Mount Polley Tailings: Updates on Geochemical Testing and Conceptual Model

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Presentation Overview

- Brief review of results from 2015
- Updates – kinetic testing and field sampling
- Geochemical Conceptual Model
- Implications for reclamation planning

Summary of 2015 Results

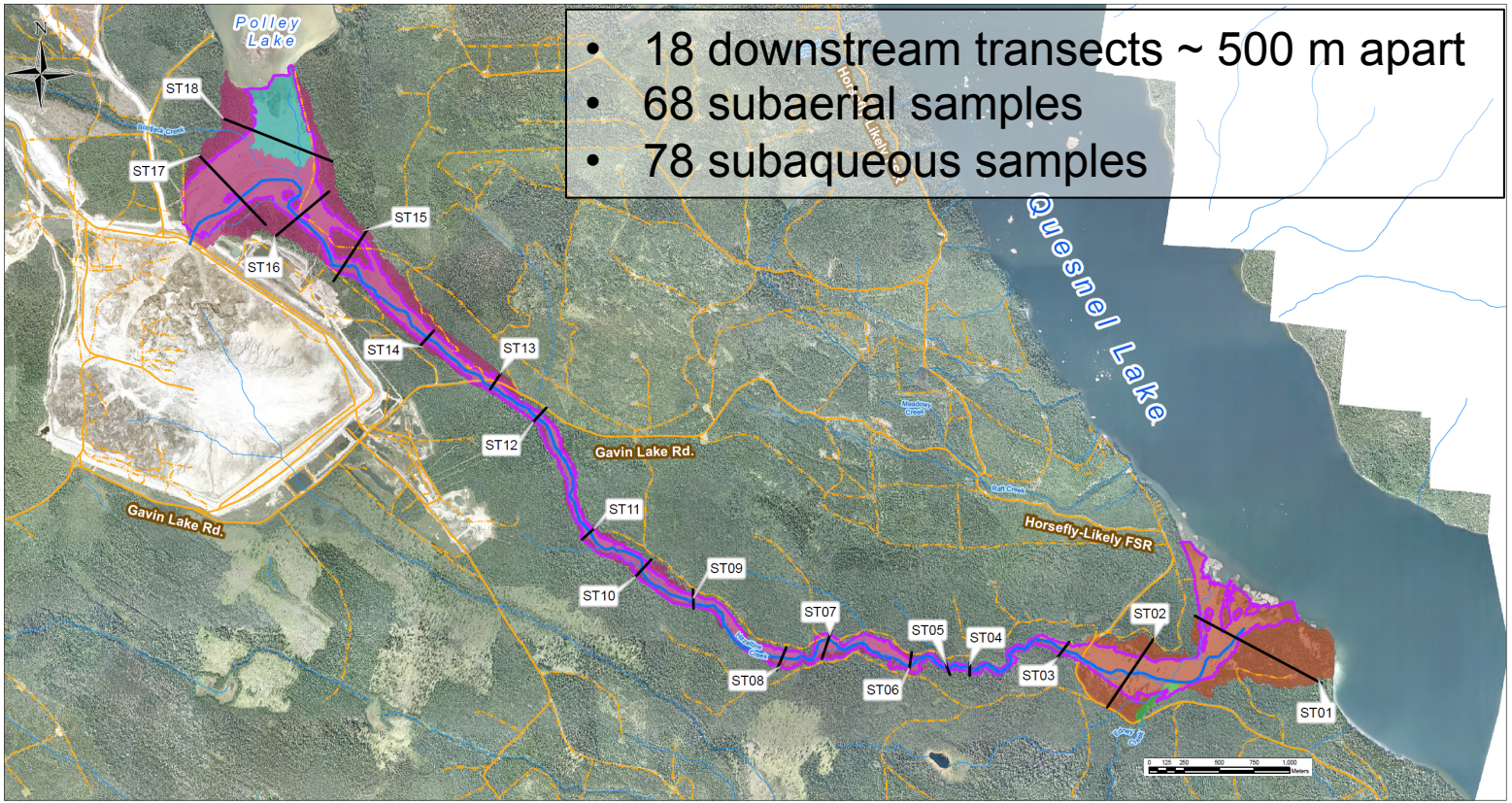
- A geochemical characterization program was started in September 2014 to help inform remediation and reclamation planning for “spilled tailings” (i.e. a mixture of tailings, natural soil and sediments and dam construction materials)

- Previous presentation and 2015 presentations provide more background information

2015 Summary: Initial Conceptual Model

- Developed geochemical conceptual model that indicated two deposition configurations needed to be assessed:
  - Tailings along the banks of Hazeltine Creek as these would be exposed to atmospheric oxygen and facilitate sulphide oxidation
  - Tailings that settled at the bottom of Polley and Quesnel Lake would inhibit sulfide oxidation but may facilitate dissolution of secondary oxide minerals

