Sediments in affected river systems – lessons learned from WISMUT remediation

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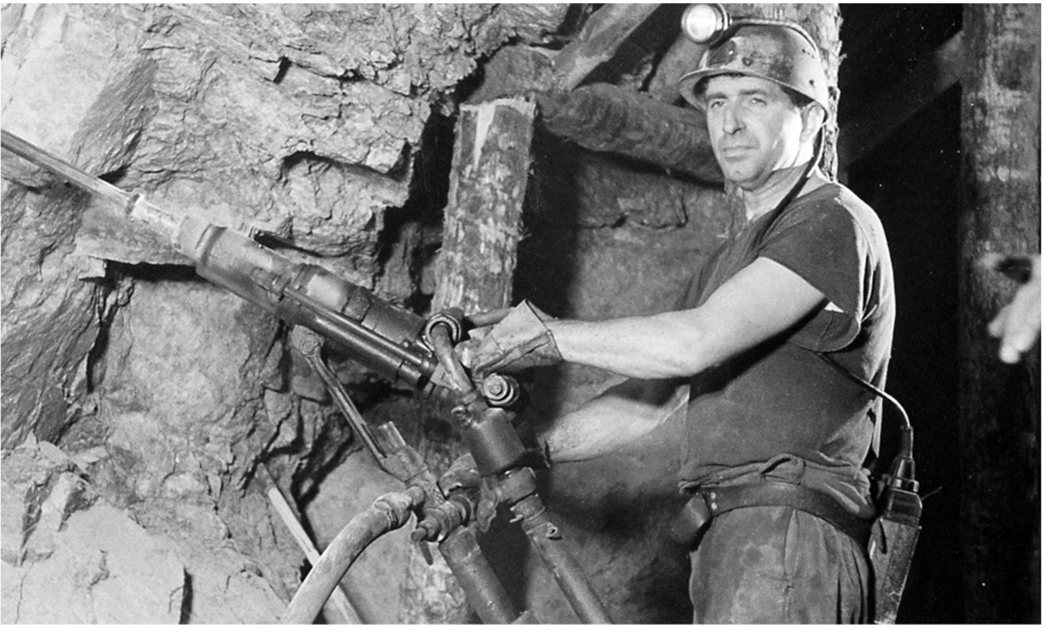
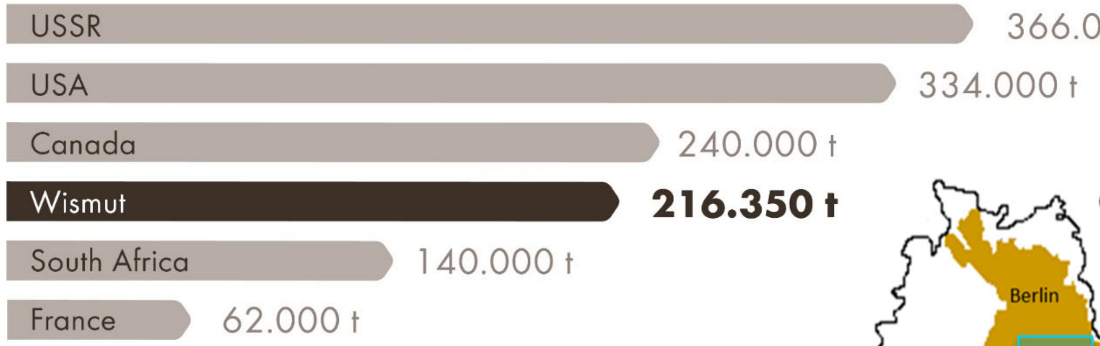
Gefördert durch:

Bundesmin
für Wirtsch
und Klimas

aufgrund eines Bes
des Deutschen Bun

Retrospect





- until 1990 uranium ore mining and processing by SDAG Wismut
- 216,350 t cumulative production making Wismut the world's fourth-largest uranium producer
- 20.12.1991 transformation of SDAG Wismut into Wismut GmbH
- since 1991 decommissioning and remediation of the uranium mining legacies

1946 Start of uranium mining under supervision of Soviet military

1954 Establishment of the bi-national Soviet-German Stock company (SDAG) Wismut

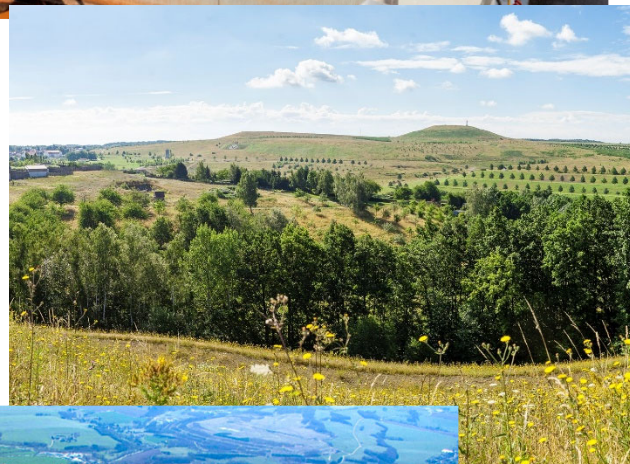
Legacies of uranium mining in eastern Germany in 1991

- 5 underground mines
- 1 open pit

- 48 waste rock dumps (WRD) (310 Mm^3)
- 3 tailings management facilities (TMF) (570 ha)
- Processing / operating areas (3,000 ha)

Remediation activities until 2024

- Mine flooding (“mine water rebound”) and water treatment (in operation)
- Backfilling of open pit (completed)
- (In-situ-)remediation of WRD (majority completed)
- Demolition of mills and operating areas, partial reuse for commercial or flood protection purposes (majority completed)
- (In-situ-)remediation of TMF (not yet completed) and water treatment (in operation)



Long-term tasks

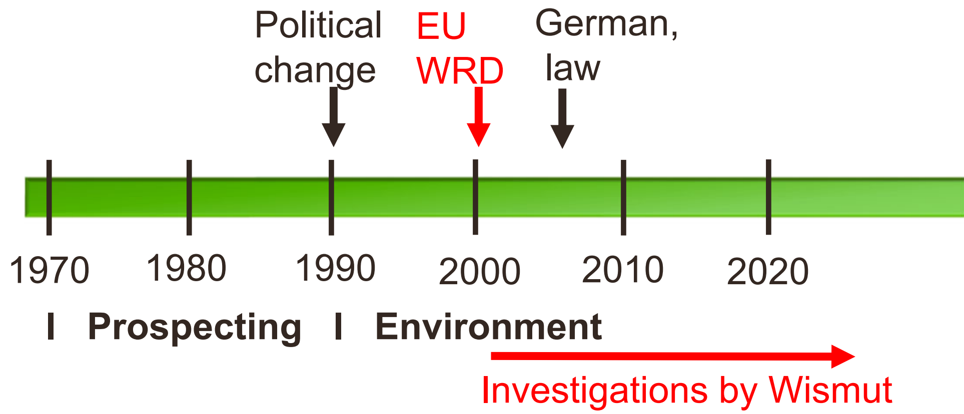
- 6 Water treatment plants (WTP), mostly conventionally with lime precipitation, one with ion exchange / adsorption, including the safety storage of the residues
  - Treatment of 14 M m³/a mine and seepage water (2023)
  - Main pollutants: U, Ra-226, As, Fe, Mn, Ni
- After care measures
- Monitoring systems (water, air and solids)

