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Management of Radioactive Residues & Wastes Generated During Remediation of Uranium Production Legacy Sites in Germany

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Int. Symposium NORM VIII, Rio de Janeiro, Brazil, 18 - 21 October 2016

Supported by:

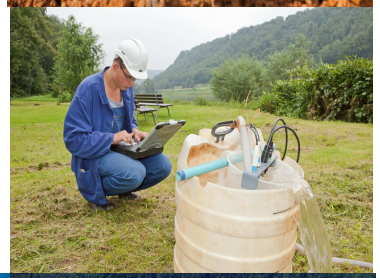
Federal Ministry
for Economic Affairs
and Energy

on the basis of a decision
by the German Bundestag

The WISMUT Env. Remediation Project

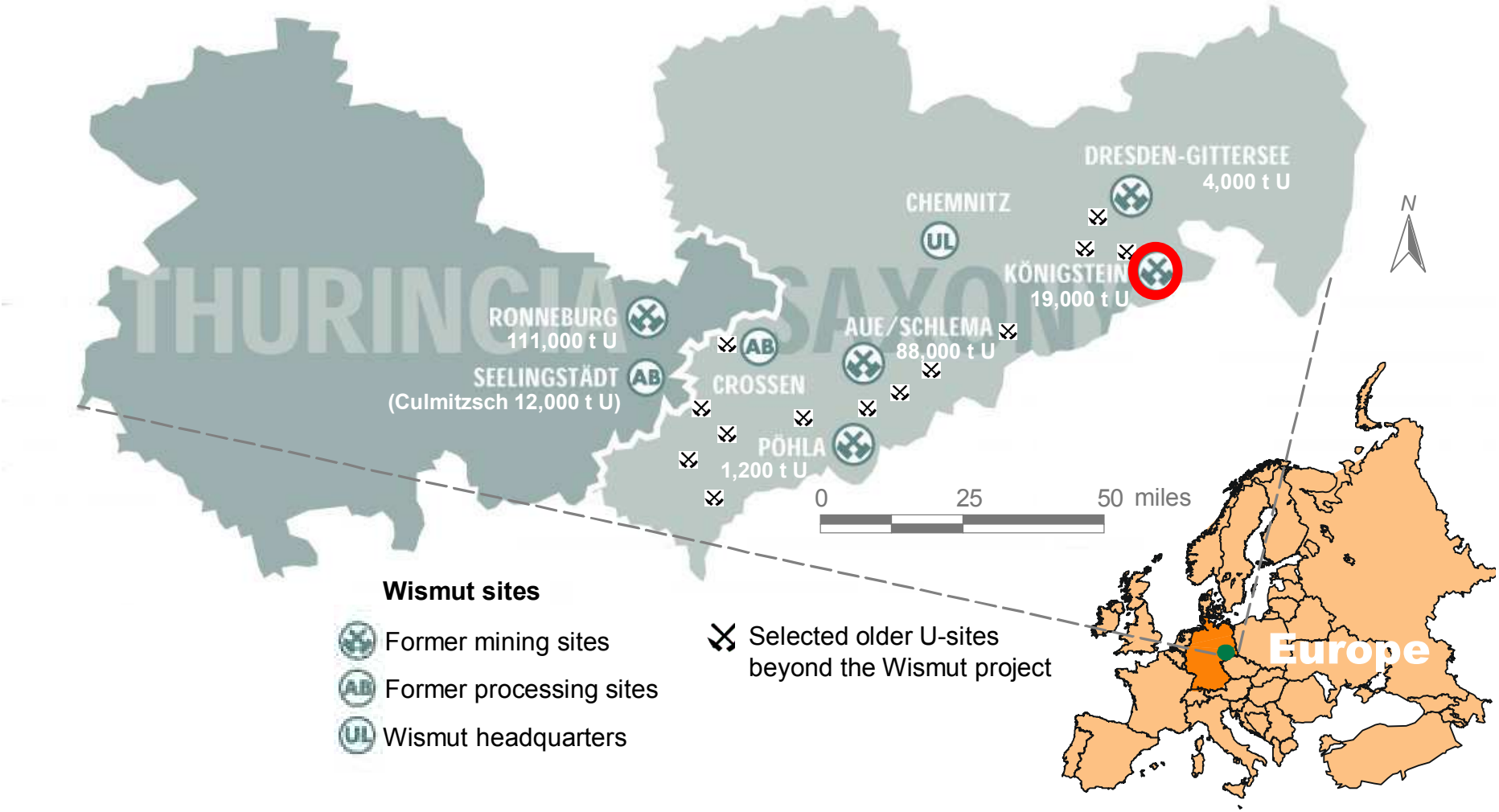
- 1946 – 1990, Soviet-German WISMUT Company in East Germany, major uranium supplier to the Soviet Union (~ 216,000 tonnes of U)
- 1990, U production terminated (i.t.w. of German reunification)
- Legacies left behind: 300 Mio. m³ waste rock materials (65 dumps); 178 Mio. m³ rad. sludges (5 tailing management facilities; 3'700 hectares industrial areas, …)
- Remediation funded by the German Government (7,1 b€)
- Physical work till 2028, long-term activities till 2045






