



Status and Results of the WISMUT Environmental Remediation Project

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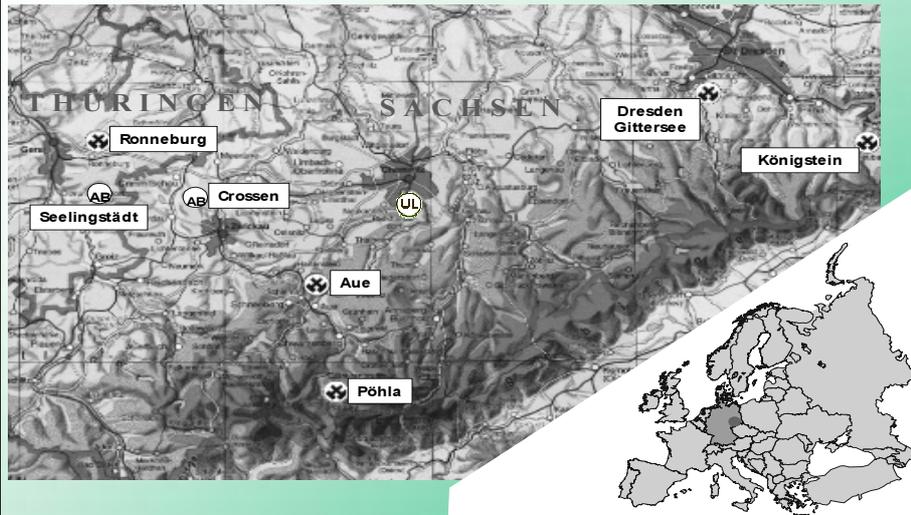
Historical background (1)

- 1946 The Soviet occupation forces in Germany established the state-run company SAG WISMUT with the sole aim to exploit the East German uranium deposits for the Soviet nuclear programme.
- 1954 Foundation of the bi-national Soviet-German company SDAG WISMUT, continuation of the uranium production with a workforce of up to 120 000 employees.
- 1990 Following reunification of Germany, the uranium production was suspended due to particularly economic reasons.
- 1991 The Soviet Union disclaimed its shares under the terms of the WISMUT Treaty Act. The Federal Republic of Germany took over the stock shares to 100 %.

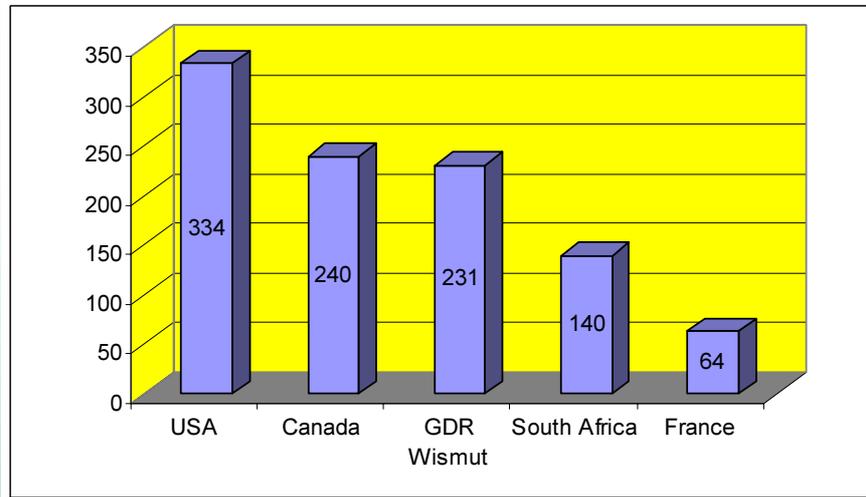
Historical background (2)

- 1991 The reunified Germany was faced with one of its largest ecological and economic challenges because WISMUT turned at once from the production to the decommissioning phase without any preparation or preplanning.
- 1991 The SDAG WISMUT was legally transferred into a company under German corporate law: WISMUT GmbH, with the Federal Republic of Germany as sole shareholder. The corporate purpose is to decommission the former uranium mining and milling facilities and to rehabilitate the land for reuse.
- 1991 The WISMUT Environmental Remediation Project was initiated and the German Federal Government earmarked a total of € 6.2 billion to conduct the Project.
- since 1991 Implementation of the Project on the base of the WISMUT Act, and the radiation protection regulations of the former GDR (VOAS, HaldenAO)

