Water Stewardship in the South African Mining Sector

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2013
Vast quantities of Mine Residue on surface
Proposed West Wits Pit Rehabilitation

- Precipitation falling onto the rehabilitated TDF arising from rainfall (100 Units)
- Evapotranspiration off the rehabilitated TDF (±94 Units)
- Surface runoff (±5 Units)
- Limited void ingress (≤1 Unit) created by reducing water inflow
- High confidence model of pit hydrogeology is under development
- ECL (±1600 m amsl)
- Void water table
- Rehabilitated pit perched above void water table
**Tailings Management**

- Deposited at high pH (>10)
- Lowers pH and triggers release of Hydrogen – **genesis of acidification**
- Leaches *in situ* Uranium
- Concentrates in the crust
- Becomes dust
- Dumps classified as “spoil”

**Solutions:** (1) legal reform of waste classification, (2) develop MRA policy, (3) remove/consolidate dumps

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**Rainfall as a Variable**

- Acidifying (pH <3)
- Falls on dumps
- Eroded by water
- Falls on land

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**AMD Management**

- Ingress into the void *via* multiple points
- Attacks pillars mobilizing metals and pyrite
- Decants at lowest shaft
- Becomes AMD in rivers

**Solutions:** (1) neutralize pH in void, (2) close ingress points, (3) remove pillars, (4) close void with tailings, (5) rehabilitate surface

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Flow Pathway “A”

- Genesis of acidification
- Scale - Localized in the dump
- Mechanism - acid rain falls on alkaline tailings generating hydrogen
  - Acid leaches Uranium
  - Wind blows dust over a larger geographic area

Remedy:
- Policy on coal combustion
- Rehabilitate to prevent ingress and dust
- Remove dump if possible
- Uranium sequestration

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Flow Pathway “B”

- **Gateway** to alternative pathways
- **Scale** – Quaternary catchment
- **Mechanism** – mostly hydraulic
  - Either AMD seeps from the base of the dump into the void
  - Or AMD flows off the dump into adjacent wetlands
- **Remedy:**
  - Rehabilitate to prevent slumping and erosion
  - Remove dump if possible
  - Uranium sequestration

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Flow Pathway “C”

• Aquatic Ecosystems
• Scale - Catchment and beyond
• Mechanism – hydraulic mobilization of dust deposition and dump erosion by rainfall BUT also precipitation in rivers
  - Yellow Boy as manifestation
  - Metals accumulate in wetlands
• Remedy:
  - Rehabilitate dumps to prevent wind and water erosion
  - Wetland rehabilitation to sequester metals and trap sediment
  - Ingress control into void
  - Neutralize decant as temporary measure
  - Uranium sequestration

Dust → Rainfall → Sediment from Dumps → Flow Pathway “C” Aquatic Ecosystems → Streamflow
Flow Pathway “D”

- **Underground**
- **Scale** – Mining basin and multiple catchments
- **Mechanism** – Ingress from surface hydraulic flows
  - Acid mobilizes heavy metals and oxidises pyrite in pillars
  - Bacteria (*Thiobacillus ferroxidans*) convert Pyrite to additional acid

**Remedy:**
- Ingress control from surface
- Pillar removal
- Closure of void by paste backfill
- Drawdown of water level
- Neutralize as temporary measure to prevent Uranium mobilization

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AMD is complex so we need **carefully designed interventions** at specific parts of the overall cycle.

**Misdiagnosis** of the cause-effect relationships will cause **massive investment into the wrong intervention** and an angry taxpaying public over time.
Surface holings, fatality at old mine smelt house and re-opened shaft
Rescue of a Zama Zama miner who fell while illegally entering an abandoned shaft

Fatality of illegal miner underground
Ten Cardinal Values of Stewardship

• **Respect** – Even if we are “Masters and Owners”
• **Reduce** – Improve productive efficiency
• **Reuse** – Water is a flux (infinity)
• **Recycle** – Different quality at different cost
• **Renew** – Nature is our ally so assist it
• **Regenerate** – Where ecosystems have collapsed
• **Reinvigorate** – Where ecological functioning still exists
• **Restore** – Aquatic ecosystems provide useful services
• **Revitalize** – Water retains a memory
• **Repair** – Maintenance is a good thing
Thank You
Mintails is going to become like the Scarab Beetle moving waste and making landscapes safe
Emerging Thinking on Stewardship as an Element of Mine Closure at Mintails

• GDARD report – concept of consolidating smaller TDF’s into Mega Dumps engineered to 21st Century standards.

• Wonderfontein Spruit as a logical focal point

Surface holing showing reef exposed before rehabilitation
Rehabilitation of surface holings before pillars are removed.
All surface outcropping of reef removed ready for backfill and rehabilitation
Schematic of the Upper Wonderfontein Spruit
The Hydrological Problem in which CoAL is Embedded

- Rainfall: 100 units
- Evapotranspiration: 94 units
- Surface Runoff: 5 units
- Shallow Soil Water: < 1 unit
- Deeper Ground Water: < 0.1 unit
- Natural slope of the land