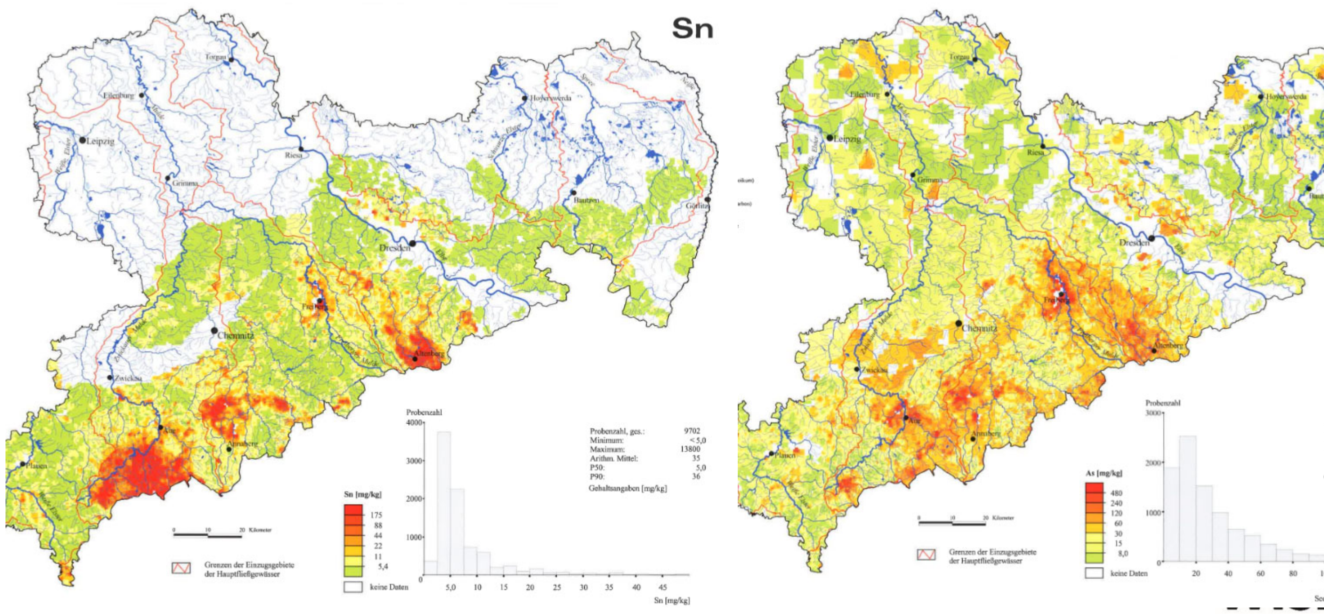
WTP Schlema-Alberoda: lime preci

WTP Helmsdorf new: ion exchang
adsorption

Why investigations of suspended particulate matter / sediments?

- Sediments represent the long-term memory of the river catchment
  - Sinks and sources of pollutants accumulated through natural processes (weathering) and anthropogenic use
- 1970/1980s: Systematic investigations of stream sediments for geochemical prospection (deposits)
- 1990: Focus on environmental pollution
- 2000: Start of EU WFD
- 2006: EU WFD adopted into German law, 2016 updated

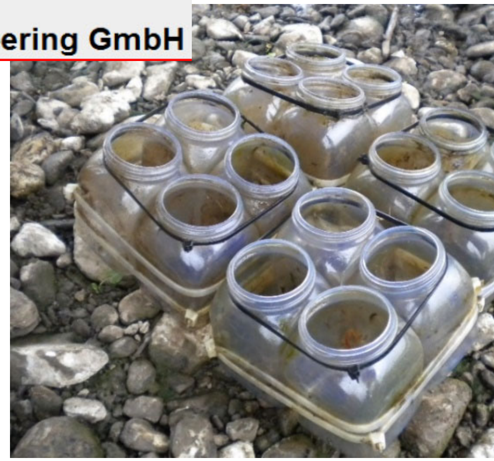




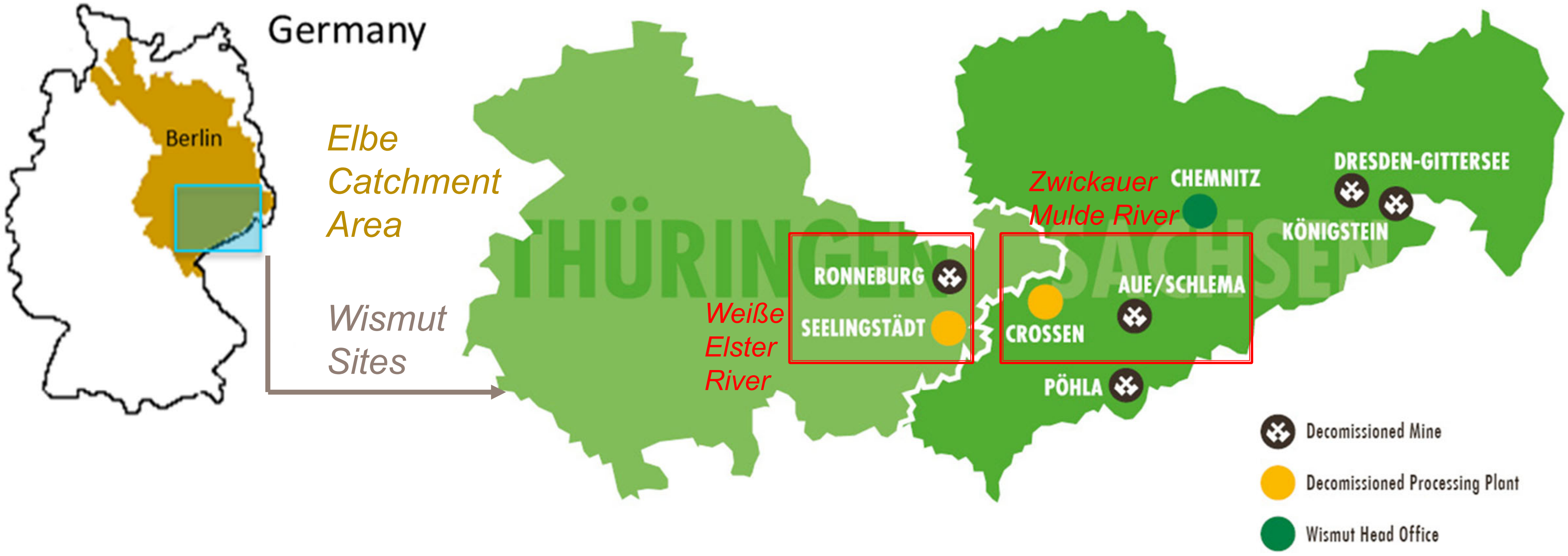
Methodology for sampling suspended particulate matter