WISMUT sites



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Main remediation activities

Demolition of Structures

Mine Flooding

Water Treatment

WT residues Management

Stabilisation/cove-rage of radioactive sludges (tailings)

Clearances/ waste management

Relocation/coverage of waste dumps

Monitoring

Residues and wastes generated during remediation

- Contaminated mine water, seepage and pore water
- Water treatment residues
- Scrap from demolition and dismantling
- Debris from demolition and dismantling
- Excavated soil from area clean-up and waste rock remediation

→ Reuse

→ Recycling for reuse ?

→ Sale

→ Long-term safe disposal

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Water treatment

- At WISMUT, six water treatment facilities (WTF) in operation, with capacities from 200 – 1’150 m³/h
- Mine, seepage and pore water (U-nat: 2 - 50 mg/l ; Ra-226: 1 - 5 Bq/l)
- Total annual water volume treated (2015): 17,4 Mio m³
- Main Technology: lime precipitation; at the Königstein also ion exchange
- Site-specific discharge limits: U-nat : max.300 µg/l; Ra -226: max. 800 mBq/l

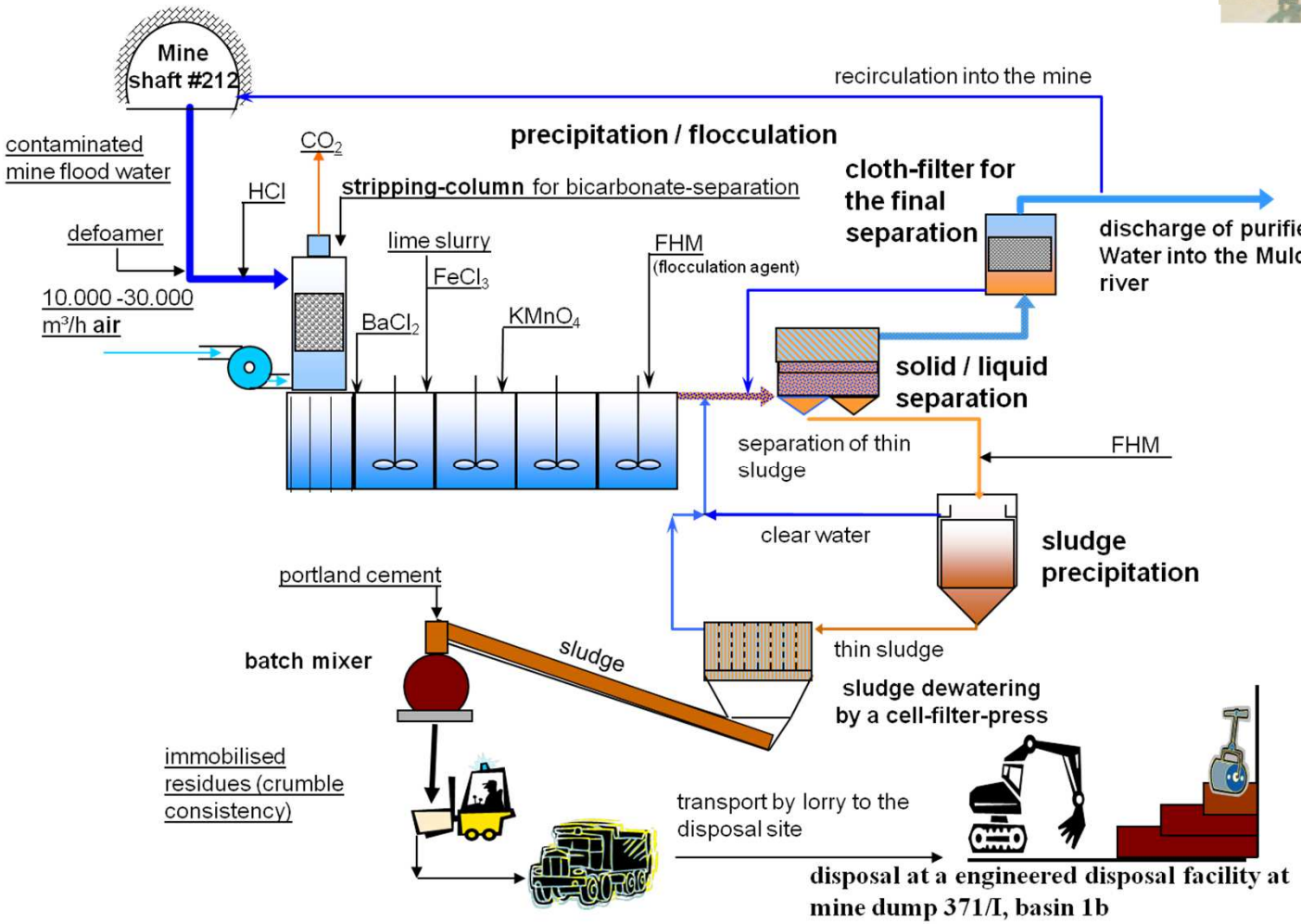
Water treatment residues

Site	Type of water treated	Hazardous Substances of conern	Annual volumes of water treated (mean 2010-2014)		Annual volumes of residues produced (mean2010-2014)	
			10^6 m^3	%	10^3 m^3	%
Schlema	Mine water, seepage water	U, As, Ra-226	**6,62**	**32,4**	1,72	6,7
Ronneburg	Mine water	Heavy metalls, U, As	**6,11**	**29,9**	**19,14**	**74,4**
Königstein	Mine water	U, Ra-226, heavy metalls	**3,50**	**17,1**	0,92	3,6
Seelingstädt	Mine water, seepage water	U, Ra-226	2,18	10,7	1,60	6,2
Helmsdorf	Mine water, seepage water	U, As, Ra-226	0,97	4,8	1,91	7,4
Pöhla	Mine water	As, Ra-226	0,11	0,6	0,14	0,6
Andere [2)]	Diverse	Diverse	0,95	4,6	0,30	1,1
Total			20,45	100,0	25,73	100,0

2015: 30‘000 t precipitates; …100 Bq/g ^{238}U, …40 Bq/g ^{226}Ra
40 t extracted uranium

WTF Schlema-Alberoda

- 1150 m³/h capacity
- discharge limits: max. 200 µg/l U-nat; max. 300 mBq/l Ra-226



