Recovery and mineral value addition of copper in tailings from the Zambian Copperbelt

Presenter: Dr. /Eng. Precious Chisala Mwanza
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precious.chisala@cbu.ac.zm/ pcchisala@gmail.com

Background

- Mining in Zambia dates back to the 1920s
- Inefficient processing methods – copper-enriched waste
- Significant amounts of waste:
  - Waste rock – 77M tonnes
  - Mine tailings – 800M tonnes
  - Estimated: 6.8M tonnes of copper
- Over 9,000 hectares of land impacted

Problem Statement

- Mining activities generate large amounts of waste that are detrimental to health and the environment.
- Geotechnical issues (ground collapse) - e.g. 1970 Mufulira disaster.
- Water pollution.

Impacts of Mine Tailings

- **Geotechnical issues**

Table 1: Fatalities from tailings dam failures (Davies et al, 2002).

Date	Name	Location	Ore	Dam Type	Failure Cause	Fatalities
1928	Barahona	Chile	Cu	upstream	earthquake	54
1937	Dos Estrellas	Mexico	Au	upstream	slope instability	70
1965	El Cobre	Chile	Cu	upstream	earthquake	>300
1966	Mir	Bulgaria	Pb/Zn	upstream	unknown	(>10)
1970	Mufulira	Zambia	Cu	-	tailings into mine collapse	89
1974	Bafokeng	South Africa	Pt	upstream	seepage	12
1985	Stava	Italy	F	upstream	slope instability	269
1986	Huangmeishan	China	Fe	upstream	seepage/slope instability	19
1988	Jinduicheng	China	Mo	-	dam breach (spillway blockage)	~20
1993	Marsa	Peru	Au	upstream	overtopping	6
1994	Harmony (Merriespruit)	South Africa	Au	upstream	overtopping/slope instability	17
1995	Surigao del Norte	Philippines	Au	upstream	foundation failure	12
					Total Fatalities	**>878**

Mufulira Mine Disaster of 1970, Zambia

Figure 1: Sinkhole in the No.3 dam with the met site in the background (Norman Kenward – Independent Photographer)

Black Mountain Collapse in Kitwe (2018)

https://www.zambianobserver.com/breaking-news-20-people-buried-alive-at-black-mountain-in-kitwe/

Environmental Impacts of Mine Tailings

- Water pollution

Toxic sludge seeping from the Muntimpa tailing dam into the environment.

Effluent sludges flow into Chingola stream at reclamation plant

- Air pollution

Dust particles into the environment from mine tailings.

Aims and objectives

- Investigate and optimise key leaching parameters (leaching).
- To selectively extract copper ions from leach solution (solvent extraction).
- To produce copper cathode from copper bearing electrolyte solution (electrowinning).
- To manufacture copper rods (melting and casting).

