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Radionuclides in tantalite ore and radiation exposure in tantalite mining in Ethiopia

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Kenticha Tantalum project

- Elenilto is operating a tantalite mine in Ethiopia for the last 3 years with its local management.
- It has executed wide geological works and has identified potential of over 17,000 tons concentrate containing 0.017%Ta_2O_5.
- The weathered zone plus part of primary zone is calculated to be 4700 tones Ta_2O_5 proved reserve, with an average grade of 0.015%Ta_2O_5 .
- EMDSC(Ethiopian Mineral Development Share Company) produces a good quality tantalum concentrate which is supplied for export.
- EMDSC is one of the top ten producers of tantalite in the world

Process flow

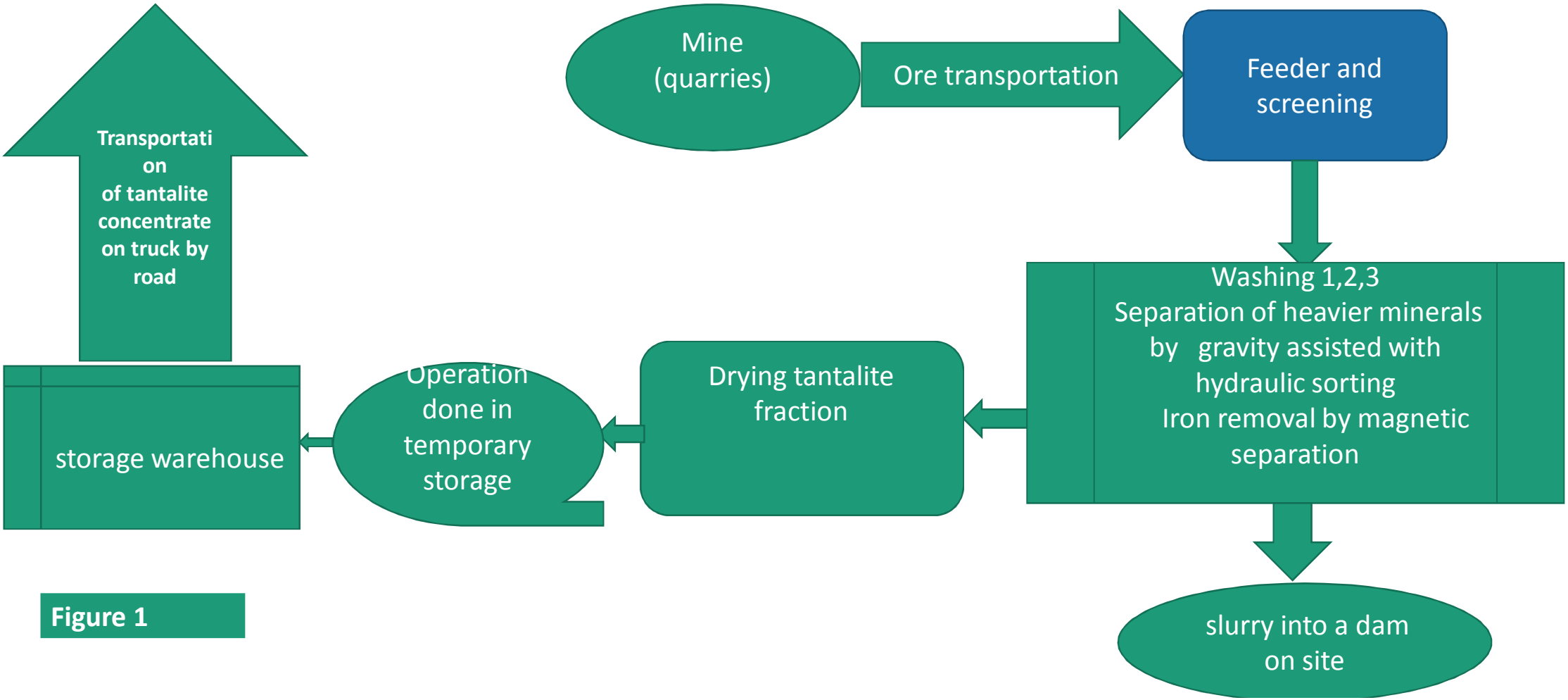

Figure 1

Tailing dam of Kenticha tantalite production

Plate 2.Tailing dam of Kenticha Tantalum production

Ambient radiation measurement and sample collection

- **Visit of** facilities, understand the process, monitor doses at:
  - Mine (quarries)
  - Ore transportation
  - Feeder and screening to remove stones
  - Ore Washing 1, Washing 2, Washing 3 steps
    Separation of heavier minerals by gravity assisted with hydraulic sorting
    Iron removal by magnetic separation
  - Drying tantalite fraction
  - Operation done in temporary storage
  - Tantalite transfer to storage
    Underground, locked, separate from areas with permanent work posts

