EVALUATION OF THE MILL TAILINGS DISPOSAL SITE AT THE ZIROVSKY VRH URANIUM MINE IN SLOVENIA (two abstracts together)

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1st Abstract (Evaluation of the mill tailings disposal siting on Zirovski Vrh uranium mine in Slovenia)

The Zirovski vrh uranium mine was closed due to the economic reasons. After that the extensive work on decommission was done in the area. In the frame of this work several studies on mill waste location were done. The results of the comparison between several sites are presented.

The mine is situated in the western part of Slovenia in a hilly area with steep slopes. The climate is temperate with 1800 mm/year average rainfall, yearly evapotranspiration of around 550 mm and 7°C average air temperature. Ore is developed in the Permian clastic beds. The ore was excavated during the period between 1960 to 1990. The landslide of 2.9 million cubic meters of uranium mill tailings and underlying rock occurred in the Boršt area in 1990.

The main goal of the represented study was to recognize the best possible location for the mill waste to place. The options were:

A) To stay at the present Borst location and improve it (no mass transport).
B) Relocation with transport of the entire disposal material as well as contaminated subsoil into underground openings of the abandoned mine.
C) Relocation with transport of the entire disposal material as well as contaminated subsoil onto the mine waste disposal site Jazbec above the mine.

The mill tailings site Borst is positioned around 1,5 km from mine entrance. It covers 4,2 ha between two ravines and is situated on piroclastic Triassic rocks. The tailing consist of silty to sandy aggregate formed during the hydrometalurgical process. Chemically it is silica, gypsum and sulfate salts.

The Jazbec mine waste disposal site covers the area near the mine. It consists mainly of mine waste. It is situated on clastic rocks of Carboniferous, Permian and Triassic age.

The mine is positioned in the groden beds of Permian age. The ore was excavated from gray quartz sandstone and conglomerate. In the excavation period 3307 000 tones of material in total was removed, of which 633 000 tones was ore, and 206 000 tones low grade ore. After the end of mining several break down phenomenons occurred.

All of the variants for the mill tailings disposal site have some clearly visible geological drawbacks, therefore we had to make comparisons between the sites based upon the most important common factors before deciding upon the final disposal site. The main disadvantage of the variant A is the possibility of landslide reactivation. The original movements, which were stopped with the excavation of an underground dewatering tunnel, could be reactivated. In the variant B, where the relocation into the underground mine openings is investigated material could be leached away and there are
possibilities that break down of roof would occur. In the variant C the recharge area of the waste disposal site is big and relatively great water inflows into the body of landfill could occur.

In the first step we examined the existing data from previous investigations and reevaluated some former modeling results. We used them in the probabilistic approach to the factors of safety and confidence, seismic hazard analysis, hydrogeological models and in economic evaluation.

To evaluate and summarize the results of previous studies we used the decision matrix approach of the UMTRA project sites. It takes into account four different groups of factors. In the geotechnical group we estimated the stability of bedrock slope, erosion potential, distance from active faults and the influence of seismic activity. In the hydrological group we estimated the influence of the potential disposal site on groundwater, we estimated the status of aquifers and their geological position. Among the environmental factors we estimated the distance from the urbanized area, endangered species, cultural and historical monuments. In the economic group factors we estimated the distance of the transport needed for relocation of tailing and delivery of new cover. All together 34 factors was estimated and evaluated. We used two proposed time projections: present construction phase and projection into the future after 1000 years.

According to the natural factors and qualitatively made future projections the relocation of the mill waste into the mine openings seemed to be most suitable disposal solution. The calculation of the UMTRA matrix showed that staying in the location (variant A) where there is no mass transport is the best solution for the present state. For the future projections after 1000 years the relocation into the mine is better (variant B).

Our investigations and final decisions with the aid of the UMTRA matrix are derived from preexisting documentation. Conclusions from these materials are sometimes, due to the lack of real data, based on assumptions and are not empirically verified. In the future the UMTRA matrix approach must also be checked and modified for such detailed study in a relatively small area. At the present stage of knowledge about the three potential mill tailing sites the UMTRA matrix is additional aid in engineering judgment for the potential site selection.

REFERENCES


2nd Abstract (Zirovski Vrh uranium mill decommissioning)

The paper gives a report on the Zirovski Vrh uranium mill decommissioning that was practically finished in the third quarter of the year 2000. The mill ceased the production in July 1990 and the mill site remediation has been going on for ten years. The activities have been intensified in the last two years. The work has been hindered due to poor financing.