Location of the WISMUT sites



**World uranium production until 1990
(tonnes in thousands, selected countries)**



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Production phase 1946 – 1990



5 mines, 1 open pit
3 700 ha operational areas



2 processing plants
covering an area of 140 ha



64 mine dumps
311 Mio. m³ waste rocks



Tailings compoundments
570 ha, 178 Mio. m³

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Radiological situation at the time of termination of uranium mining and milling in 1990

- 37 km² „WISMUT-covered“ region
population density: Saxony 247, Thuringia 154 inh./km²
- 311 Mio m³ waste rock piles, 48 piles (20 at the Schlema site)
0.2 ...2 Bq/g (Ra-226); inventory: 20 000 t Uranium
- 30.6 Mio m³/a seepage water
27 t/a Uranium controlled release into surface waters
- 5.7 km² tailings pond surface, 178 Mio m³ sludges (Seelingstädt)
inventory: 1 800 TBq (Ra-226), 16 000 t Uranium
- 1.6 km² open pit; 84 Mio m³ open volume (Lichtenberg)
- 5 mines (Aue, Pöhle, Königstein, Ronneburg, Gittersee);
1.53 Mio m³ volume of the mine galleries, 1 470 km length;

Radiological questions of concern

- **Determination of the contamination, exposure analysis,**
- **Identification of the measures to be taken (justification of remediation, 1 mSv/a criteria)**
- **Monitoring of the radiological impact, dosimetry (limitation of radiation exposure)**
- **Identification of the preferred remedial option (optimization)**
- **Development of measuring procedures and techniques, development of release procedures**
- **Radioactive material management**
- **Licensing, information of the public, stakeholder involvement**
- **Handling of these questions by determining classes of objects**



Remediation concepts and technologies

Class of Objects	Technology
Contaminated structures and areas	Demolition, decontamination, cleanup of areas, release of lowly contaminated material for restricted reuse, safe disposal of higher contaminated material
Waste rock dumps	In-situ remediation (reshaping, slope stabilisation, covering); alternatively relocation to a safe site
Tailings management facilities (TMF)	Dry in-situ remediation (dewatering, geotechnical stabilisation, cover placement)
Open pit Lichtenberg	Refilling of waste rock material, covering
Mines	Closure of mine openings, stabilisation of underground galleries, controlled flooding
Contaminated water (mine water, seepage, pore and supernatant water from TMF)	Active water treatment in special plants, alternatively passive water treatment procedures (biological and treatment technologies, phytoremediation)

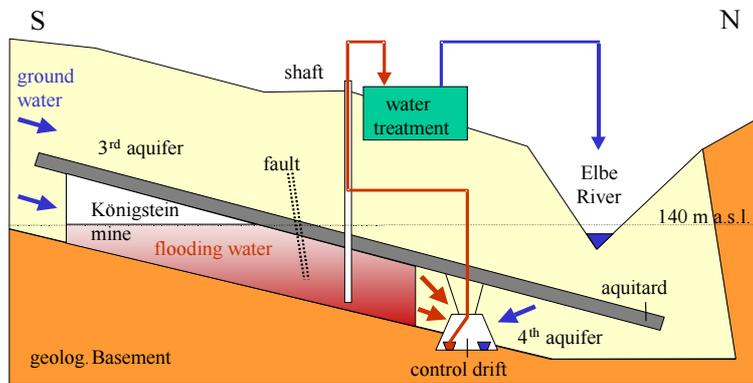
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Closure of mines

- Goal:**
- stabilisation of near-surface mine workings
 - minimisation of water born and air borne emissions of radiological contaminants, chemical pollutants and heavy metals
 - protection of aquifers

