Underground storage for mercury waste final disposal

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UNITAR Training on Chemicals and Waste Management

About GRS

- Non-profit research & expert organization based in Germany
- Majority owned by the German state & federal states
- Fields of expertise
  - Reactor safety
  - Storage & disposal of nuclear waste
  - Physical & radiation protection
  - Environment & energy

- **Braunschweig office:**
  - Underground disposal of nuclear & hazardous waste
  - Mercury policy

GRS Braunschweig

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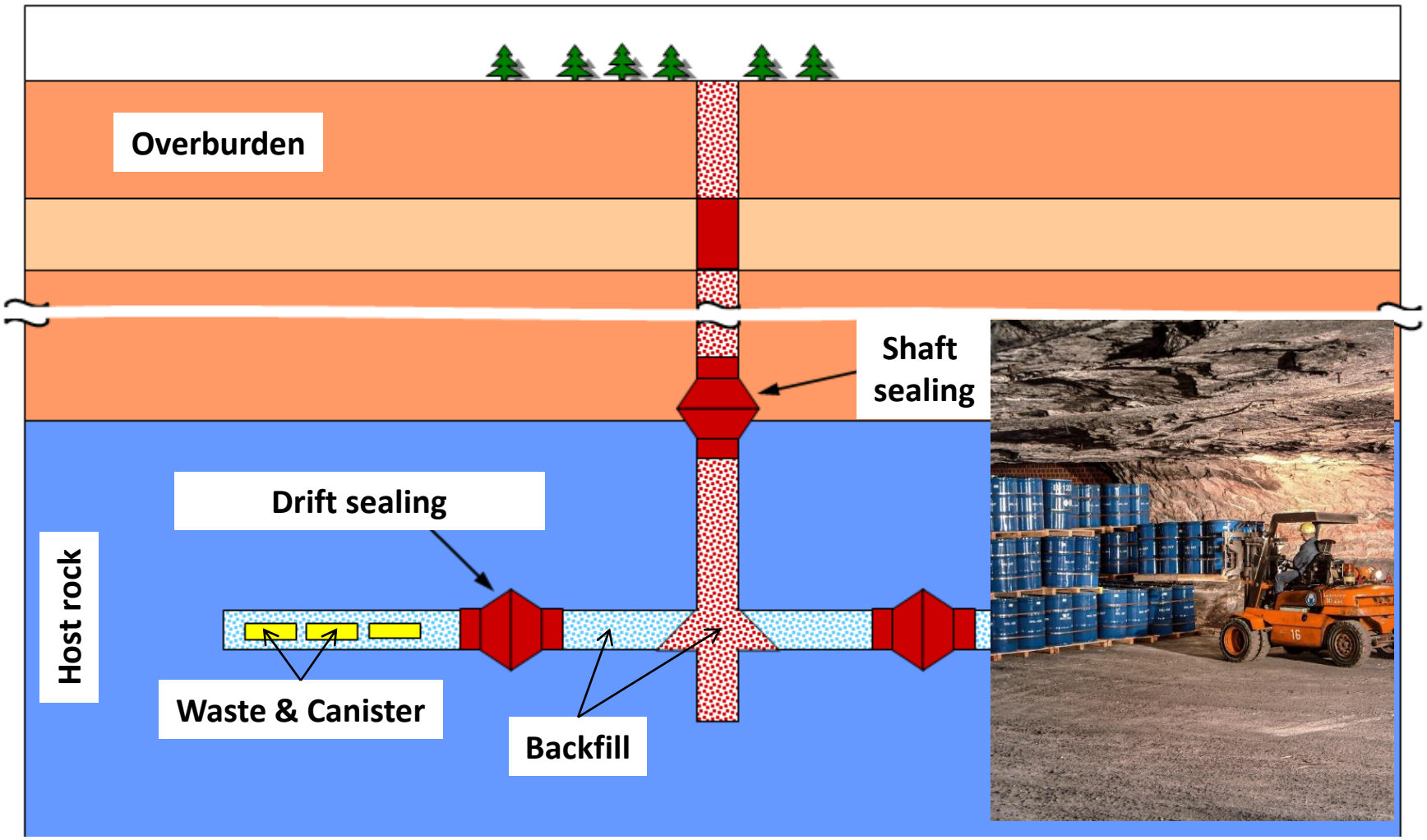
Underground waste disposal facilities in salt mines: general concept and long-term safety