Flow chart of the water treatment process in Schlema-Alberoda

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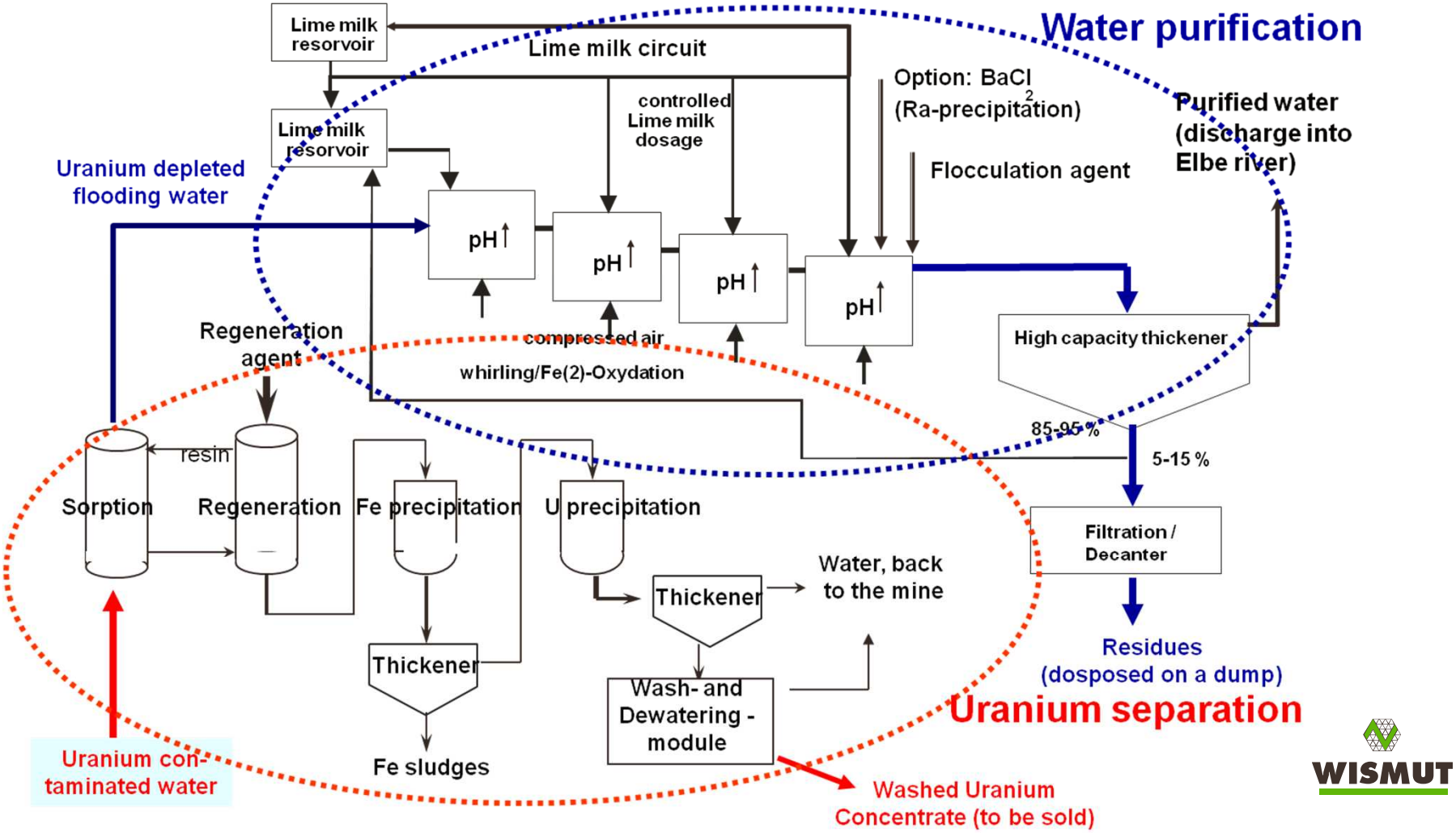
WTF Königstein:

- 500 m³/h capacity
- mean discharge limits: 300 µg/l U-nat; 400 m Bq/l Ra-226



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Management of WT residues (waste)

Sale of extracted uranium

- At a break-even price to a nuclear sector company; monitored by EURATOM,

Solidification and Immobilisation

- Sludge separation, dewatering (thickening, filter press)
- Embedding into a cement-based matrix

