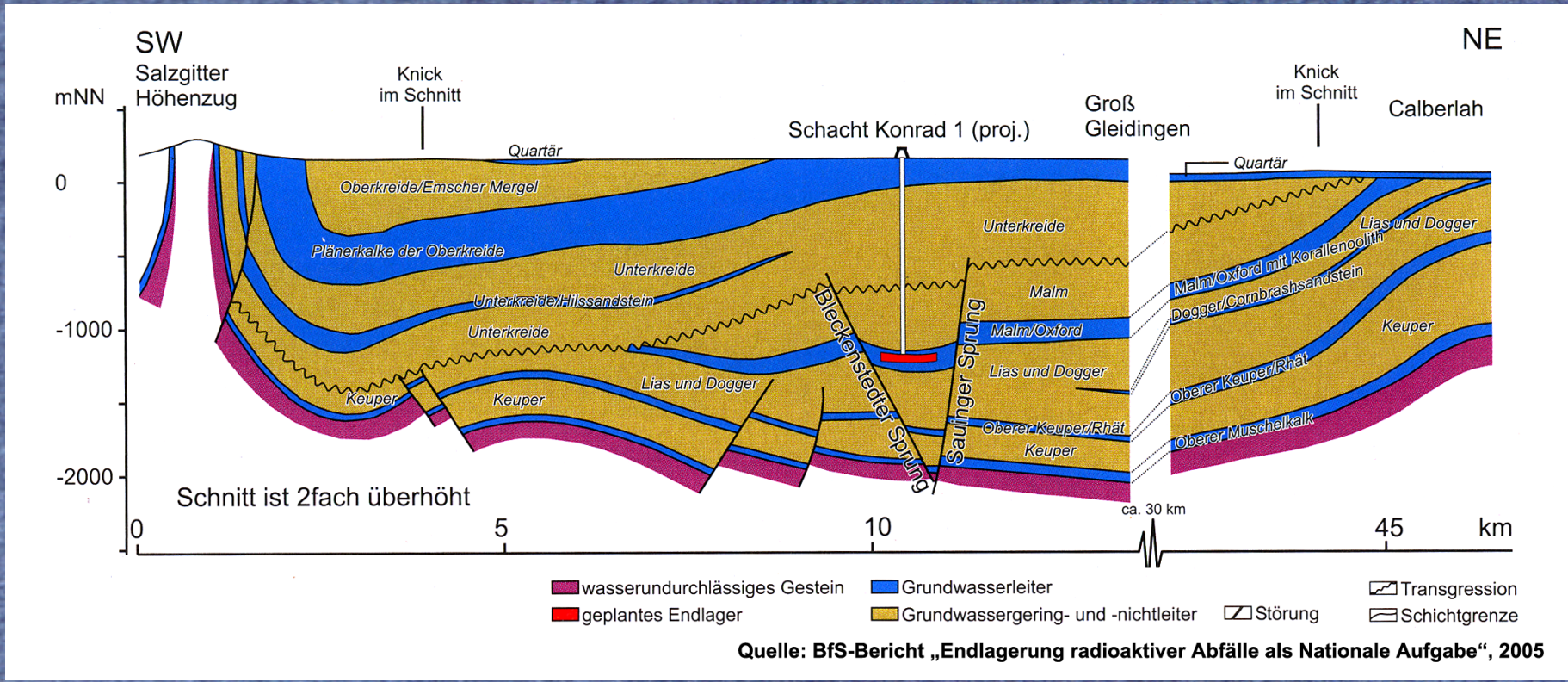
  -> radioactivity would quickly escape the repository
  -> recovery of atomic waste would be impossible

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

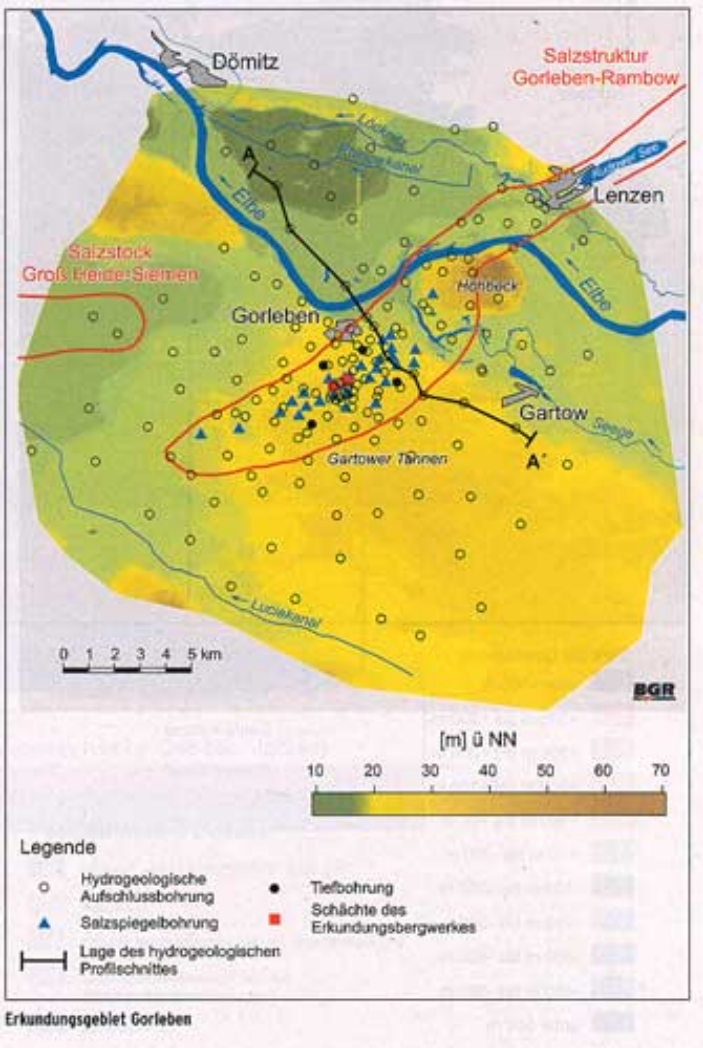


Quelle: BfS-Bericht „Endlagerung radioaktiver Abfälle als Nationale Aufgabe“, 2005

Gorleben

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

Gorleben (II)

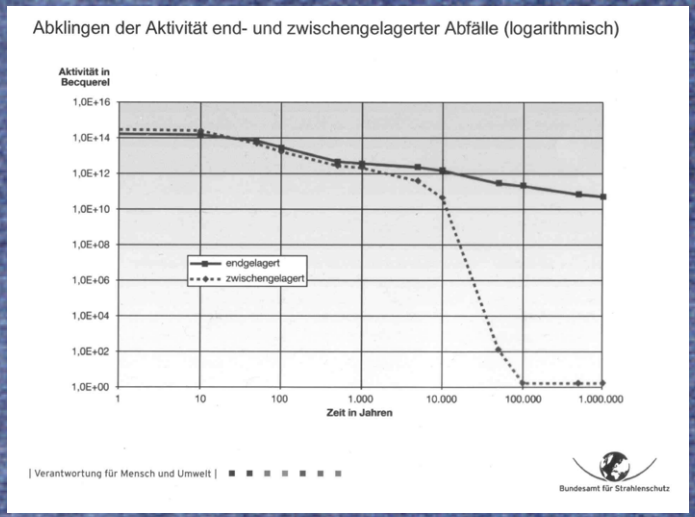


Erkundungsgebiet Gorleben

- 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.