Controlled flooding of the Königstein mine



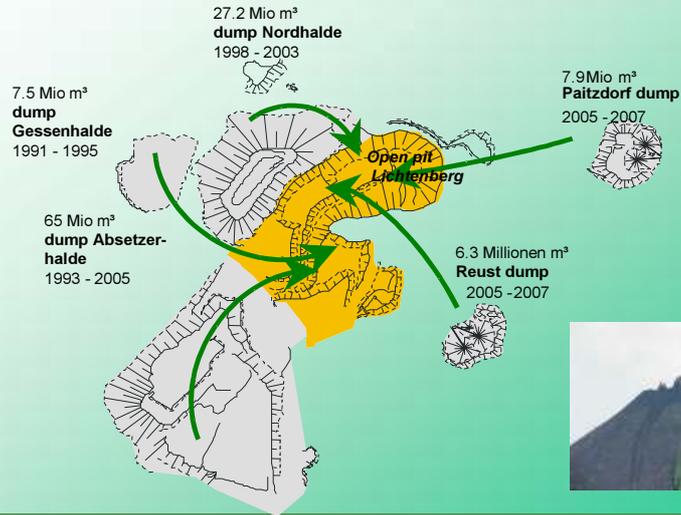
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Relocation of waste rock dumps into the Lichtenberg open pit, in-situ remediation of waste rock dumps by profiling and covering

- Goal:**
- safekeeping of radioactive material
 - minimisation of radon exhalation
 - minimisation of seepage of contaminated water
 - restricted land reuse

Refilling of the Lichtenberg open pit



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Refilling of the Lichtenberg open pit



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Reshaping and covering of waste rock dumps at the Schlema site



1965

Waste rock dump
„Hammerberghalde“

1991

2005



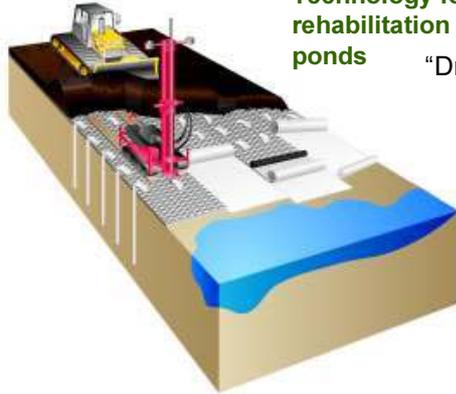
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Closure of tailing ponds

- Goal:**
- safekeeping of radioactive material
 - minimisation of radon exhalation, avoidance of propagation of dust born radioactivity
 - minimisation of percolation of precipitation water through tailings, protection of aquifers
 - restricted land reuse

► Remediation of Tailings Management Facilities (TMF)



Technology for rehabilitation of tailings ponds

“Dry” in-situ stabilization:

- (a) Removal of the „free” pond water and pore water;
- (b) Placement of an interim cover on the tailings surface to provide the consolidation load and create a stable working platform;
- (c) Construction of a stable surface contour providing suitable run off conditions for the surface water;
- (d) Capping of the surface with a final cover



► Remediation of the Trünzig Tailings pond : Profiling

2004



1991



Water treatment

- Goal:**
- protection of surface waters and aquifers
 - minimization of radiological exposures on the water pathway

Water treatment plants at WISMUT

Water treatment plant	Capacity [m ³ /h]	Type of feed water	Main radiological component	Permitted discharge standard / discharge		
				U _{nat} [mg/l]	Ra-226 [Bq/l]	U _{nat} [t/a]
Aue	1000	Mine water	5 mg/l U _{nat}	0.5 / 0.2	0.4 / 0.01	4.4
Pöhla	130	Mine water	2.5 Bq/l ²²⁶ Ra	0.2 / 0.02	0.3 / 0.07	0.175
Helmsdorf	250	Supernatant w.	10 mg/l U _{nat}	0.5 / 0.3	0.2 / 0.03	0.88
Königstein	650	Mine water	100 mg/l U _{nat}	0.3 / 0.006	0.4 / 0.03	1.7
Seelingstädt	300	Supernatant w. Seepage	2 mg/l U _{nat}	0.3 / 0.12	0.2 / 0.01	0.63

- production of radioactive residues:
between 50 t/a (Pöhla site) and 15 000 t/a (Königstein site)
- anticipated end of operation:
2015 (Seelingstädt site) – 2030 (Aue site)

Water treatment plants at WISMUT

from sophisticated water treatment plants to passive water treatment facilities



WTP
Königstein



wetland
Pöhla

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Management of radioactive materials

