The German Wismut Environmental remediation Programme – Status achieved and Challenges remaining

Michael Paul, Andrea Kassahun
Wismut GmbH, 09117 Chemnitz, Jagdschänkenstraße 29

Challenges and Best Practices in Metal Leaching and Acid Rock Drainage
BC MEND 2013, Vancouver, December 4 - 5, 2013
Introduction

- 1946 - 1990, SDAG Wismut in East Germany major foreign uranium supplier to the Soviet Union (~ 216,000 tonnes of U from 20+ deposits)
- 1990, U production terminated in the wake of the German reunification (45,000 employees)
- Rigorous production philosophy, operation in densely populated areas
- East German U industry left behind one of the most extensive uranium-mining legacies in the world
- 1991, start of the remediation program after abrupt closure
  - German government as new company owner earmarked 6.6 bn Euro to fund the project (largest European environmental remediation programme)
Site setting and areal extent of the legacy

- 7 production complexes, with more than 1,000 objects:
  - 5 Underground mines (~ 80 million m³ excavation volume)
  - 1 open pit (~ 84 million m³)
  - 2 Processing plants, 10 TMF, containing 160+ million m³ tailings
  - 3,700 hectare operational areas with contaminated facilities
  - 60+ Waste rock piles, containing 325 million m³ WR
Situation in 1990

- 325 million m³ waste rock piles (1,540 ha contact area)
Situation in 1990

- 3,700 hectare contaminated operational areas:
  - 250,000 m³ demolition waste
  - 260,000 tonnes scrap
- 160 million m³ tailings
Situation in 1990

• 1 open pit: 84 million m³
• 5 underground mines (1,500 km mine workings),
  1 in-situ-leaching mine
Remediation goals

- Ensure public safety
- Enable future land use
- Minimize radiation risks and hazards
  - achieve individual effective dose for public: < 1 mSv/a
- Reduce adverse effects to water resources
  - minimize WR seepage, flood mines, pump & treat tailing seepage and mine drainage to meet regulatory standards (U, Ra, As, heavy metals, Fe, Mn, SO₄)
- Destigmatize regions affected by uranium mining
Main Activities

- Dismantling of surface structures, decontamination and site clean-up, disposal of contaminated material into containments
- Safe closure of underground mines and controlled mine flooding
- Tailings dewatering & stabilization
- In-situ stabilization or Open Pit disposal of mine waste, segregation / conditioning of reactive mine waste
- Vegetated soil covers on tailings and waste rock
- Active water treatment and safe management of residues
- Environmental monitoring & Maintenance
Main Activities

- Dismantling of surface structures, decontamination and site clean-up, disposal of contaminated material into containments
- Safe closure of underground mines and controlled mine flooding
- Tailings dewatering & stabilization
- In-situ stabilization or **Open Pit disposal of mine waste**, segregation / conditioning of reactive mine waste
- **Vegetated soil covers** on tailings and waste rock
- Active water treatment and safe management of residues
- Environmental monitoring
Open pit disposal of mine waste

- ARD, 16 dumps
- Spatial concentration of waste rock in open pit
- 132 million m³ = 230 million tonnes
- Transport capacity 10 million m³/a
- Necessary investment in powerful transport fleet (1993, 1995)
- Backfill concept includes zonation according to waste rock acid / neutralizing potential
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
Backfilling concept

Zone A: high acid potential / lime addition (saturated)
Zone B: low acid potential (transition)
Zone C: high neutralizing potential (unsaturated)
Remediation result


Waste concentration, reduction of environmental impacts, enable future land use

Remediation: 1991 - 2010
Vegetated soil covers

- Encapsulation of 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

Physical stability, reduction of environmental impacts, enable future land use
Main Activities

- Dismantling of surface structures, decontamination and site clean-up, disposal of contaminated material into containments
- Safe closure of underground mines and controlled mine flooding
- **Tailings dewatering & stabilization**
  - In-situ stabilization or Open Pit disposal of mine waste, segregation / conditioning of reactive mine waste
  - Vegetated soil covers on tailings and waste rock
  - Active water treatment and safe management of residues
- Environmental monitoring & Maintenance
Tailing try in-situ stabilization

- Total tailing volume 160 million m³
- Removal of surface water
- Dewatering of sludges
- Mechanical stabilization
- Cover and vegetation

area 250 ha
thickness 72 m
volume 85 million m³

temporary cover
drain drills
permanent cover

TMF Culmitzsch 1991
TMF Culmitzsch 2013
Main Activities

- Dismantling of surface structures, decontamination and site clean-up, disposal of contaminated material into containments
- **Safe closure of underground mines and controlled mine flooding**
- Tailings dewatering & stabilization
- In-situ stabilization or Open Pit disposal of mine waste, segregation / conditioning of reactive mine waste
- Vegetated soil covers on tailings and waste rock
- Active **water treatment** and safe management of residues
- Environmental monitoring & Maintenance
Closure of underground mines and water treatment

- Mine Schlema, 36 million m³
- Flooding 1991 - 2011

- Mine Königstein, 11 million m³
- Experimental fooding 1993 - 2000
- Flooding since 2001; stopped in 2012
Closure of underground mines and water treatment

- 7 water treatment plants (2 at TMF, 5 at flooded underground mines)
- mine flooding since 1991; water treatment since 1995
- Water treatment technology: modified or HDS lime precipitation / ion exchange
- Discharge limits for U, As, Ra, heavy metals, Fe, Mn, SO₄
- German water legislation / european water frame work directive
- treatment capacity of individual plants 100 - 700 m³/h (max. 1,200 m³/h)
- total throughput ~ 20 million m³ / a
- water treatment cost ~ 35 million € / a
## WISMUT Remediation Programme
### Status of Remediation Activities March 2013

<table>
<thead>
<tr>
<th>Underground</th>
<th>Percent achieved*</th>
<th>Work remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine workings abandoned</td>
<td>99 %</td>
<td>99 %</td>
</tr>
<tr>
<td>Backfilling of Mine Voids</td>
<td>99 %</td>
<td>99 %</td>
</tr>
<tr>
<td>Mine workings flooded</td>
<td>98 %</td>
<td>98 %</td>
</tr>
<tr>
<td>Stabilization of mine workings</td>
<td>94 %</td>
<td>94 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface Remediation</th>
<th>Status</th>
<th>Percent achieved</th>
<th>Work remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demolition of facilities</td>
<td>90 %</td>
<td>90 %</td>
<td></td>
</tr>
<tr>
<td>Contouring</td>
<td>93 %</td>
<td>93 %</td>
<td>TMF</td>
</tr>
<tr>
<td>Final capping</td>
<td>73 %</td>
<td>73 %</td>
<td>planned until 2040</td>
</tr>
<tr>
<td>Reclaimed areas</td>
<td>74 %</td>
<td>74 %</td>
<td></td>
</tr>
<tr>
<td>Water treatment</td>
<td>53 %</td>
<td>53 %</td>
<td></td>
</tr>
</tbody>
</table>

* Based on the 2010 revision of the remediation programme
Challenge: In-situ contaminant immobilization
Summary

- Per 10/2013: 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 permits
  - Decrease of radionuclide discharge into surface waters by 90-99% (27.5 t U in 1989 → 2.4 t U in 2007)
- Following land reclamation, some 1,150 ha sold or leased out of a total of ca. 3,700 ha appropriated land
- Core remediation tasks to be completed by 2022
- Long-term tasks dominated by water treatment, maintenance, and environmental monitoring planned until 2040