Mine Drainage in Southland

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1 Introduction – Mine Drainage Chemistry

• Pyrite oxidation
  
  – \( \text{FeS}_2 + 3.75\text{O}_2 + 3.5\text{H}_2\text{O} \rightarrow 2\text{SO}_4^{2-} + 4\text{H}^+ + \text{Fe(OH)}_3 \)
  – Biologically catalysed

  – \( \text{Fe}^{3+} + 3 \text{H}_2\text{O} \rightarrow \text{FeOH}_3 + 3 \text{H}^+ \)

• Release of other components
  
  – \( \text{KAlSi}_3\text{O}_8 + 2\text{H}^+ + 6\text{H}_2\text{O} \rightarrow \text{K}^+ + 3\text{H}_4\text{SiO}_4(\text{aq}) + \text{Al}^{3+} 2\text{OH}^- \)
  – Other sulphide minerals \( \text{FeAsS, ZnS} \)
  – Trace elements also included as impurities in sulphides
Mine Drainage Chemistry

• Formation processes well understood

• Acidity and/or elevated trace elements are the main problems

• Chemistry is variable

• Can identify PAF rocks with reasonable certainty through acid base accounting

• Can also identify trace element rich rocks
Data Compilation - Southland

• Geological and mining information

• DAME – Database for assessment of mine environments
  • Water Quality Data
  • Rock Geochemical Data

• Southland data contributors
  • Environment Southland
  • SENZ, Eastern Corp.
  • NIWA
2 Coal and gold in Southland

- Sub-bituminous coal
- Lignite
- Hardrock Gold
- Alluvial Gold
Coal and gold in Southland

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2 Coal and gold in Southland

- Sub-bituminous coal
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Mine sites in southland
• Newvale Mine
• ~200 000tpa

• Curragh Mine
• 6Mtpa
Data Compilation ctd.

- Water quality data
- Mine drainage data
  - Newvale, Bell Brooke, Ohai
- Rock Geochemistry data
Data Compilation ctd.

• Water quality data
Data Compilation - Summary

• Little data available
  • AMD at Bell-Brook
  • Acid base accounting data only from Ohai

• Gaps identified
  • Few mine drainage or pit lake analyses
  • Acid base accounting data
  • Little understanding of distribution of Bell-Brook style AMD
  • No data on groundwater chemistry in lignite deposits
Data Acquisition - Mine Drainage Chemistry

The graph shows the relationship between pH and Total Al + Fe (mmol) with data points indicated by red triangles. The pH values range from 3 to 8, while the Total Al + Fe values range from 0.0001 to 10 mmol.
Acid Base Accounting Methods

- Maximum potential acidity (MPA)
  - Estimate total acid production from S content

- Acid neutralising capacity (ANC)

- Net acid producing potential (NAPP) = MPA − ANC

- Net acid generation
  - Oxidise sulphides and react neutralising components simultaneously
Gore Lignite Measures
Mataura Acid base Accounting

Graph showing the relationship between NAG pH and NAPP kg(H₂SO₄)/t.
MPA Data

• Sulphur can be present in several different oxidation states in rocks
  • Sulphide
  • Sulphur
  • Sulphate
  • Organic bound S

• Can conduct sulphide specific analyses
  • Chromium reducible sulphur
  • More expensive
  • Require a fresh sample
Chromium Reducible Sulphur

- Conducted chromim reducible sulphur (CRS) on several samples from Mataura

- In general CRS about half total sulphur
However...
Chromium Reducible Sulphur

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However…

![Graph showing Gypsum peaks](image.png)
Mataura Acid base Accounting

![Graph showing the relationship between NAG pH and NAPP kg(H₂SO₄)/t](image)
Net Acid Generation Data

- Uses a strong oxidising agent
  - $\text{H}_2\text{O}_2$ – not selective
- Organic material also reacts with $\text{H}_2\text{O}_2$
- Limited use especially in carbonaceous sediments
- Causes a false positive result
Net Acid Generation Data

- Example

- Samples from Croydon
  - $\text{MPA} = 1 \text{ kg}(\text{H}_2\text{SO}_4)/\text{t}$ \quad $\text{NAG} = 11 \text{ kg}(\text{H}_2\text{SO}_4)/\text{t}$
  - $\text{MPA} = 9 \text{ kg}(\text{H}_2\text{SO}_4)/\text{t}$ \quad $\text{NAG} = 34 \text{ kg}(\text{H}_2\text{SO}_4)/\text{t}$
? Alkaline

? Acidic

Conglomerate

Claystone

Sandstone

Carbonaceous Mudstone

Mudstone
Other Acid Base Accounting Data

- 7 representative samples from Nightcaps mine
  - NAF rocks

- 10 representative samples and 25 suspected PAF samples from Croydon
  - Representative samples NAF
  - Some suspected PAF samples highly acid producing

- 14 samples from gravels
  - All NAF

- 10-15 samples from Newvale Mine
  - Mostly NAF – one PAF
Other data acquired

- Piesometers samples from throughout Southland
  - PAH analyses
  - Trace element analyses
- Slight elevation of some naturally occurring PAHs
- No substantial elevation of trace elements
- Turbidity prediction
Turbidity at Southland Mines

- **Newvale**
  - Turbidity settles naturally
    - Days to month

- **Ohai**
  - Turbidity requires treatment
    - Little settling > 6months

- Nightcaps, Mataura
Summary of data acquired

- Gaps identified
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  - Acid base accounting data
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Comparison to West Coast – Mine Drainage Chemistry

![Graph showing pH vs. Total Al + Fe (mmol)]
Comparison to West Coast – Acid Base Accounting

Paparoa Coal Measures
Bruner Coal Measures
Conclusion

• There is currently only very localised acid mine drainage in Southland

• There is potential for AMD – there are some PAF rocks in the Gore Lignite Measures

• Any acid mine drainage issue is almost certain to be much more mild than the West Coast AMD

• We have an opportunity in Southland to be proactive rather than reactive and prevent mining related impact on aquatic ecosystems