- Types: box trap, cup trap
- Collection period: approximately one month (4 or 12 cycles per year)
- Preparation: sieving to the fraction < 63 µm, drying and partitioning
  - aqua regia digestion for chemical analysis (metals)
  - Ra-226 activity by gamma spectroscopy
- Key analytical parameters: U, Ra-226
- \+ Site-specific parameters: As, Fe, Mn, Cu, Ni, Zn, total organic carbon
- Evaluation: Comparison with the objectives (EQN: Environmental quality standards) of the EU WFD and German law
  - As (40 mg/kg), Cr (640 mg/kg), Cu (160 mg/kg), Zn (800 mg/kg) (annual mean value)

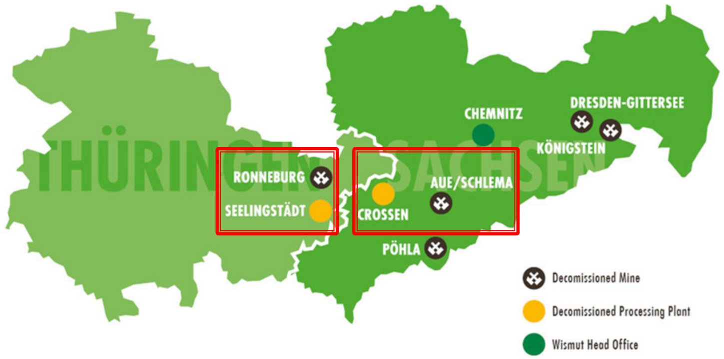
B.P.S. Engineering GmbH

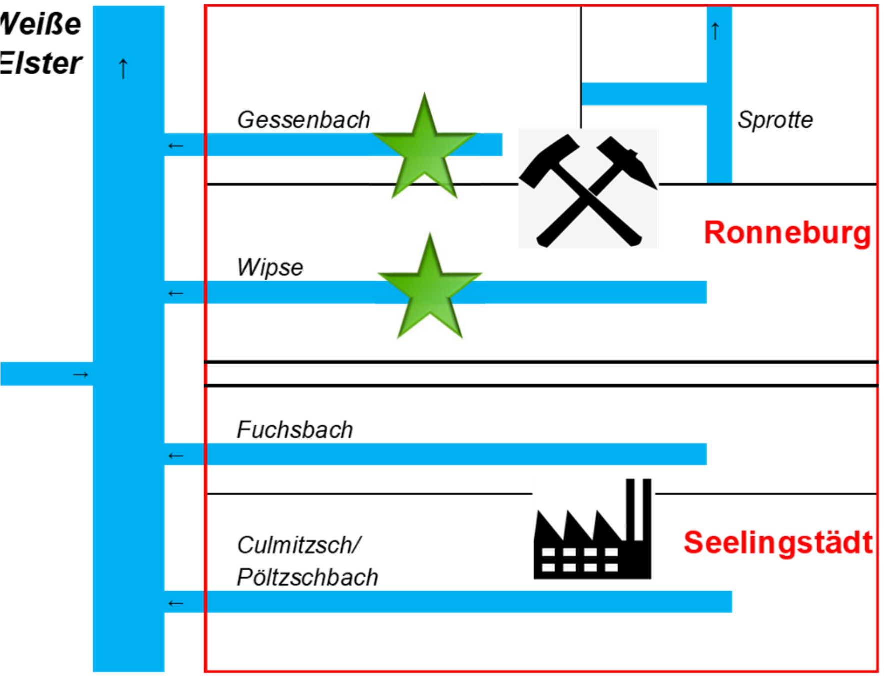


Regional description



Case study areas



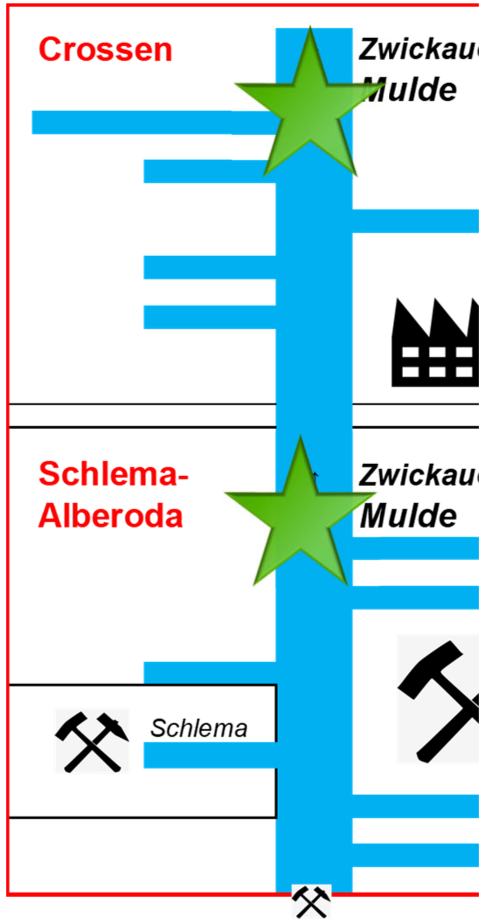


Differences

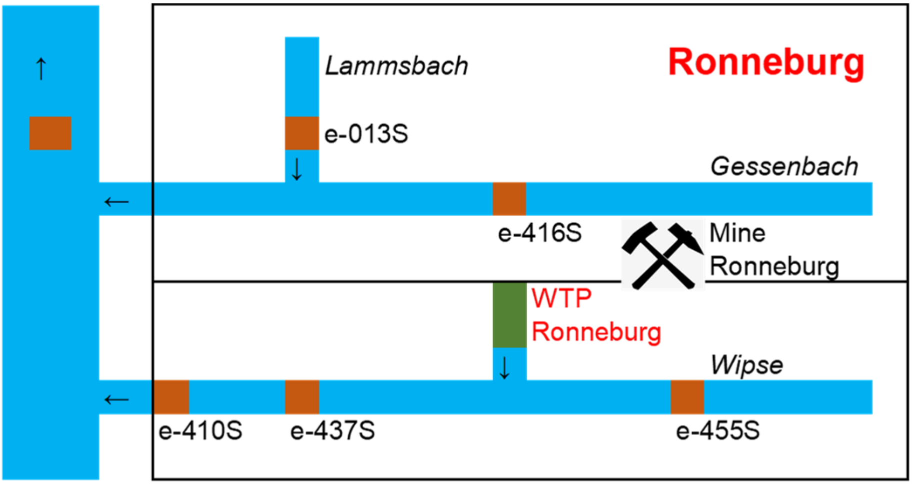
- mining vs. processing
- small streams vs. river

Similarity

- WTP at all 4 sites



Case study: Ronneburg site



Gessenbach e-416S

- Mine Ronneburg, cavity 17
  m³
- Flooding since 1998
- Natural drainage in the dir
  of **Gessenbach**
- Removal of the contamina
  water via a drainage syste
  the morphologically deepe
  area of the Gessental valle

e-410S

WTP Ronneburg

- Water treatment plant (WT
  since 2002 capacity 550 m
  since 2011 capacity 850 m
  treated volume 5 M m³/a
  (2023),
- Discharge in **Wipse** (strea
- 2 small influenced water b
  5 traps

