THE REPROCESSING OF NORM RESIDUES FROM TIN MINING AND SMELTING

To extract further valuable metal content of tantalum, niobium and tin, and to reduce waste

Ulric Schwela, for the Tantalum-Niobium International Study Center (T.I.C.)

NORM X Symposium, Utrecht, 9th-13th May 2022
“Waste isn’t waste until we choose to call it waste.”
NORM RESIDUES FROM THE TIN INDUSTRY

What are the NORM being generated from the mining, processing and smelting of tin
THE TIN SUPPLY CHAIN

Tin ore
1-2% Sn
5-200 ppm Th, 2-20 ppm U

Physical processing

Tin mineral concentrate (cassiterite)
55-75% Sn
0.001-0.2% Th, 0.0005-0.2% U

Smelting / pyrometallurgy

Tin metal
>99% Sn
nil Th & U

Tin slag
1-7% Sn
0.05-0.8% Th, 0.002-0.9% U

Waste?
TIN SMELTING AND TIN SLAG
THE TANTALUM SUPPLY CHAIN

Tantalum ore
0.05-0.1% Ta
5-200 ppm Th, 2-20 ppm U

Physical processing

Tantalum concentrate (tantalite)
20-40% Ta
20-40% Sn
0.01-0.3% Th, 0.05-0.7% U

Pyrometallurgy

Synthetic concentrate
30-60% Ta
0.01-0.3% Th, 0.05-0.7% U

Chemical processing

Ta metal
>99% Ta
nil Th & U

Secondary material from recycling and tin slag
1-7% Sn
1-15% Ta
0.05-0.8% Th, 0.002-0.9% U

Filter cake
nil Ta
0.01-0.3% Th, 0.05-0.7% U
PHYSICAL REPROCESSING OF RESIDUES

How ‘waste’ from past mineral processing becomes a resource
REPROCESSING TIN MINING RESIDUES

Tin ore 1-2% Sn
5-200 ppm Th, 2-20 ppm U

Physical processing

Tin mineral concentrate (cassiterite) 55-75% Sn
0.001-0.2% Th, 0.0005-0.2% U

Smelting / pyrometallurgy

Tin metal >99% Sn
nil Th & U

Tin slag 1-7% Sn
0.05-0.8% Th, 0.002-0.9% U

Waste?

Amang
REPROCESSING TIN MINING RESIDUES

- Zircon (Zr)
- Xenotime (Y)
- Scheelite (W)
- Monazite
  - Rare earths, Th
- Ilmenite, rutile, strüverite
  - Ti, Ta

Amang
REPROCESSING TIN MINING RESIDUES
TIN SLAG REPROCESSING

How a residue from tin smelting becomes a valuable raw material
PYROMETALLURGICAL PROCESSING

- **Blending with reagents;**
- **Arc furnace reduction**
- **Tin slag**
  - 1-3% Ta
  - low Th & U

- **Other residues w. Ta**
  - nil Th & U (usually)

- **Heap slag**
  - low Th & U

- **Roasting in stepped oven;**
- **Arc furnace reduction (selective)**

- **Ta synthetic concentrates**
  - 35% Ta
  - nil Th & U

- **Ferro granules**
  - nil Th & U

- **Tin granules**
  - low Th & U
PYROMETALLURGY OVERVIEW

Incoming materials:
- Tin slag (NORM)
- Other residues
- Reagents: cast iron, coke

Outgoing materials:
- Heap slag (NORM)
- Synthetic concentrates
- Ferro granules
- Tin granules
HEAP SLAG

• Glassy material
  - mainly Si, Ca, Al

• Lumpy material up to 20 cm
  - can be crushed

• <10 Bq/g
  - combined Th and U

• ~5 μSv/h near surface
HEAP SLAG
Heap slag: previously used in construction; not accepted under current rules.

Heap slag is currently disposed of to waste depository. - What options for:
  - Re-classification in its current form?
  - Re-purposing for particular civil engineering applications?
  - Dilution prior to the above?

Reassessment required to identify practical limits and requirements to re-purpose residues.
CONCLUSIONS FOR WAY FORWARD

Reassess overarching objectives for NORM residue strategy, within framework of UN Sustainable Development Goals

Allow for regulatory change and new approach to residue classification; enable transition to environmentally and socially acceptable sustainable circular economy

Consider all options with a balanced view of positive / negative factors, whether landfill disposal or practical possibilities for reuse

Take account of long-term safety of NORM residues; understand the practice specific radionuclide pathways

Apply a tailored graded approach to the long-term management of NORM residues,

optimise regulatory limits and requirements, commensurate to the radiation risk
THANK YOU

DANK U WEL

Ulric Schwela
Salus Mineralis Ltd
+44 775 385 7878
us@salusmineralis.com