  Transportation of tantalite concentrate on truck by road

Recordings in Facilities

- **External radiation doses measured (micro Sv/h):**
  - Background (outside):0.04-0.05
  - Mine: 0.08-0.10
  - Ore feeder: 0.07-0.08
  - Washing tables:0.10-0.12
  - Last Wash station and tantalite separation:0.09-0.20
  - on the final waste pond it was 0.07 µSv/h
  - Tantalite drying:0.86-1.22 (ore drum 14)
  - out side the temporary storage 1.43
  - Permanent storage: 1.42-1.50
  - Cantine, Admin, Car Park: 0.03-0.07

Recordings in Facilities before transportation

❑Recordings by weighing station and truck loading

- Tantalite pile on ground (weighing): 22.5 (µSv/h)
- Loaded truck on side: 8.2 µSv/h
- Back of driver seat: 1.7 µSv/h

Other pathways to assess

- Dust Inhalation and Ingestion.
- Radon inhalation
- Food chain transfer

Loading the truck

Figure 3

Analyses of samples

- Analyses of samples from soils collected near the mine area and materials collected in the quarries indicated that uranium and thorium are present in nearly the same concentrations in bulk minerals and soils.
- after sorting and concentrating the tantalite ore, uranium was found associated with the tantalum fraction at higher concentrations than thorium.
- The soils in the region have about 111±3 Bq/kg of ^{238}U and similar activity concentrations of the uranium descendants.

Analyses of samples (cont.)…

- Materials left (gravel) in the exploited quarry, displayed less content of uranium and ^{238}U at 69±2 Bq/kg.
- The iron fraction, after magnetic separation from raw tantalite ore, is still rich in uranium, with 254±8 Bq/kg of ^{238}U,
- but after recycling for improved separation of tantalite, the materials disposed into the final waste pond although containing little tantalum were richer in uranium.

Analyses of samples (cont.)…

- However, the specific activity of ^{238}U in the tantalite concentrate was very high with 53,810±4570 Bq/kg.
- while ^{232}Th was 515±73 Bq/kg, indicating a much higher association of uranium relative to thorium in the tantalite concentrate (Table 1).

Analyses of samples (cont.)…

Sample	^{238}U ± 1σ	^{230}Th± 1σ	^{226}Ra ± 1σ	^{210}Pb= ^{210}Po ±1σ	^{232}Th ± 1σ
ETI#4, Panview	111 ± 3	85 ± 5	94 ± 10	101 ± 5	9.7 ± 0.9
ETI#5, new quary	106 ± 4	111 ± 7	202 ± 16	159 ± 8	46 ± 3
ETI#7, old quary	69 ± 2	41 ± 8	71 ± 4	78 ± 4	17 ± 5
ETI#13,iron fraction	254 ± 8	187 ± 13	202 ± 30	221 ± 10	30 ± 3
ETI#14, recycled tailing top	142 ± 4	104 ± 5	104 ± 5	118 ± 7	40 ± 2
ETI#16, tailings	274 ± 8	188 ± 10	137 ± 8	194 ± 10	88 ± 5
ETI#17- end product	53810±4570	36271±5018	29416±4528	25408±1523	515 ± 73

(Table 1).

CONCLUSIONS

- The mine operation phase does not seem to generate high radiation doses at workplaces, such as at the excavation pit and at the sieving and hydraulic mineral sorting facilities.
- Uranium and Thorium concertation turns in to high specific activity material when the tantalite is segregated to produce the dry concentrate.
- During the operations of ore packaging, loading and transportation by road the radiation exposure of workers may become significant and are likely to exceed the radiation dose limits for non-radiation workers set in the international Basic Safety Standards.
- Furthermore, as all workers live in the mine concession and in the neighborhood grow vegetables and animals for family consumption, an in depth radiological risk assessment including assessment of the exposure of members of the public through ingestion of food and water should be carried out.

Notes and lessons to retain cont....

➢ **For ore transportation:**

- Assess radiation doses
- Apply Regulation of Transport of Radioactive Materials

➢ **Reporting and enforcing radiation protection law**

- Stablishing and apply regulation on NORM waste
- Role of Inspector
- Role of ERPA

Thank you !!