Case study: Ronneburg site - Gessenbach

I Flooding since 1998

First water leakages in Gessenbach valley in 2006

→ water and suspended matter quality in stream declined

II Drawdown 2011-2017

Optimization of the hydrotechnical system

III Flood 2013

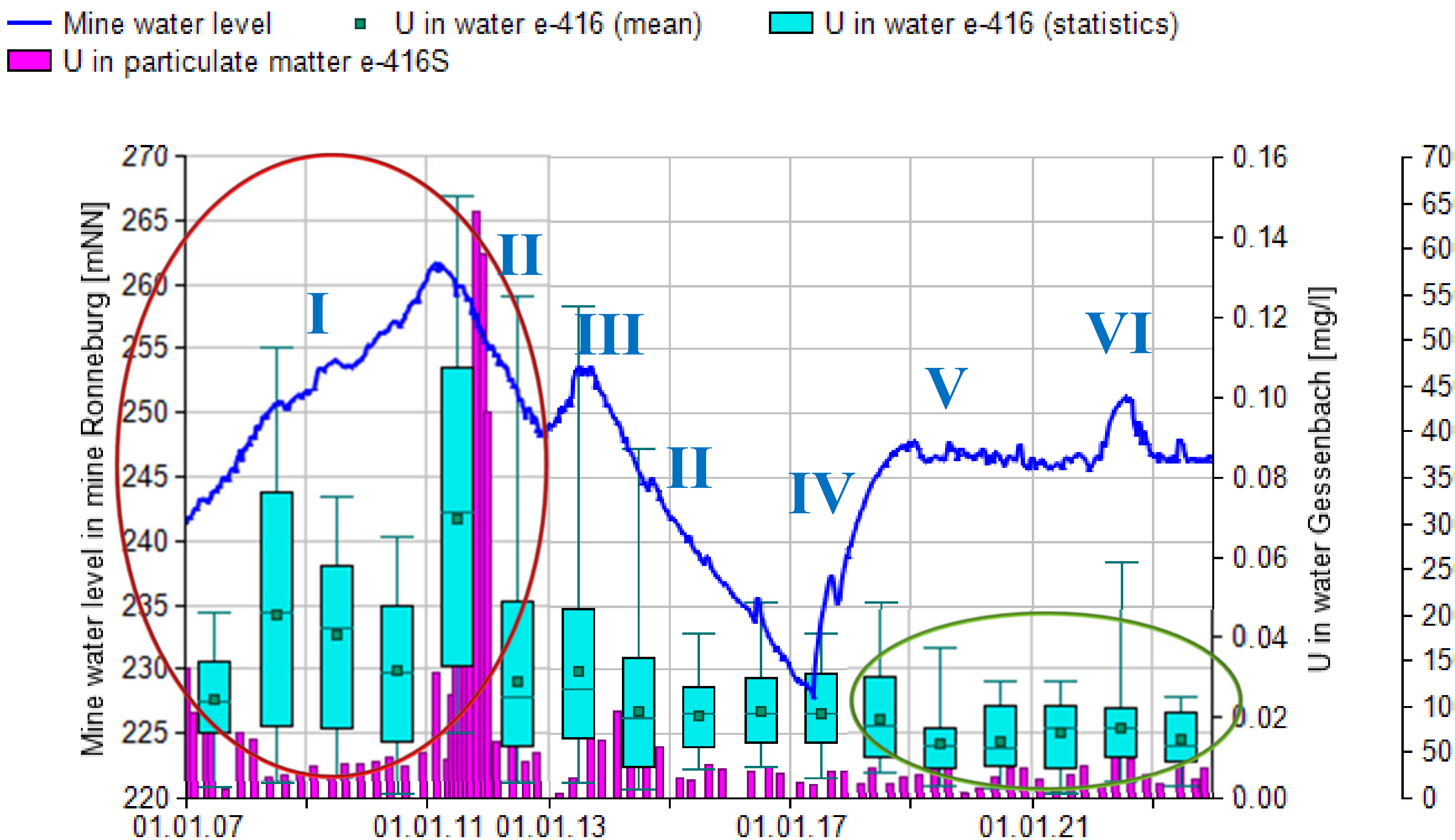
IV Recovery since 2018

V Keeping the water level

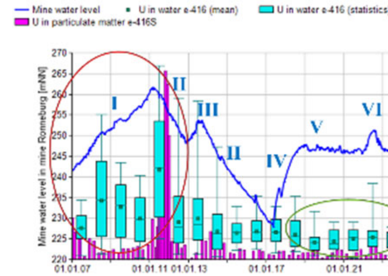
Quality in stream improved

VI Hydraulic test 2022

No harmful effects



Gesse



Case study: Ronneburg site - Wipse

I Water treatment since 2002

Upgrading the WTP capacity from 550 to 850 m^3/h

II Large quantity to be treated

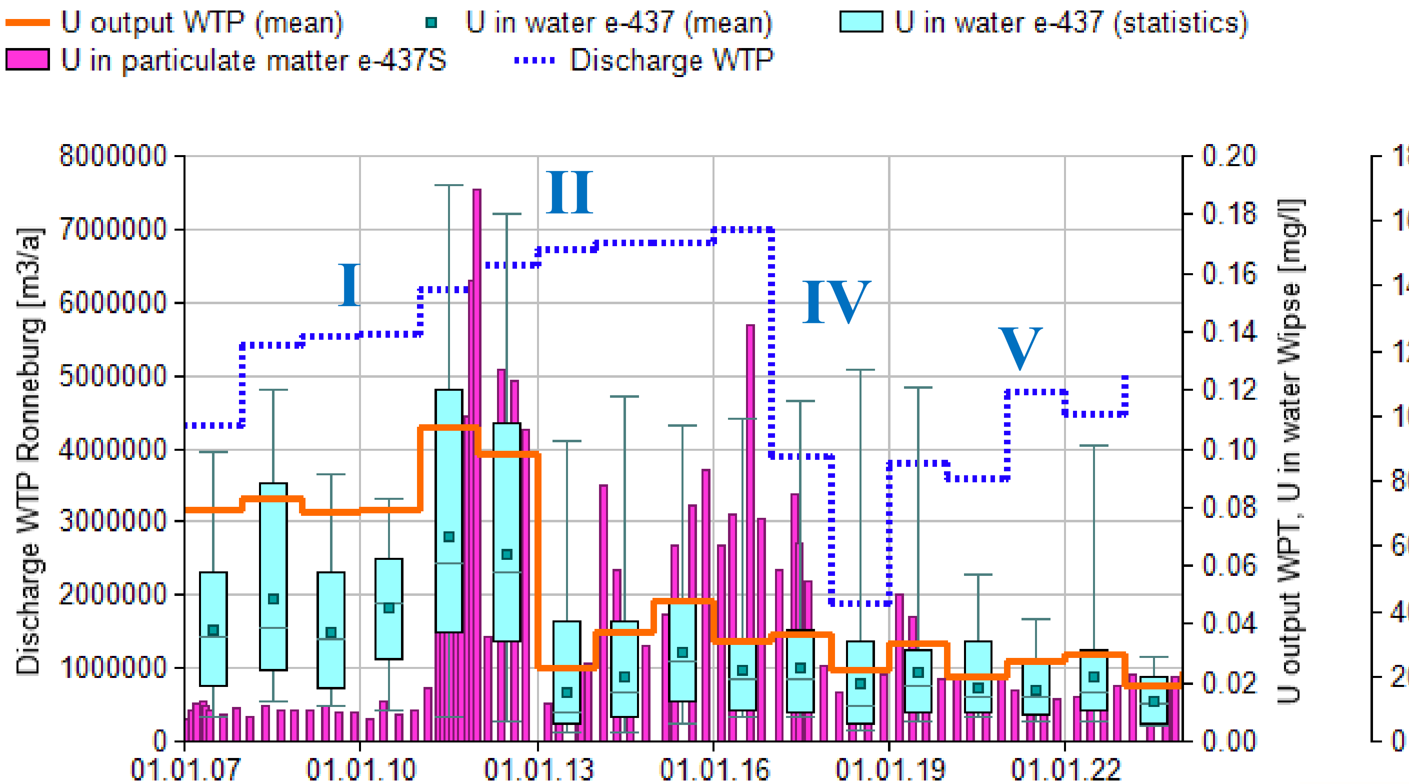
due to the drawdown of mine water level 2011-2017