Initially the work was rounded up in the following steps:

- inventarisation and radiological characterization of the site (by RZV),
- obtaining of decommissioning permits and authority approvals (by RZV and contractors),
- solid and liquid process inventory removal (by RZV),
- process equipment removal (by RZV),
- buildings decontamination, buildings demolition and land decontamination (by RZV and contractors),
- waste management (by RZV),
- radiological monitoring during the mill site remediation (by RZV), and
- final radiological measurements (by RZV and contractors).
1. PROCESS INVENTORY REMOVAL

In the first stage of the mill decommission implementation the following ore processes liquids were removed by adequate technological treatment:

- acid leach pulps from leach circuit tanks by filtering and following uranium extraction and raffinate neutralization,
- organic solvent (kerosene, tertiary amine, isodecanol) by careful stripping and soda wash at high pH, by this way purified kerosene was used in boilers (50 m$^3$)
- uranium bearing liquors were chemically treated by ammonia to precipitate uranium,
- liquors with ammonia and ammonia sulphate were chemically treated at higher temperatures by milk of lime to remove ammonia, purified ammonia liquor was used in nearby building materials plant (20 m$^3$ of concentrated ammonia liquor),
- process water with ammonia was sprinkled at the thickener after pH adjustment and the water with low ammonia content was released under control,
- uranium concentrate residues were packed in drums and sold to another uranium producer, and
- ore and tailing dusts, scales were collected and deposited at the mill tailings site.

2. PROCESS EQUIPMENT REMOVAL

Process equipment, pipelines, electrical equipment and wiring was washed with water at site and then removed to the control point. Material was radiologically measured and decision was made on the following decontamination handling at this point. Two important groups were formed finally after decontamination with water wash under pressure:

- slightly contaminated material for recycling in the steel mill: 650 ton, (fixed surface contamination alpha bellow 40 Bq/dm$^2$, beta bellow 400 Bq/dm$^2$), and
- contaminated material for long-term storage (600 m$^3$ in metal containers, 500 m$^3$ steel and FRP tanks).

Some clean materials and equipment were sold to the customers, if the control measurements had showed fixed surface contamination alpha bellow 4 Bq/dm$^2$, beta bellow 40 Bq/dm$^2$, no removable contamination at all.

3. BUILDINGS AND LAND DECONTAMINATION

The decision of the plan was to demolish contaminated process buildings and to remove contaminated areas of land. The debris and contaminated soil, rocks were deposited at the mine waste pile site (35,000 ton). The pits were back filled by rock materials after successful radiometric control (alpha and beta surface contamination, gamma dose rate readings).

Auxiliary buildings (boiler room, crew change rooms) and offices have been decontaminated to the prescribed levels (fixed surface contamination alpha bellow 4 Bq/dm$^2$, beta bellow 40 Bq/dm$^2$, gamma dose rate bellow 0.2 μGy/h). Radon-222 concentrations in these buildings are 3 normally bellow 250 Bq/m$^3$.

4. WASTE MANAGEMENT

The main objective of the whole remediation process was to decontaminate the former uranium mill area for public use. Secondary goal was to produce minimal possible quantities of wastes. For this reason we set free some chemicals, wasted time with scrap metals etc.
Containers with contaminated metals, plastics, FRP, insulation, rubber and other were deposited together with useless contaminated tanks into the mine waste pile. All voids have been filled with concrete and sand. Also, building debris were deposited nearby in careful levelled layers. Containers and trucks with debris passed radiometric control point for radiological control and mass balance determination.

All decontamination wash waters were collected, mechanically clarified and after ammonia and uranium measurements have been released under control into nearby surface waterflow. Settled materials were collected and have been trucked to the deposition site.

The remnants of chemicals like tertiary amine, isodecanol, ammonium sulphate, tertiary phosphate and similar, were transferred to authorised companies for extermination or further use as mentioned previously.

5. CONCLUSION

The former uranium mill site of 6 ha area has been successfully remediated. Radiological control measurements performed by Zirovski Vrh Mine crew and contracted radiological supervision team showed no readings of gamma dose rates above 0.2 μGy/h, and no surface contamination above prescribed limits.

Only mechanical shops and change rooms remained as control area temporary. This area will be set free after decontamination, when the tailings and the underground mine will be remediated by year 2005.

REFERENCE

Inter office documentation: Yearly Reports.