Geochemistry and Water Quality of the Britannia Mine Workings

by Kelly Sexsmith and Stephen Day
Acknowledgements

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- BMARC
Background

- Geology/Mineralogy
- Low pH’s and High Copper Concentrations Early in Mine Life
- Copper Recovery Mine Water Starting in 1928.
- Historic Discharges to Britannia Creek and Howe Sound
Britannia Remediation Project

- Water Treatment Plant
- Water Quality
  - Flow-through conditions
  - Seasonal flooding and draindown
- Study Objective
  - Predict chemical effects of storage behind the plug
Approach

- Review of Historical Water Quality Data
  - Historical trends
  - Relationship between flow and chemistry
  - 1980’s Plug Test Data
  - Equilibrium Modelling

- Plug Test
Historical Data – 2200 Level

Copper (mg/L)

Dissolved Cu
Total Cu

't29 '39 '49 '59 '69 '79 '89 '99
### 1990 to 2001 Data – 2200 Level

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Std. Dev.</th>
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<tbody>
<tr>
<td>pH</td>
<td>3.1</td>
<td>0.3</td>
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<tr>
<td>SO₄</td>
<td>1088</td>
<td>354</td>
</tr>
<tr>
<td>Al</td>
<td>42</td>
<td>11</td>
</tr>
<tr>
<td>Cd</td>
<td>0.19</td>
<td>0.05</td>
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<tr>
<td>Cu</td>
<td>59</td>
<td>20</td>
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<tr>
<td>Fe</td>
<td>31</td>
<td>12</td>
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<tr>
<td>Zn</td>
<td>29</td>
<td>7.3</td>
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</table>
Seasonal Flows and Copper Concentrations (1945 to 1952)
4100 Plug – Early 80’s data

- Pressure head (m)
- Copper (mg/L)

Pressure

Copper

[Graph showing pressure and copper levels from 1980 to 1987]
1990 to 2001 Data - 4100

<table>
<thead>
<tr>
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<th>Std. Dev.</th>
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</thead>
<tbody>
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<td>SO4</td>
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<td>199</td>
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<td>Al</td>
<td>26</td>
<td>5.9</td>
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<tr>
<td>Cd</td>
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<td>0.022</td>
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<tr>
<td>Cu</td>
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<td>3.9</td>
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<tr>
<td>Fe</td>
<td>4.5</td>
<td>2.1</td>
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<tr>
<td>Zn</td>
<td>21</td>
<td>3</td>
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Plug Tests

Water Level (m)

13-Mar, 10-Apr, 08-May, 05-Jun, 03-Jul, 31-Jul, 28-Aug, 25-Sep, 23-Oct

April 25, June 19, Aug 16
Conceptual Model (Filling)
Conceptual Model (Draindown)
Initial Estimates of Sulphate Concentrations

Two Approaches

- Establish Equilbrium Controls
- Extrapolate from Cumulative Increase in Load Measured During the Initial Test

Results

- Equilibrium: 2600 mg/L
- Extrapolation: 1800-2200 mg/L
Sulphate

Sulphate (mg/L)


Pre-Plug
Average
Copper

Copper (mg/L)

Pre-Plug Average

SRK Consulting
Engineers and Scientists
## Contaminant Release During Plug Test

<table>
<thead>
<tr>
<th></th>
<th>SO4</th>
<th>Cu</th>
<th>Fe</th>
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<tbody>
<tr>
<td>Measured</td>
<td>4926</td>
<td>100</td>
<td>47</td>
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<tr>
<td>Calculated (Pre-plug Avg.)</td>
<td>3995</td>
<td>65</td>
<td>12</td>
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<tr>
<td>Calculated (Historical Avg.)</td>
<td>4003</td>
<td>77</td>
<td>30</td>
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</table>
Conclusions

- Copper concentrations increased from 23 mg/L to as high as 65 mg/L, and sulphate concentrations went from 1400 mg/L to 2700 mg/L.

- Plug test was the preferred approach for estimating concentrations in the reflooded mine.

- The initial test allowed us to estimate the magnitude of change that could be expected under fully flooded conditions.