IV Minimal treated volume

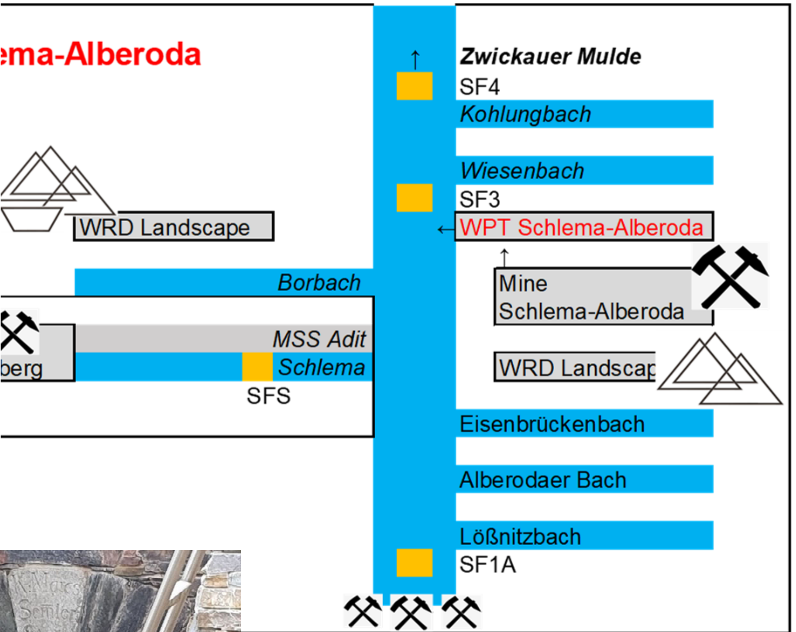
due to recovery since 2018

V Regular operation

Maintaining mine water level at 247 m above sea level



Case study: Schlema-Alberoda site



Zwickauer Mulde SF1A

neeberg →

emmler Adit

Schlemabach SFS

Mine → WTP Schlema-Alberoda

- Mine Schlema (Wismut) cavity 35 M m^3, flooding starts 1991
- WTP since 1999, capaci 1150 m^3/h since 2001 , treated volume: 5 M m^3/ (2023)
- WRD landscape
- Discharge in **Zwickauer Mulde** (river)
- high pre-load of metals f upper catchments

- Mine Schneeberg (histo 5 M m^3/a (2023), water n treated, discharge via ad **Schlemabach** (stream)
- 2 influenced water bodies, 4 traps