Field Sampling from Tailings Dams

- Site locations: Akatiti, Kitwe and Uchi

Akatiti and Uchi Tailings Dams

Akatiti Dam

Uchi Dam

Kitwe (Martindale) Tailings Dam

Kitwe (Martindale) Dam

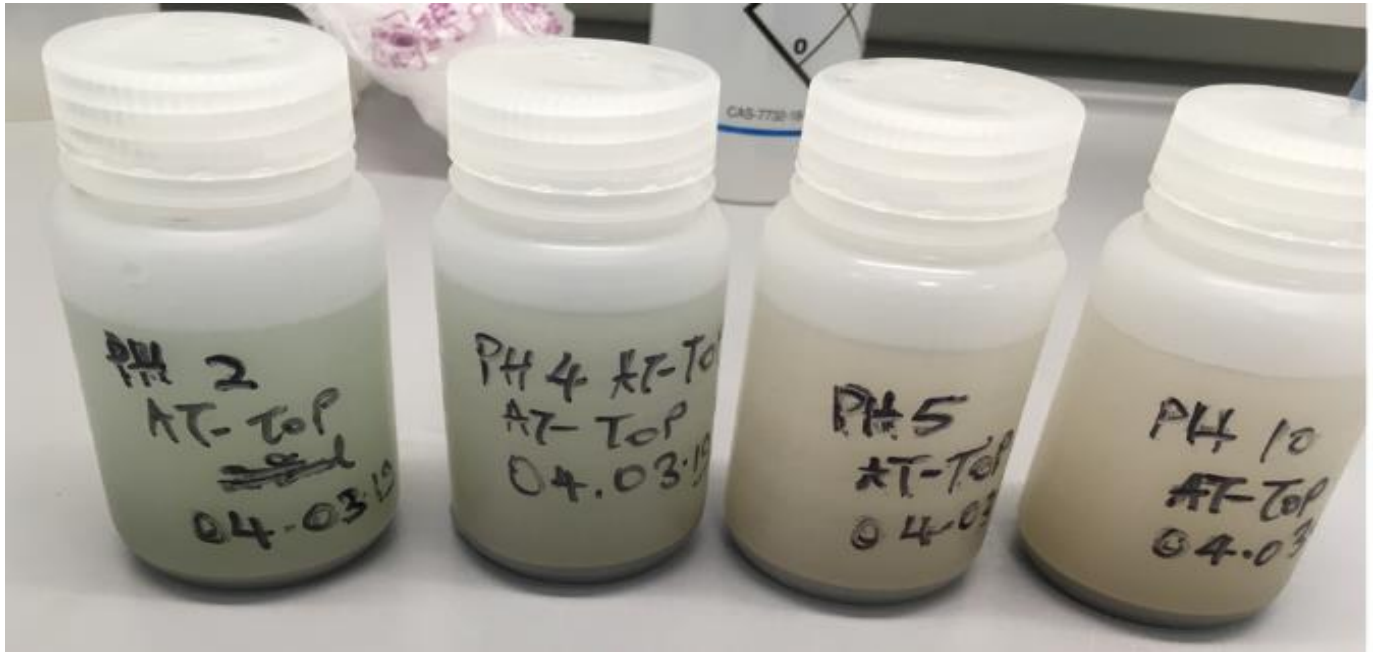
Methodology: Field Sampling

Tailings: Sample depth 2 m

Bottom soil: Sample depth 2 m

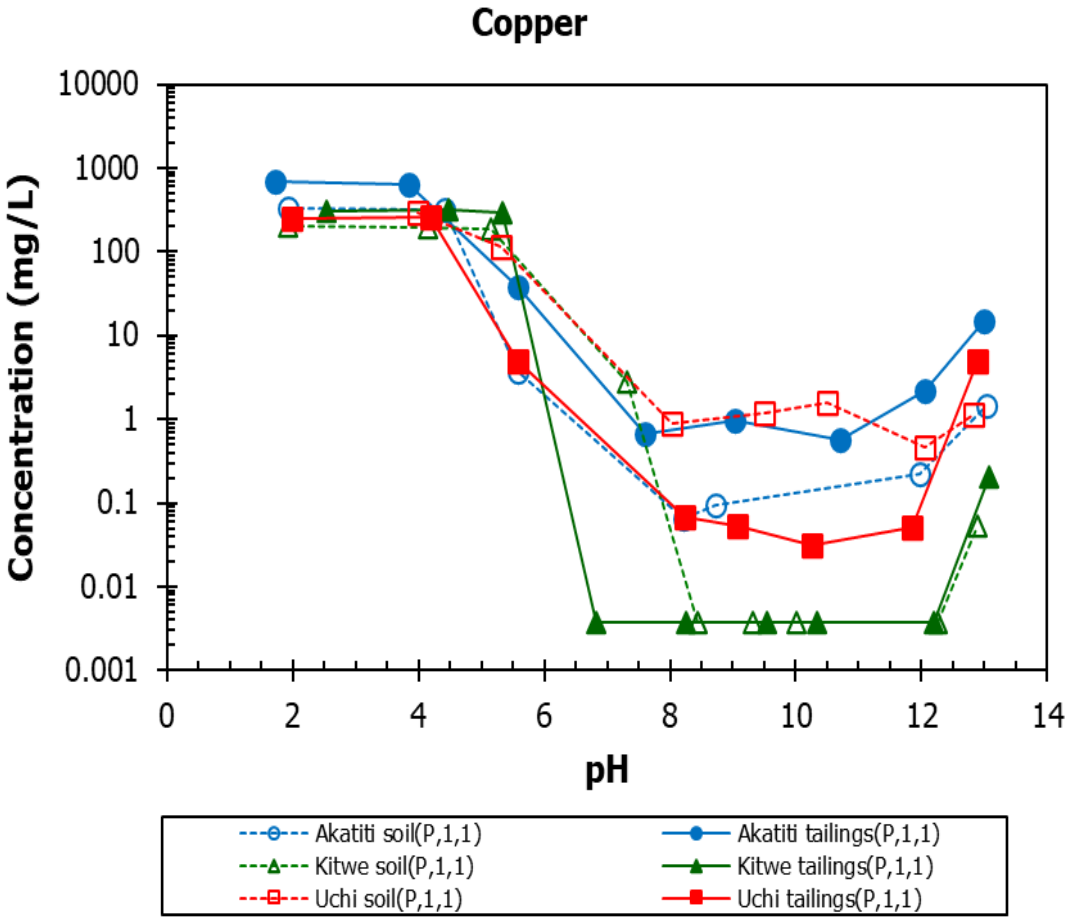
Methodology

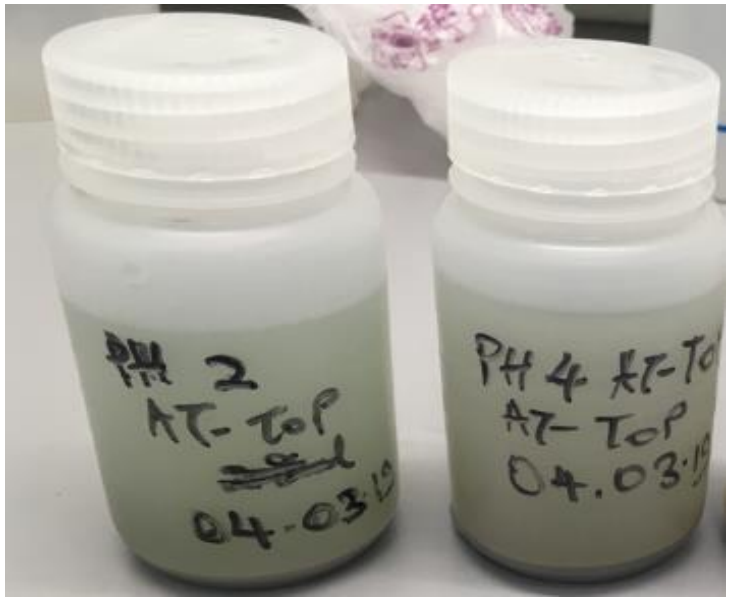
- Leaching
- Solvent extraction
- Electrowinning
- Melting and casting
- Mineralogical characterisation-XRD



pH dependence leaching

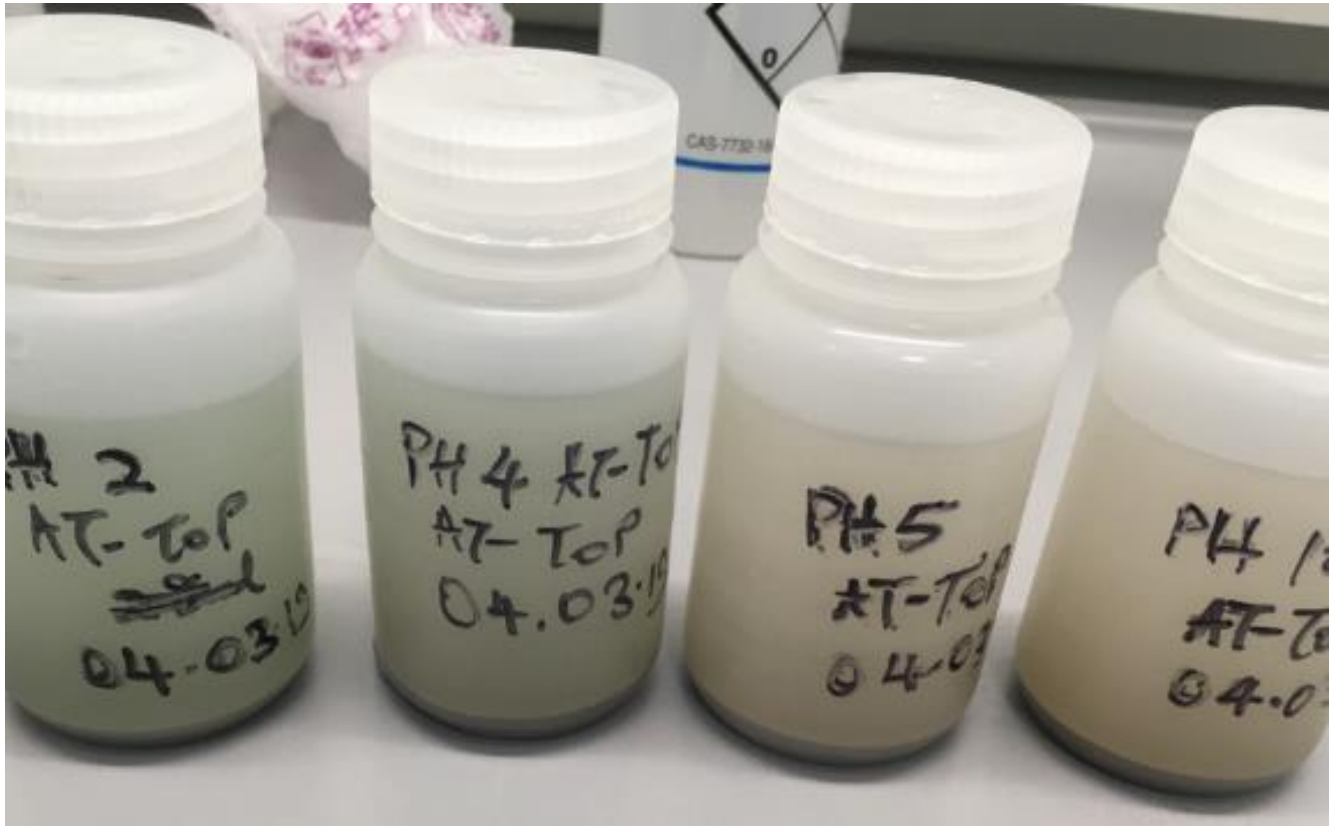
Expected results – Higher Extraction of Copper





Operationalisation of the project

- Experiment will be conducted batchwise (e.g. pH, particle size).
- Continuous columns on a laboratory scale.
- Possibility of scaling-up on a pilot plant (phase 2).



Batch leaching

Continuous leaching via column leaching

Conclusions and future work

- Mine tailings contain high levels of PTEs, especially copper;
- PTEs are likely leaching into underlying soils and groundwater;
- Recovery of copper and other valuable elements is an opportunity;
- Hydrometallurgy could recover significant copper from some tailings;
- Future works: production of copper rods at laboratory scale.

END OF PRESENTATION

THANK YOU……