Experience from the WISMUT Project with the Management of Large Volumes of Radioactive Residues

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Presentation Outline

- Background
- Remediation approach and technologies
- A case study
- After use
- Lessons learned & Summary
Background

- 1946 - 1990, SDAG Wismut in East Germany major uranium supplier to the Soviet Union (~216,000 tonnes of U)
- 1990, U production terminated in the wake of the German reunification, start of remediation
- German government earmarked 6.6 billion Euro to fund the remediation project.
- Mining and milling affected approximately 100 km² in densely populated areas.
Site setting and areal extent of radioactive contamination

- 1990: Survey of affected areas:
  - 85% of territory released for unrestricted use (dose rates < 200 nSv/h)
  - Delineation of areas providing main radioactive impact, focus on 3,700 ha operational areas at 5 mine & 2 processing sites
Remediation goals

- **Ensure public safety**, physical/chemical stability of all remaining structures/objects
- **Enable future land use**
- **Minimize radiation risks** and hazards
  - Achieve individual effective dose for public: <1 mSv/a (action level and remediation goal)
- **Reduce adverse effects** to water resources
- **Destigmatize** regions, affected by uranium mining
Wismut Programme: Main Technologies

Comprises full scope of mine remediation, amongst others:

- Dismantling of surface structures, removal of contaminated material and safe disposal
- Safekeeping of waste (tailings, waste rock)
- Effluent treatment
Radioactive residues

- **Waste rock, Low grade ore**: 325 Mm$^3$; 60+ objects (dumps), 0.2...2 Bq/g $^{226}$Ra
- **Tailings**: 160 Mm$^3$; 600 ha, 7 objects (ponds), 10 Bq/g $^{226}$Ra
- **Material from area clean-up** *
  - Debris/concrete (865,000 m$^3$; 0.2...1 Bq/g $^{226}$Ra)
  - Contaminated Soil, waste rock (14.5 Mm$^3$)
  - Scrap metal (200,000 t; 0.5...50 Bq/cm$^2$ $\alpha$-activity)
- **Water treatment residues**

* Ref.: Wismut GmbH, Sanierungsprogramm 2010
Safekeeping of mine waste

<table>
<thead>
<tr>
<th>Site</th>
<th>Waste rock (Mm³)</th>
<th>Main remediation technology</th>
<th>Tailings (Mm³)</th>
<th>Main remediation technology</th>
<th>Main waste disposal area for other residues</th>
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</thead>
<tbody>
<tr>
<td>Aue/Schlema</td>
<td>46</td>
<td>In-situ</td>
<td>0.3</td>
<td>In-situ</td>
<td>WD #371</td>
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<tr>
<td>Ronneburg</td>
<td>211</td>
<td>Relocation</td>
<td>-</td>
<td>-</td>
<td>Lichtenberg OP</td>
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<tr>
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<td>Integrated</td>
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<td>Culmitzsch TMF</td>
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<tr>
<td>Crossen</td>
<td>3*</td>
<td>Relocation</td>
<td>54</td>
<td>In-situ</td>
<td>Helmsdorf TMF</td>
</tr>
</tbody>
</table>

* Low grade ore
Case study: Ronneburg mine site
Ronneburg: Remediation strategy

- Spatial concentration of Waste rock in Lichtenberg OP key decision
- Scope: 132 Mm³ = 230 M tonnes
- Evaluation of transport options and relocation technologies
- Necessary investment in powerful transport fleet (1993, 1995)
- Transport capacity up to 10 Mm³/yr
- Construction of special transportation roads
**Ronneburg: Investment in Mobile Technical Equipment**

Technical equipment used for the waste rock relocation at Ronneburg, reflecting the situation between 1999 and 2005 (Paul & Wille 2008)

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Aim</th>
<th>Tare weight (t)</th>
<th>Capacity (m$^3$)</th>
<th>Power (HP)</th>
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<tbody>
<tr>
<td>4</td>
<td>Dozer CAT-D11N</td>
<td>Ripping/pushing</td>
<td>97</td>
<td>34</td>
<td>744</td>
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<tr>
<td>2</td>
<td>Dozer CAT-D11R</td>
<td>Ripping/pushing</td>
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<td>34</td>
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<tr>
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<td>9.2</td>
<td>648</td>
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<tr>
<td>11</td>
<td>Haul truck CAT-785B</td>
<td>Transport</td>
<td>95</td>
<td>78</td>
<td>1399</td>
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<tr>
<td>5</td>
<td>Haul truck CAT-773B</td>
<td>Transport</td>
<td>38</td>
<td>34</td>
<td>692</td>
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<tr>
<td>6</td>
<td>Haul truck CAT-775D</td>
<td>Transport</td>
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<td>42</td>
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<td>4</td>
<td>Water truck CAT-773B</td>
<td>Dust control</td>
<td>40</td>
<td>50</td>
<td>692</td>
</tr>
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</table>
Ronneburg: Mine waste transportation