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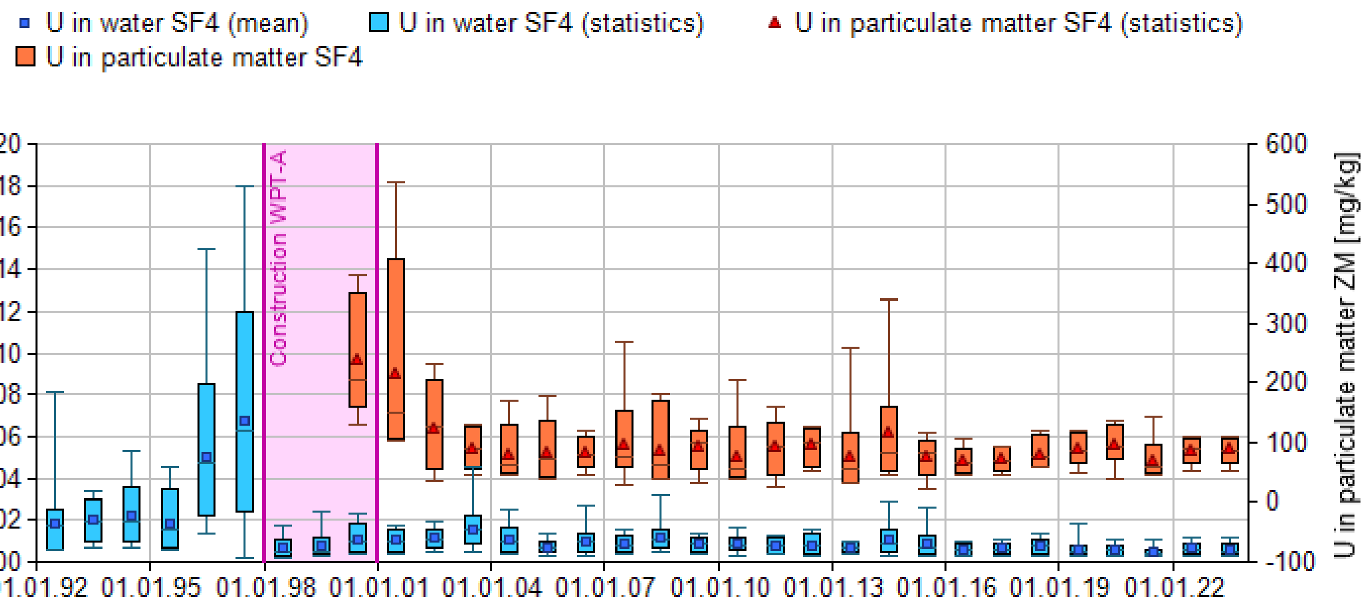
Case study: Schlema-Alberoda site – Zwickauer Mulde



- Construction of the WTP Schler Alberoda
  - substantial improvement in water and suspended matter quality in the Zwickauer Mulc river
- Influences from mining remain
- Remediation-related influences difficult to assess due to the previous pollution from the uppe catchments (As, Cu, Ni …)
  - Geogenic and anthropogenic sources

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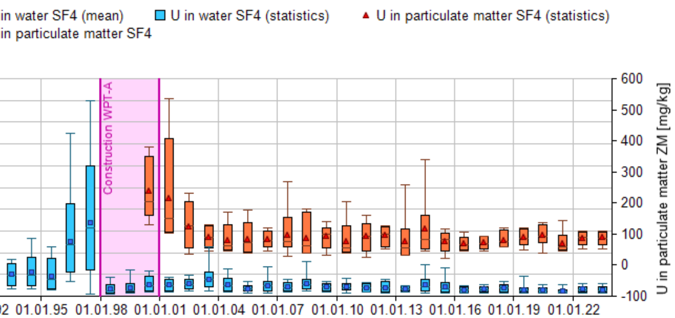
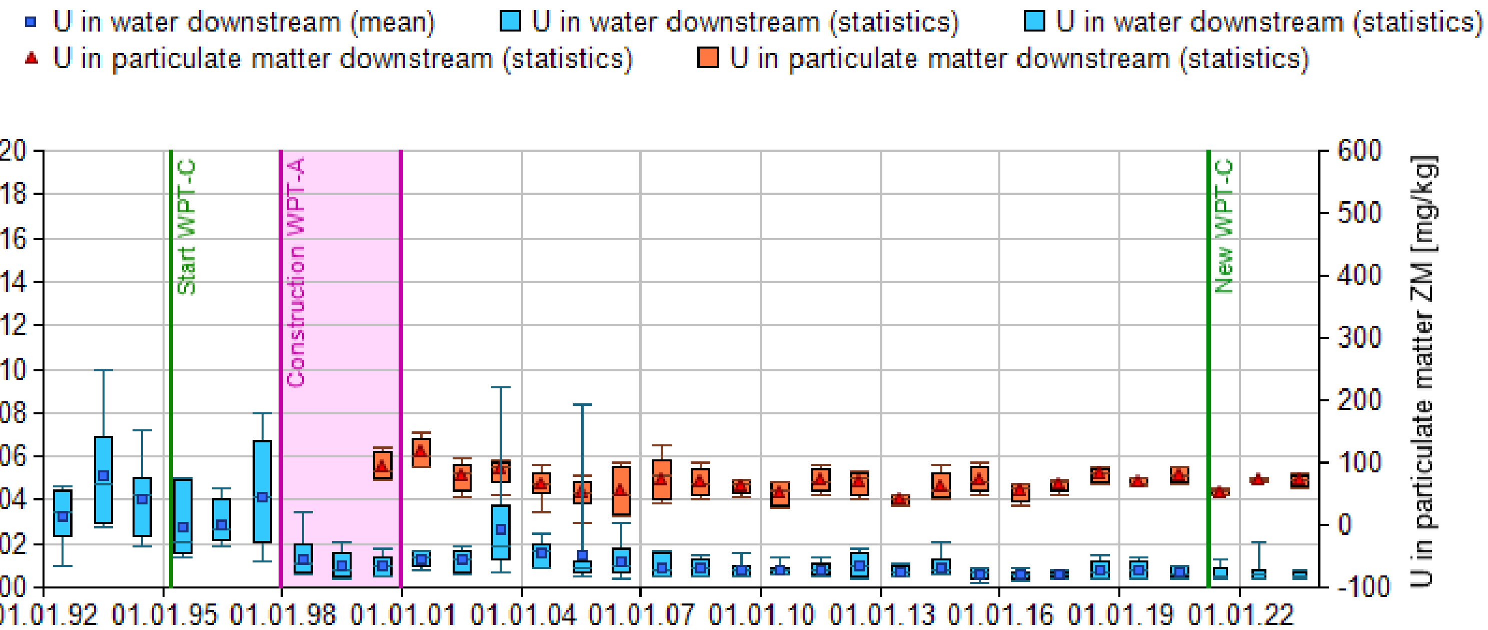
Case study: Crossen site – Zwickauer Mulde, 150 km downstream





- Construction of the Schlema Alberoda WTP was of trans regional importance for the Zwickauer Mulde river.
- The decline in concentration since 1998 can also be observed at the Crossen sit
- Concentrations fluctuate les than at Schlema site.
- At the Crossen site betweer upstream and downstream only slight differences
- The sediment pollution is similar.