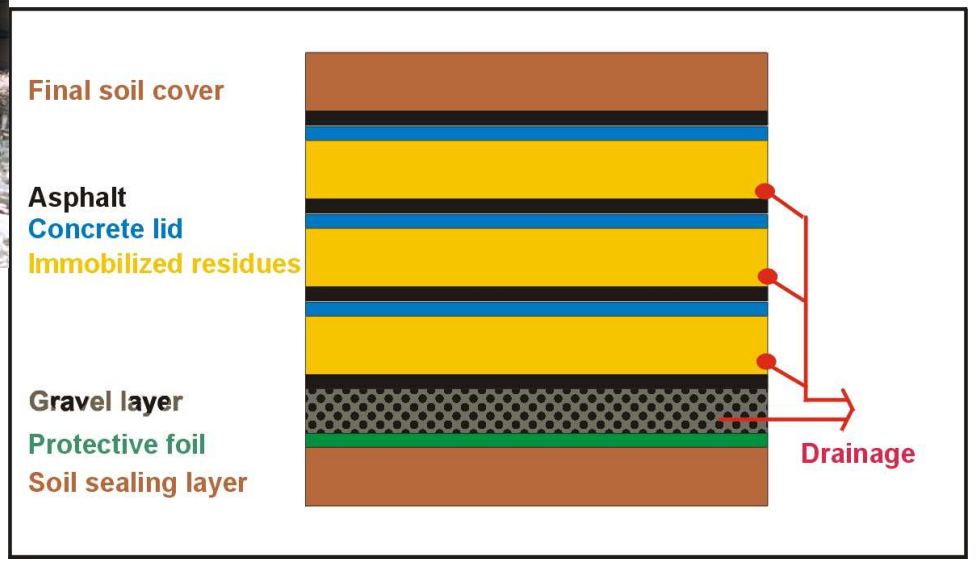
  (site-specific technologies to meet final disposal criteria, to consider the geo-/hydro-chemical and mechanical conditions)

Long-term safe disposal

- Engineered facilities
- In: waste rock piles, beach areas of tailings MF, mines

Residues from the Schlema water treatment plant

Pressing; cement mixing; filling in bigbags and disposal at an engineered facility at waste rock pile #371



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Water treatment residues at the Königstein site

Sludge separation

Waste dump Schüsselgrund, disposal of WT residues

Transport of separated uranium for sale

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Metallic scrap

- 260‘000 t of metallic scrap
- Contamination: … 50 Bq/cm² surface total activity (TAA)
- Different nuclide vectors (rad. equilibrium, tailings, radon progenies, U concentrate)

Options:

- Unrestricted reuse (TAA < 0,05 Bq/cm²)
- Restricted reuse (smelting; TAA < 0,5 Bq/cm²),
- Safe disposal (TAA > 0,5 Bq/cm²), as for WT residues
- Reuse after de-contamination (clearance measurements)
- Re-use after separation (clearance measurement)

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Decontamination of metallic scrap

Scrap shear

Decontamination facility
(abrasion mill; only for “core” scrap)

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Decontamination of metallic scrap in combination with clearance measurements

Recent example (2014/2015):

- Demolition of the shaft complex #388/390, Königstein site
- Decontamination of surfaces by a water-jet system
- From 4’230 tons of metallic scrap, almost 2’020 tons could be released for smelting

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Separation by clearance measurements

Re-use of lowly NORM-contaminated metallic scrap for smelting

Clearance criteria: Surface Total Alpha Activity TAA = 0,5 Bq/cm²

Requires a special measurement methodology for clearance

WISMUT approach: screening measurements of the beta surface activity; calibration against alpha activity, statistical data interpretation; QA (lab)