- Goal:**
- safekeeping of radioactive material
 - minimisation of the radiological impact of the huge amounts of radioactive mining and milling residues radon exhalation at the sites
 - release of lowly contaminated material for restricted reuse



Release of low-contaminated scrap for recycling



Release criteria:

0.5 Bq/cm² for the Total Alpha
surface Activity TAA



TAA determination by combination
of in-situ measurements using hand-
held monitors, and laboratory
analyses



Disposal of residues from water treatment

underground disposal



disposal in beach
areas of tailing
ponds



disposal at
a waste rock
dump



Why are the radioactive residues from WISMUT sites not considered as radioactive material ? (1)

- According to Section 118 of the German Radiation Protection Ordinance and Article 9 /together with Appendix II of the German Reunification Act, the following regulations are to remain in force for the WISMUT sites:
 - the GDR Ordinance on Nuclear Safety and Radiation Protection (VOAS, 1984)
 - the GDR Order on Radiation Protection in Relation to Slagheaps and Industrial Repositories (HaldenAO, 1980)
- VOAS defines:
 - radioactive releases as “radioactive substances which are released to the environment, ... , and whose activity concentration exceeds the specified exemption criteria for radioactive releases
 - radioactive waste as “radioactive substances which cannot be reused or recycled, ... , and whose activity and activity concentration levels exceed the exemption criteria stipulated for radioactive waste

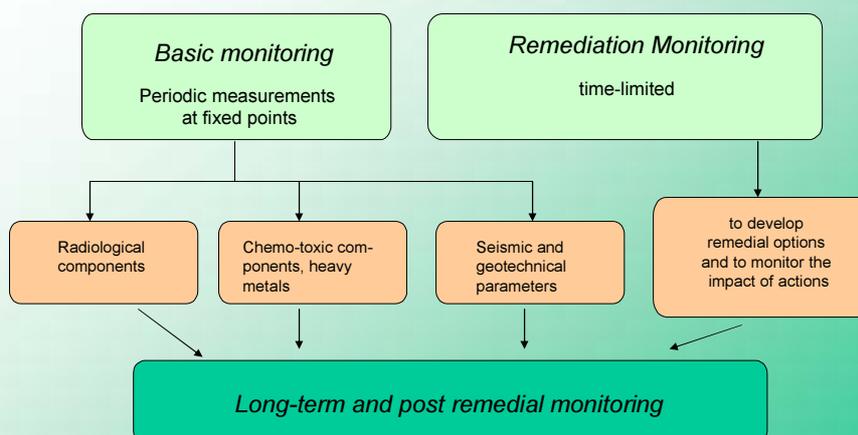
Why are the radioactive residues from WISMUT sites not considered as radioactive material ? (2)

- With respect to the categorisation of the material generated from past practices at uranium mining and milling sites, recourse must be made to the definitions and exemption levels of the VOAS and HaldenAO.
- According to Section 28 of the Implementing Regulations for VOAS, the exemption level for solid radioactive releases is 0.2 Bq/g.
- The same regulations figure out, that for radioactive waste the exemption levels are the same as those for radioactive material:
 - 100 Bq/g for the activity concentration
 - 500 Bq/g in case of solid, naturally radioactive material
 - 5 000 kBq for the total activity of U_{nat} , 5 kBq for the total activity of Ra-226
- Heaps and tailings and other waste material from WISMUT sites are generally not classified as radioactive wastes within the meaning of VOAS or the Implementing Regulations for the VOAS !