- **Emplacement of waste in underground cavities produced by salt rock/ potash mining**
  - Salt formation> 200 Mio. y old
  - Disposal area > 150 m deep (3 out of 4: > 500 m)
- **Permanent isolation of waste from the biosphere through multibarrier system**
  - Salt rock (dry + plastic)
  - Overburden (e.g., clay stone, sand stone)
  - Technical barriers (backfill, drift + shaft sealing
- **Long-term safety assessment**
  - according to European and German legal requirements

Graphic: GRS. Photo credits: K+S/ REKS

Underground disposal of waste in salt mines (UTD): current situation in Germany

Herfa-Neurode

Zielitz

Sondershausen

Heilbronn

- Four operating facilities in Germany (first commissioned in 1972)
- Each facility is licensed to accept an individual set of waste types
- In 2020: disposal of 136.000 t of hazardous waste

Waste acceptance criteria (incomplete list)

Waste is not accepted, if it is

- Radioactive
- A liquid or contains free liquids
- Infectious
- Unidentified (from research & development)
- Biodegradable

Further exclusion criteria:

- Waste is not sufficiently stable with respect to geomechanical conditions
- Waste has a high caloric value. Exemptions may be granted for
  - Waste containing elemental (activated) carbon
  - Mercury-containing waste
- Waste that may react with itself or with salt rock to produce flammable or toxic gases
- Waste that causes considerable odour pollution

Mercury waste types that are typically eligible for underground disposal

- Mercury-contaminated soil and building materials (e.g. from chlor-alkali plants)
- Calomel from zinc production
- Mercury sulphide (= stabilized mercury) and other solid mercury compounds
- Filter dust from non-ferrous metal production (Pb, Zn, Cu)
- Dried sludges from industrial waste water treatment (non-ferrous metal production)
- Activated carbon loaded with mercury (alternative may be thermal treatment/ recycling)

Waste types that typically require prior recycling / extraction and stabilization of mercury

- Mercury-containing lamps + measuring instruments
- Liquid mercury
- Mercury-containing waste from gas & oil industry (typically, the caloric value exceeds accepted limits + content of flammable substances)
- Catalysts contaminated with mercury
- Waste types where liquid mercury is not bound to the waste matrix

Practice of underground disposal: waste declaration, packaging and delivery

1. Waste declaration: origin + source of waste (process), chemical analysis, sample → operator
2. Operator checks compliance with allowed list of wastes and waste acceptance criteria
3. Prior notification of competent authorities about intended transboundary shipment of waste
4. Delivery of waste only in pre-determined packaging types (site- and waste specific)
   - Steel drums on palettes,
   - sheet steel crates,
   - cage boxes
   - big bags

Photo credits: K+S / REKS

Practice of underground disposal: inspection upon arrival

Upon arrival of waste delivery:

- Checking of accompanying documentation
- Optical inspection of waste packaging, Check for temperature and outgassing
- Verification of declared waste composition by chemical analysis (on-site)
- → Decision whether to accept delivery

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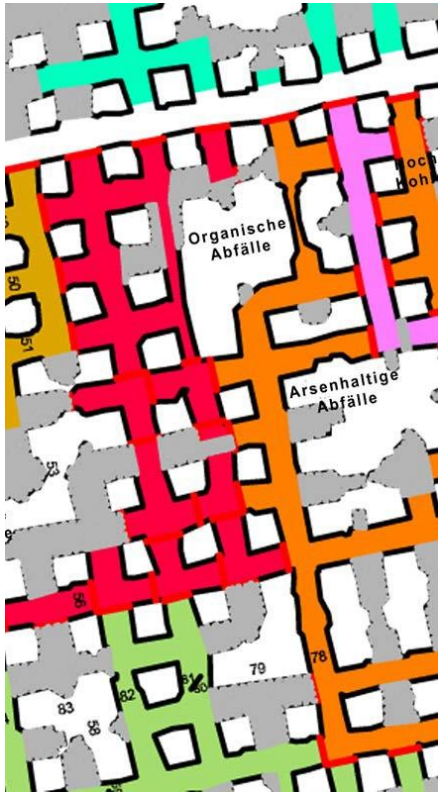
Practice of underground disposal: transport to storage area



- Transport of waste underground via shaft and network of drifts to the designated storage area
- Waste of similar/ compatible types is placed in a separate storage sector)

