Geotechnology of Mining Waste
Topics

• Sedimenting slurries
• Mine backfill
• Electrokinetically enhanced processes
Sedimenting slurries

The thickened tailings continuum

Solids Concentration (%)

Yield Strength (Pa)

Slurry  Thickened Tailings  “Paste”  Cake
Sedimenting slurries

Key questions:
- Do additives affect long-term strength of tailings?
- Can we manipulate surface chemistry to minimise these effects?
Mine backfill

The graph shows the relationship between height above base (m) and vertical total stress (kPa) for drained and undrained conditions. The stress is divided into self-weight stress and additional stress. The diagram illustrates the underground mine structure with various levels and equipment.
Key questions

- Can the amount of binder (e.g. cement) be reduced without increasing hazard posed to underground workers?

- Can we utilise instrumentation inside stope to optimise filling schedule?

- Is it possible to utilise other additives to minimise cost?

- What is effect of backfilled material on regional stress conditions?
Electrokinetically enhanced processes
Permanganate ($\text{MnO}_4^-$) a very versatile oxidant

- Effective over a wide pH range:

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  \begin{align*}
  \text{At pH } < 3.5, \quad & \text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \leftrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} \quad (E = 1.51\text{V}) \\
  \text{At pH } 3.5 \text{ to } 12, \quad & \text{MnO}_4^- + 2\text{H}_2\text{O} + 3\text{e}^- \leftrightarrow \text{MnO}_2^{\text{(s)}} + 4\text{OH}^- \quad (E = 1.69\text{V}) \\
  \text{At pH } > 12, \quad & \text{MnO}_4^- + \text{e}^- \leftrightarrow \text{MnO}_4^{2-} \quad (E = 0.56\text{V})
  \end{align*}
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- Oxidises organic contaminants (TCE, PCE)
- Visual indicator (vibrant purple colour)
- Relatively cheap
Introduction:
Important aspects of electrokinetics

- DC electric field will transport charged ions via electromigration (EM)
  - Anions toward anode, cations toward cathode
  - Voltage gradient and ionic mobility determine transport rate for charged ions

- Electrolysis reactions generate $\text{H}^+$ (anode) and $\text{OH}^-$ (cathode)
  - $\text{H}^+$ migrates faster than $\text{OH}^-$
  - Acidifies porous media
  - Acidic pH conditions cause $\text{MnO}_4^-$ instability ($\text{pH} < 3.5$)
- Apparatus design
MnO₄⁻ breakthrough

- Conditions where breakthrough occurred
  - 30g/L MnO₄⁻, ‘pH isolated’ mode, ΔV = 1.1V/cm
  - Breakthrough observed after 2.9 days
  - MnO₄⁻ concentration measured in target reservoir
Future potential:

- In negotiations to conduct field trial
- Other applications, e.g. extraction of residual oil deposits from depleted reservoirs
Time for tea