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Conclusions

The remediation of uranium mining legacies and especially the operation of WTPs by Wismut prevent pollutants from entering the respective river section in the fluid phase.

The remediation measures have trans-regional significance for the respective river basins. This also applies to the quality of suspended matter and sediments.

Thereby, management of surface-, seepage- and ground water thus also represents a sediment management within the catchment area.

KOWUG
Kommunale Wasser- und Umweltanalytik GmbH

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Thanks for your attention.
Glück Auf!

WISM

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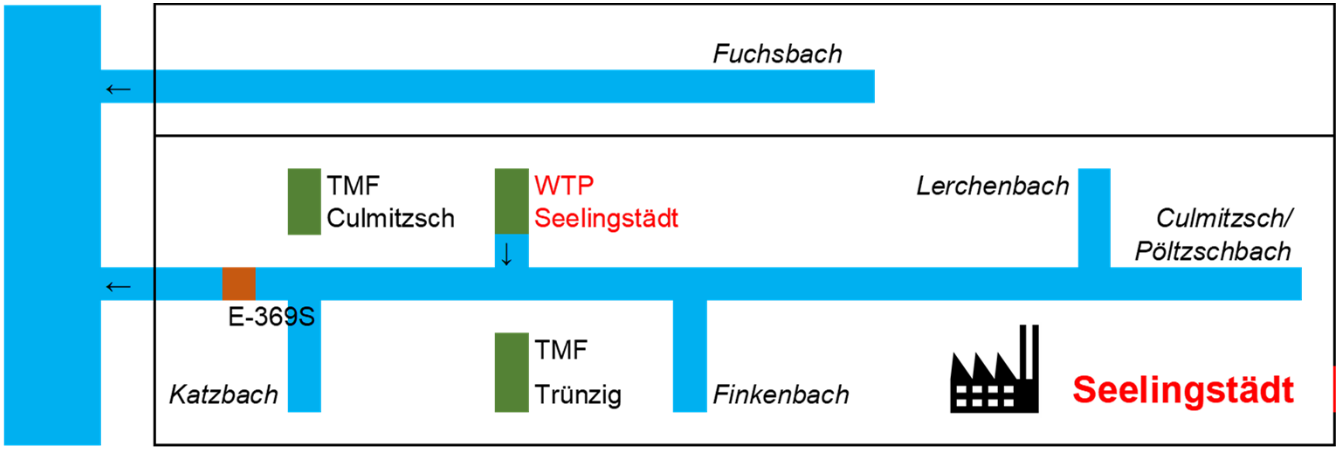
Case study: Seelingstädt site



itzsch E-369S

Tailing pond Culmitzsch and WTP Seelingstädt

- Processing site Seelings
- TMF Trünzig (Pond A+B
- TMF Culmitzsch (Pond A+B)
- WTP Seelingstädt since 2002, capacity 330 m^3/h treated volume 1.7 M m^3 (2023), treated paramete U, Ra-226 (As)
- Discharge in **Culmitzsc** (stream)
- 1 small influenced water body, 1 trap

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Case study: Seelingstädt site – Culmitzsch/Pöltzschbach

Tasks of the WTP:

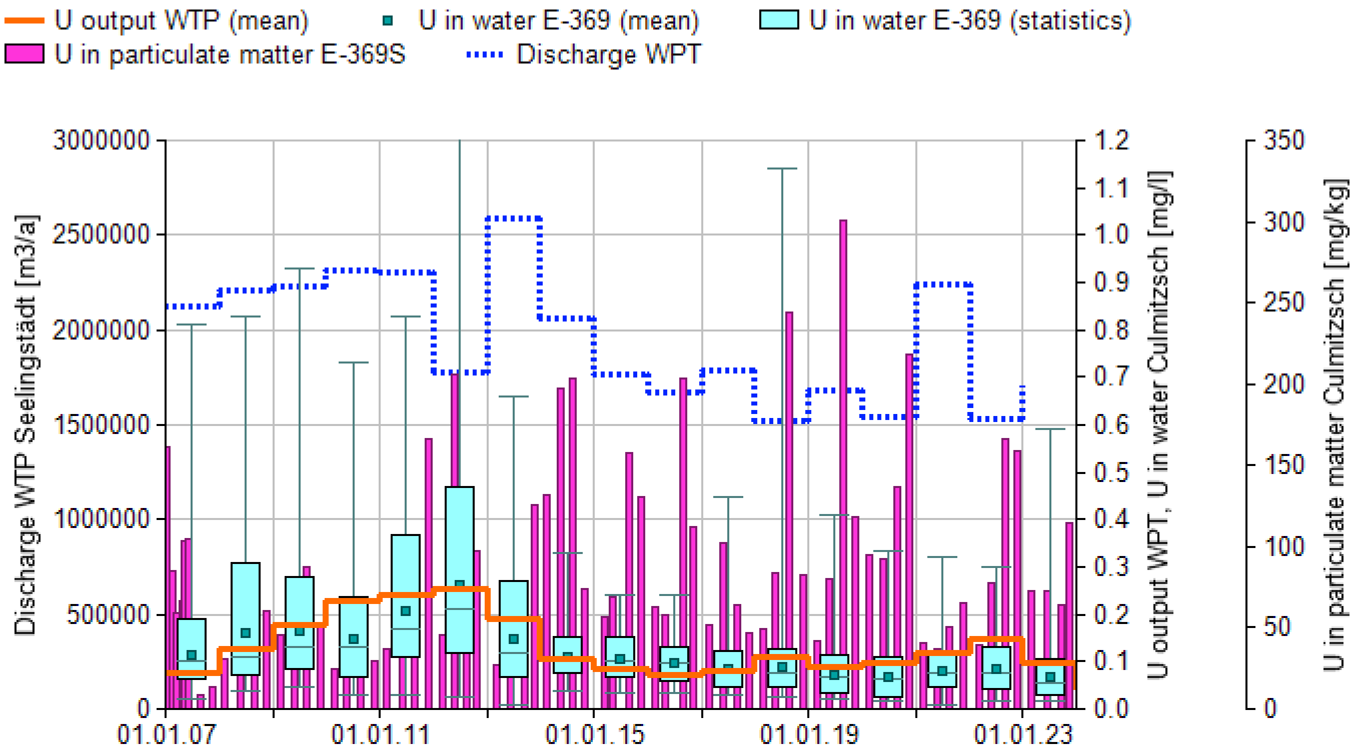
- treats seepage, pore and groundwater
- lowers water level of TMFs for remediation

Selected measures:

