



Remediation of an Uranium Mining Waste Rock Dump in Slovenia

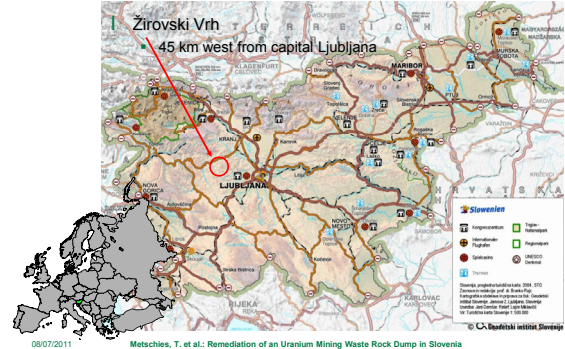
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Location



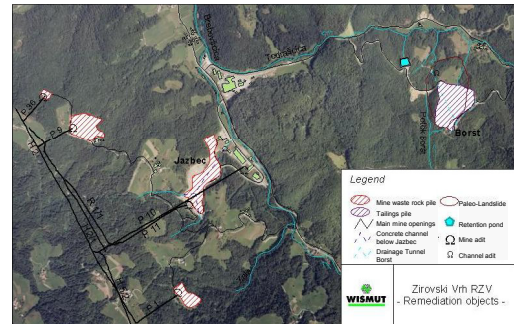
History of Uranium Mining in Slovenia

- I Žirovski Vrh Uranium Mine (RUŽV)
 - Uranium mineralisation found in 1960
 - ore exploitation started 1982
 - yellow cake production from 1984
 - production ceased unplanned in 1990
- I Uranium mineralisation in sandstone formation
 - Prospected reserves 16000 t U₃O₈, average conc. 0,084%
 - production 1982 to 1990: 452 t U₃O₈
- I remediation of underground mine, mine waste rock and tailings pile
 - planned until 2010
 - Total costs of ca. 86.3 Mio €

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Location – Mining objects



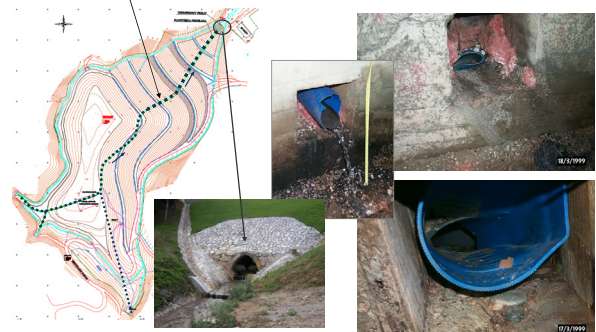
Mine waste rock pile Jazbec

- I Characterisation (August 2008)
 - 7 ha surface area
 - 1,91 Mio t rocks (Ø 51 ppm U₃O₈), 0,205 Mio t low grade ore (221 ppm U₃O₈)
 - 48.000 t sludge from water treatment (red mud; 25 ppm U₃O₈)
- I Problems
 - not fully operational drainage system at the pile bottom
 - Groundwater inflow to pile from bedrock → contaminant release
 - Water management
 - Surface water discharge through a concrete culvert below pile
 - Rainfalls (Ø 1800 mm/a) with torrential characteristics
 - Contouring of pile difficult due to
 - Limited area at the dam toe
 - Radiological problems during excavation of piled material (red mud- high Thorium content)
 - Steep slopes requiring geotechnical stabilisation measures

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Culvert: Collection of seepage (surface) waters





Concept for mine waste rock pile remediation

- I Relocation of mine waste rocks from smaller piles
 - 470000 t in total, sieved and partly re-used
 - underground mine backfilling,
 - track construction, Drainage material for contouring tailings pile
 - Revegetation of the footprint area
- I Test cover sites for determination of covering technology
- I Multi-layer, single material cover from autochthonous material
 - Burrow owned by mining company
 - Demonstration of sufficient geomechanical material properties
 - Water inflow to the pile in addition to infiltration
 - Predicted infiltration rates with significant reduction
 - Cost effective solution (availability of material, transport costs)
- I Surface and seepage water management
 - Backfilling culvert with drainable material
 - Extensive dewatering measures (cover layers, surface water)



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Covering of mine waste rock pile Jazbec



Cover thickness [m]	Cover material	k _v -value [m/s]
0.25 → Vegetation layer	Humus	1x10 ⁻⁴
0.50 → Storage layer	Jaka: 0/63mm	1x10 ⁻⁷
0.80 → Protection layer	Jaka: 0/63mm	5x10 ⁻⁸
0.40 → Sealing layer	Jaka: clayey sand	5x10 ⁻⁹

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Geotechnical aspects

- I Steep slopes → stability of cover layers
 - Short slope length
 - Slope lining with rocks
 - Additional drainage elements in cover layers to discharge interflow



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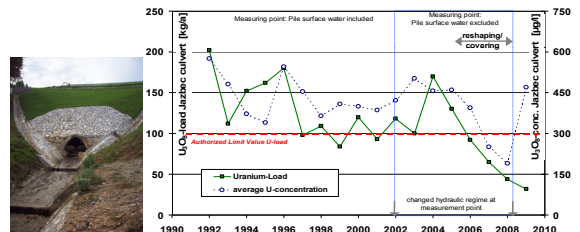
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Uranium release in seepage and surface waters

- I Outflow from culvert
 - Significant load reduction
 - But: increased concentration due to less dilution



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Lessons learned and long-term activities

- I Site specific remediation solution
 - Re-use and relocation of waste rock material to central pile
 - Reshaping with spatial restrictions → geotechnical stabilisation measures
 - stone lining, gabions
 - Cover test plot to determine
 - cover design and technology
 - Applicability of cover material
 - QA/QC parameters and procedures
 - ET-cover with locally available material
 - Management of surface and seepage waters, cover interflow
- I Radioactive legacy → necessary long-term monitoring and maintenance requiring
 - Funding
 - Record keeping

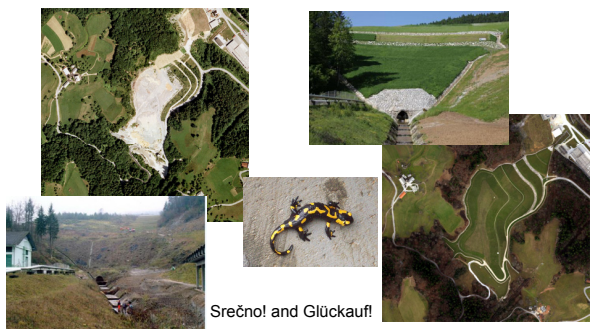
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Thank you for your attention!



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