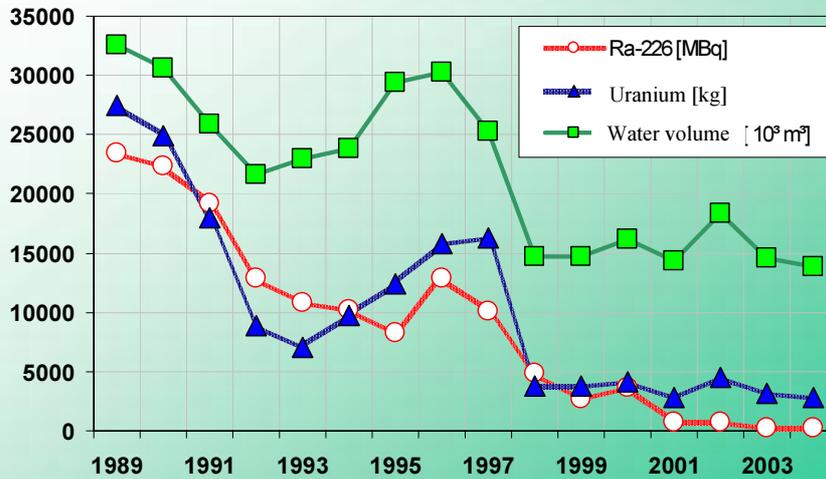
Wismut environmental monitoring

- Goal:**
- surveillance of the environmental impact of objects, residues, contaminated areas, etc.
 - surveillance of the environmental impact of remedial measures
 - proof of successful implementation of the remediation

Wismut Environmental Monitoring

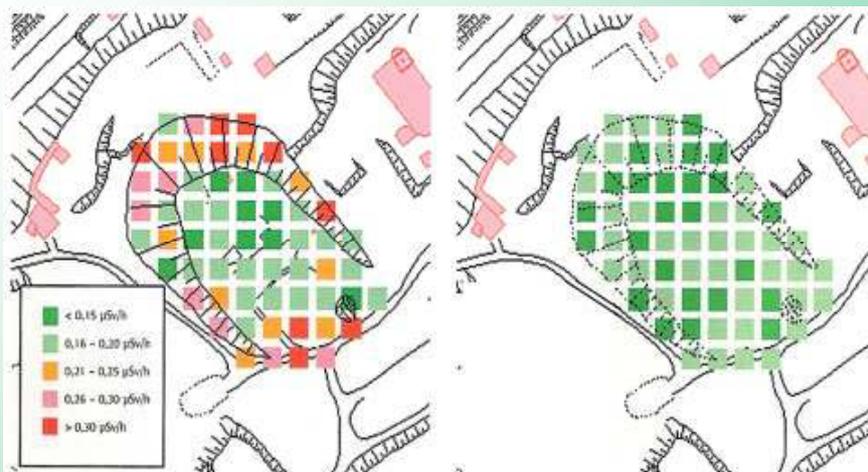


Development of the discharge of water borne radioactivity from controlled discharge points



Gamma dose rate before and after site cleanup

Example for the proof of successful remediation



State of the project and outlook

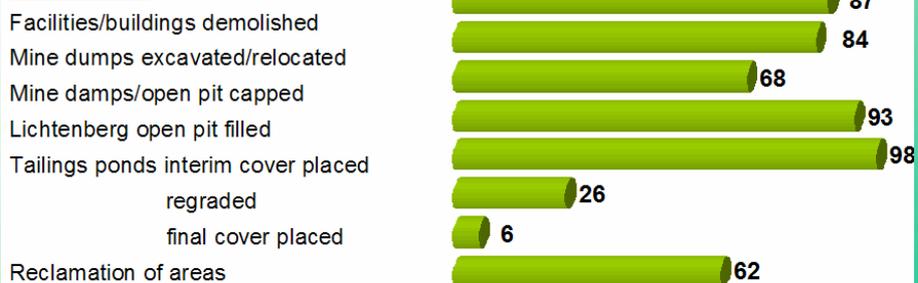


State of remediation as of end 2005 in %

underground



above ground





Long-term and post-remedial tasks:

The long-term and post-remedial activities include:

- **Water treatment**
(since water treatment is very expensive, technology should switch, where possible, towards less expensive methods, i. e. from conventional to passive treatment, like phyto-remediation, natural attenuation, reactive walls, etc.)
- **Care and maintenance of restored land**
- **Care and maintenance of ancillary mine workings**
- **Mine damage control and compensation, and**
- **Long-term environmental monitoring**

1960
Schlema (Aue site),
Waste rock pile H250



WISMUT



***new horizons
through
remediation***

2005
Schlema

Vision BUGA 2007: The Federal Garden Exhibition



*Thank you
for your attention,
the WISMUT Company, 2006*