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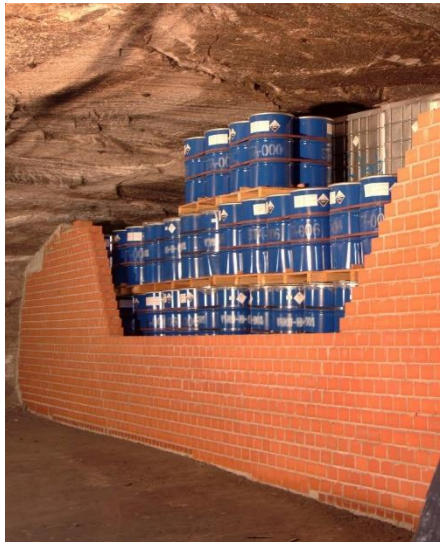
Practice of underground disposal: emplacement and documentation



- Orderly emplacement in the storage area
- Every waste container receives a code for identification.
- A reserve sample is stored in a separate underground archive. The location of every single container is documented
- Areas that are filled with waste packages are backfilled with crushed salt material & closed by walls and dams

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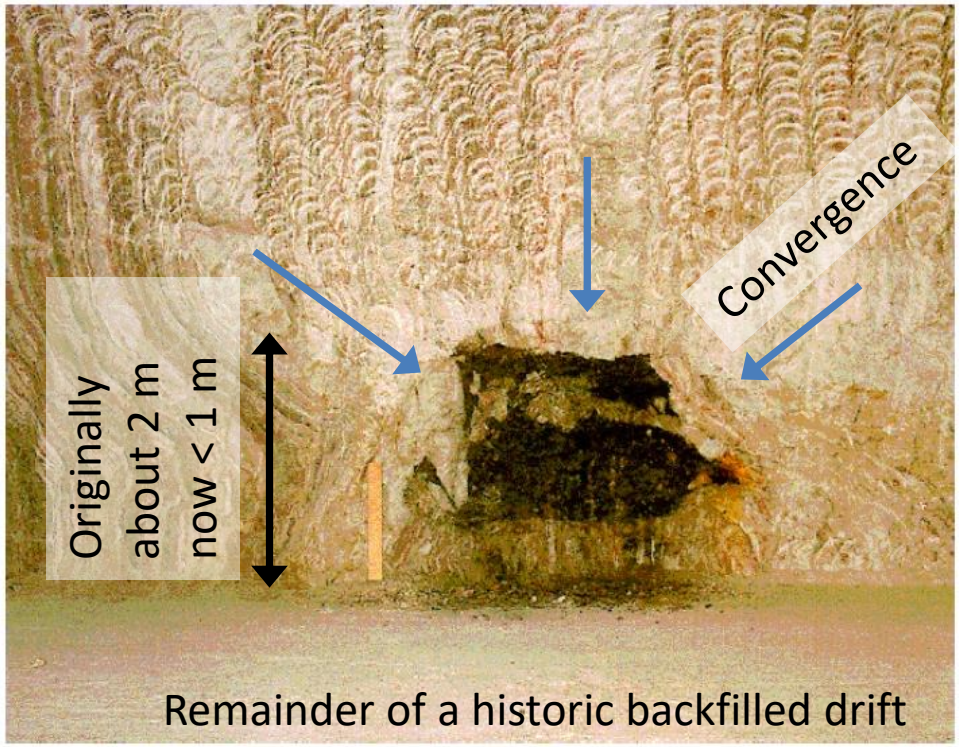
The final chapter: Closure of the mine and expected long-term development



At the end of operation: Sealing of drifts and shafts with technical barriers made of

- Salt based concrete
- Sorel cement
- Bentonite (clay)
- Crushed salt

Closure of cavities by natural convergence (some 100-1000 y)

- Convergence = Under great pressure salt rock is plastic and and behaves like an extremely viscous fluid that flows into open cavities
- Convergence compresses salt backfill and tightly encloses waste packages
- Final state: water + gas tight enclosure

Photo credits: GRS

Underground utilisation of waste as backfill (underground stowage)

- Main purpose: mechanically stabilize underground cavities produced by salt extraction by emplacing waste packages (e.g., big bags) or solidified waste
- Similar operation and legal requirements for the long-term safety assessment
- Smaller range of accepted waste types. Typically: high volume mineralic waste types with a low to moderate content of hazardous substances, e.g.:
  - Fly + bottom ashes
  - Filter dust
  - Sludges + Slags
  - Construction waste
  - Casting sand

- 13 facilities in Germany with a specific list of accepted waste types
- Capacity: ~ 3 Mio. t/a

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Thank you!

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