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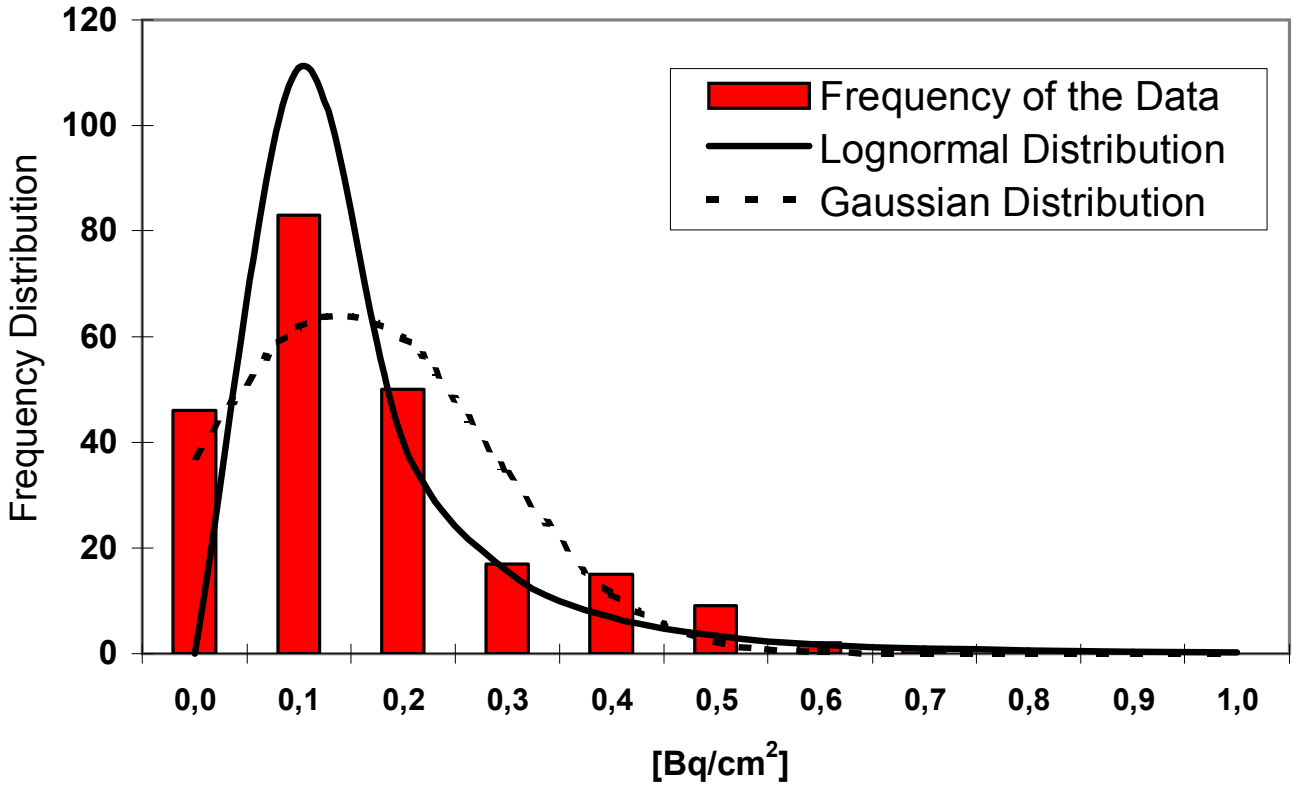
Comparison of the TAA reference value (0,5 Bq/cm²) with the upper limit of the confidence interval (95 % confidence value)



TAA mean value = 0,11 Bq/cm²

Upper confidence limit = 0,14 Bq/cm²

Frequency distributions of TAA values for a heap of scrap metal at WISMUT

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Excavated soil from area and waste rock pile remediation

- 14,5 Mio t (cumulative total at end of cleam-up)
- U-238: 0,2 – 10 Bq/g; Ra-226: 0,2 – 10 Bq/g

Relocation to other waste dumps; disposal at Tailings facilities

Reuse options – limited!

- Only inside of WISMUT
- Refilling of the Lichtenberg open pit
- Contouring of surfaces of covered tailings ponds

Blending with inert material / dilution / use of material outside of WISMUT is not allowed (0,2 Bq/g classification level)

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Tailings management facility Culmitzsch:
Use of waste rock material from dump „Nordhalde“
Contouring; construction of a hilly surface contour
Drainage, two final discharge channels

Non-metallic waste from demolition (debris…)

- 14,5 Mio t (cumulative total at end of clean-up)
- U-238: 0,2 – 10 Bq/g; Ra-226: 0,2 – 10 Bq/g

Disposal

- non-contaminated waste: at landfills
- contaminated waste at WISMUT disposal sites (tailings ponds, rock piles)
- no enhanced efforts for separation
  (space is available, easy to get approval from mining authorities; cost-effective)

→ Approach is on that score different to approaches at D&D of nuclear facilities

Limited reuse (fill material, for slope stabilization)

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Summary and conclusions

- Remediation of uranium productions legacy sites generates enormous amounts of “new” residues and wastes
- For their management, WISMUT has developed site and process specific solutions
- WISMUT benefits from available space for disposal
- When ever possible, decontamination / recycling and re-use of material is envisaged (regulatory requirements)
- However, blending of material and its reuse out-side of WISMUT is not permitted
- Nonetheless, WISMUT case study provides ample basis for sharing experiences on the management of large amounts of residues and waste with elevated natural radioactivity

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Many thanks for your attention …