Cross section of the transportation road for the relocation of Halde Paitzdorf (source: IWU, 2004)

Construction of the transportation road from Halde Paitzdorf to the Lichtenberg open pit with waste rock. View from the dump towards the former Reust dump, which had already been relocated. June 2005
Disposal area, Ronneburg 1992

Michael Paul  Wismut Experience  Vienna, Austria, January 30, 2013
Waste rock and ash co-disposal, Ronneburg 2002

Michael Paul        Wismut Experience Vienna, Austria, January 30, 2013
Annual relocation (million m$^3$)

- Schutzdamm
- Halde 4
- Halde Paitzdorf
- Halde Reust
- Halde 377
- Halde 370
- Diabashalde
- Nordhalde
- Halde Schürfe 12/13
- Schmirchauer Balkon
- Absetzerhalde
- Halde Gessen

Waste Rock relocation, 2006
Shovel & truck for area clean-up

Michael Paul        Wismut Experience        Vienna, Austria, January 30, 2013
Remediation criteria

- Secondary levels, derived from the 1 mSv/a reference level

- **Unrestricted use** of contaminated areas, buildings and mine dumps:
  - < 0.2 Bq/g for the dominating radionuclide of the U-238 decay chain
  - < 300 nSv/h ambient dose equivalent rate

- **Restricted land-use** (forestry, grassland):
  - 0.2 - 1 Bq/g for the dominating nuclide
  - If > 1 Bq/g site specific assessment needed

- Release for reuse of equipment and installations:
  - Total $\alpha$-Surface Activity: < 0.05 Bq/cm$^2$ for unrestricted release
  - < 0.5 Bq/cm$^2$ for melting of metallic scrap

Ref.: Recommendations of the German Radiation Protection Commission (SSK), 1992
Disposal Area I for treatment sludge ca. 2 ha, 120,000 m³
Vegetated soil covers

- Encapsulation of all artificial landforms
- Total area to be covered > 1,100 ha
- Predominant use of natural soils
- Object specific approach, cover thickness 0.5 – 2.5 m

**Main issues:**

- Physical stability
- Re-utilisation
- Limitation of radioactive exposures to the public
- Impact on water courses (infiltration)
Land use and ownership structure of WISMUT’s former mine land
(June 30, 2012)
Value-added after use

Enhancing Investments: Industry and Solar Parks, Ronneburg

Solar Park Ronneburg I, 2009, 4.5 MW

Solar Park Beerwalde, 2012, 5 MW

Solar Park Schmirchau, 2012, 20 MW

Former Lichtenberg OP

Beerwalde WD
Lessons learned: Some guiding principles

- Site related **top-down approach**, with step-by-step implementation
- **Design Planning based on EIA** and **cost benefit optimization**, within bounding remediation criteria
- Use “**Best Available Technologies**” (BAT)
- Invest in **Robust solutions** to ensure sustainability
- Strict **on-site QA/QC measures** are ultimate key to success
- Focus on **Stakeholder involvement**
Summary

- Per 12/2012: Remediation of the legacies of uranium mining in East Germany to > 85 % successfully completed
  - Total expenditures: 5.7 bn EURO
- Sustainable limitation of radioactive and other emissions in compliance with licences
- Following land reclamation, some 1,100 ha sold or leased out of a total of ca. 3,700 ha appropriated land
- Development of state-of-the-art remedial technologies for tailings and waste rock; water treatment; and proven in full-scale
Summary

- Core remediation tasks to be completed by ca. 2020
- **Long-term tasks** dominated by water treatment, maintenance, and environmental monitoring
- Specifics, complexity and size make WISMUT an important **international reference project** for the remediation of radioactive wastes
- Keys to success: (i) strong and decisive **political motivation**, (ii) retaining **valuable skills/infrastructure**, (iii) immediate and stable **funding**
- Remedial work pre-condition for **successful revitalization**
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