- 2012 Separation of surface water
- 2013 Increase of treatment capacity
- 2015 Construction of iron removal plant

Effects in stream:

- Stream water quality improved
- Diffuse inflows remain



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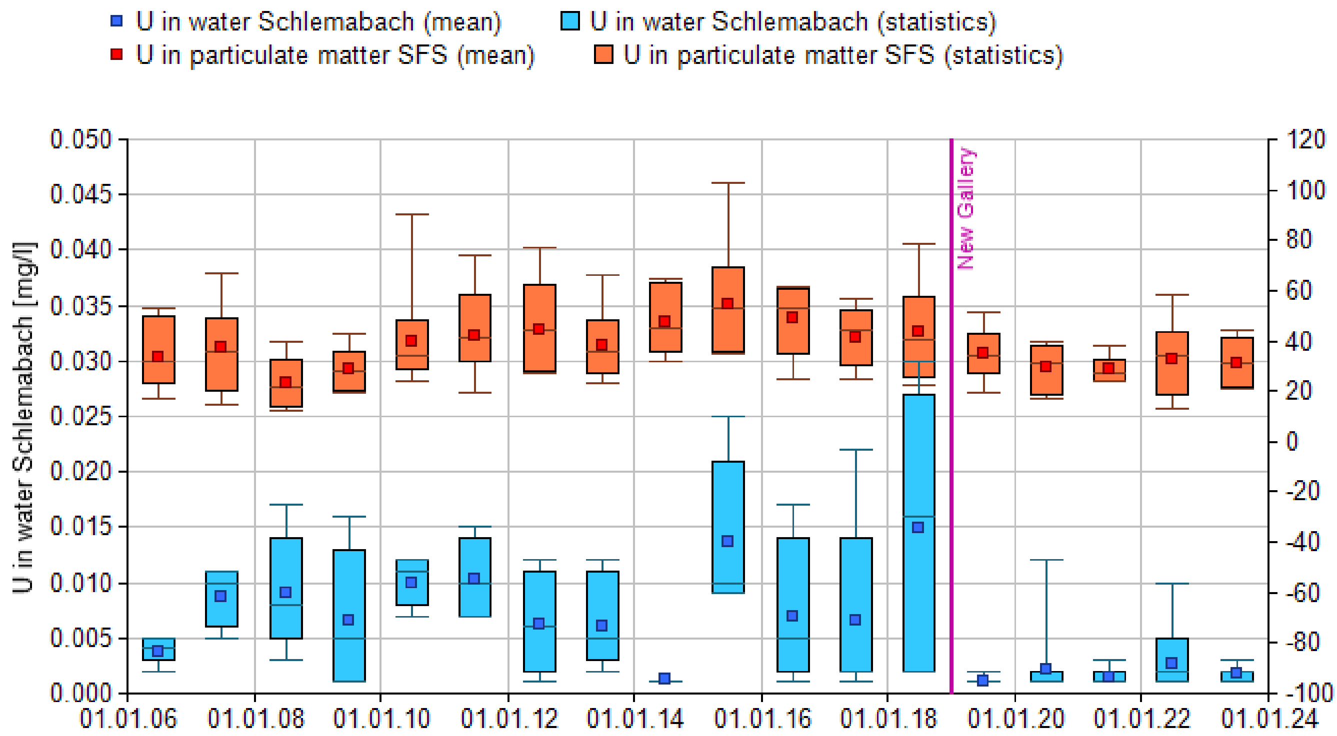
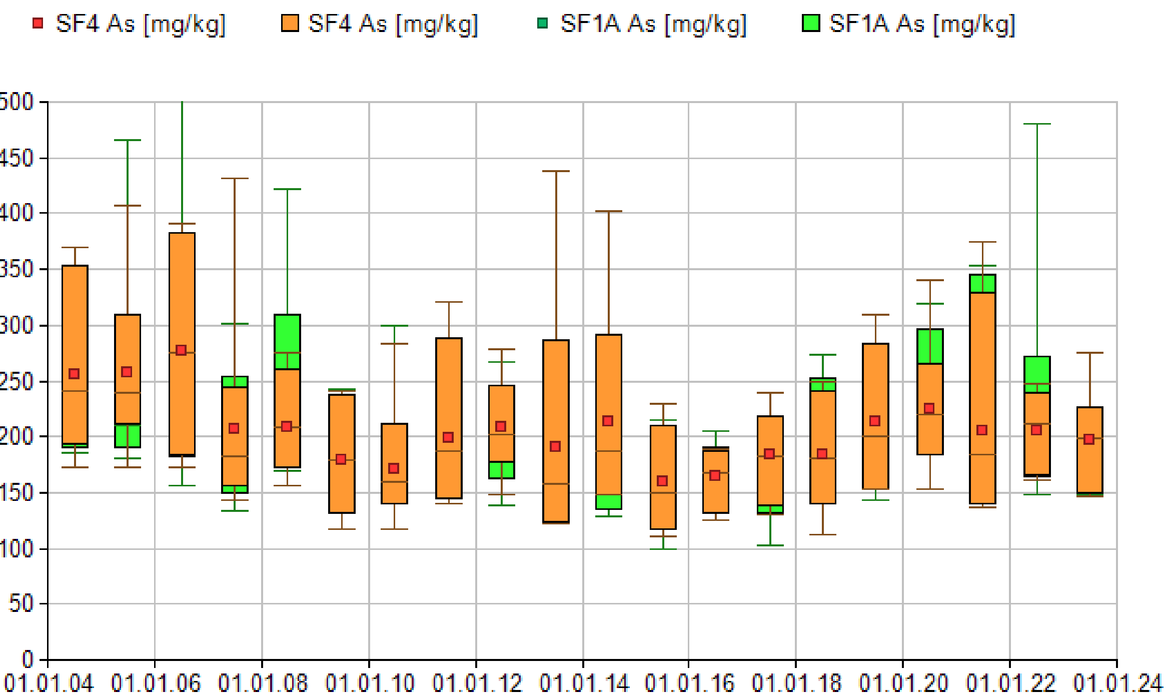
Case study: Schlema-Alberoda site – Schlemabach

Historical Mine Schneeberg:

- Until 2018 cross-section of the Markus-Semmler gallery too small for the mine water volume, partial discharge into the stream Schlemabach
- Construction of a new gallery section
- Since 2018 water quality in the Schlemabach improved
- Influences from the upper catchment area remain in the sediment signature



Case study: Schlema-Alberoda site – Zwickauer Mulde



Zwickauer Mulde:

- Remediation-related influences are difficult to assess due to the previo pollution from the upper reaches (A