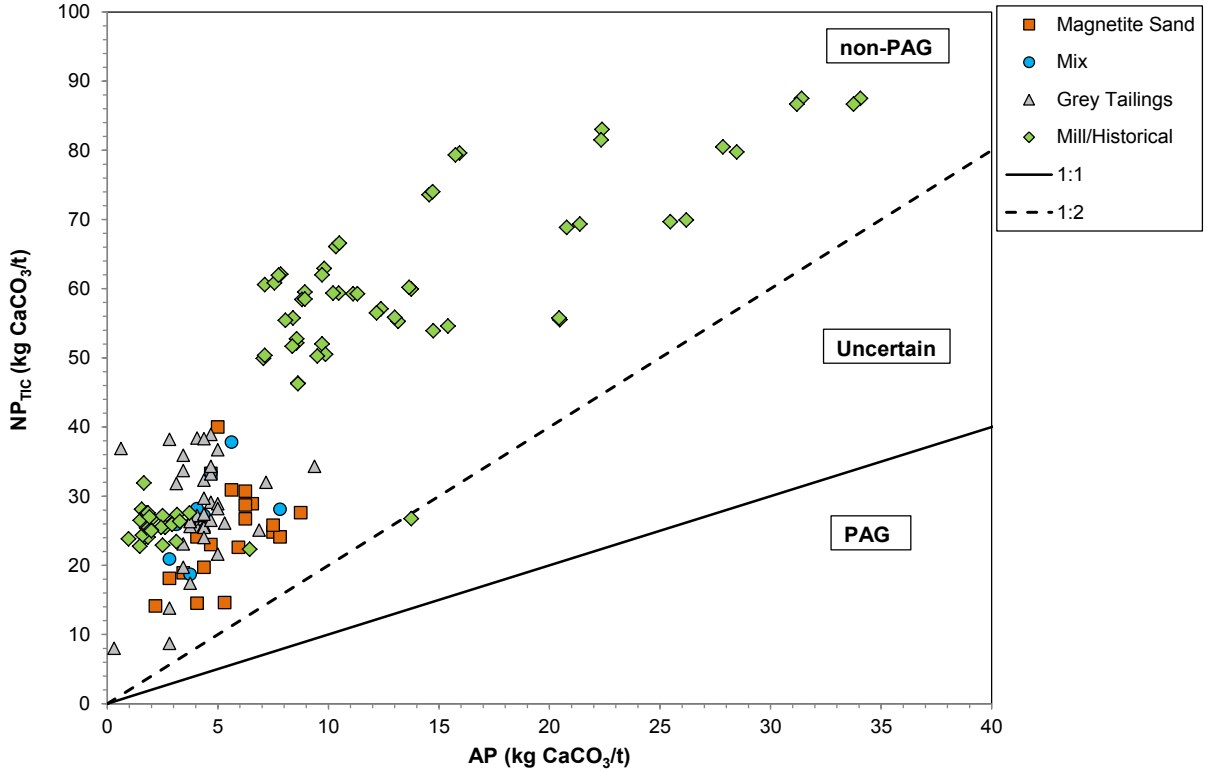
2015 Summary: Sampling



2015 Summary: Lab Testing

- Acid-base accounting
- Bulk composition (aqua regia ICP-MS, non-sulfide copper extraction)
- Mineralogical characterization – QEMSCAN, XRD, probe
- Sequential extractions

2015 Summary: Low ARD potential



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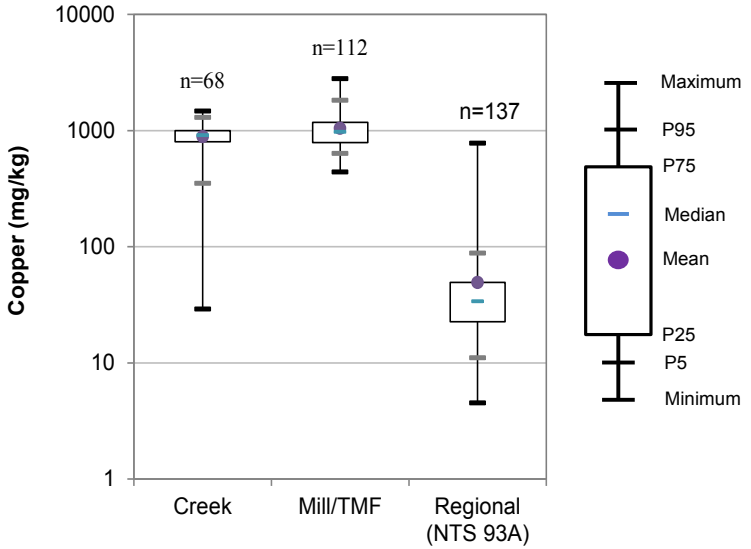
2015 Summary: Low Element Leaching Potential

- Screening of all regulated elements found only copper and selenium above typical crustal rocks
- Selenium is not elevated compared to regional sediments



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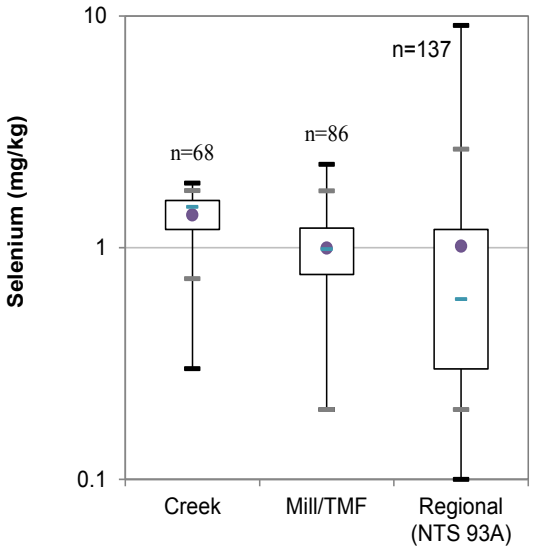

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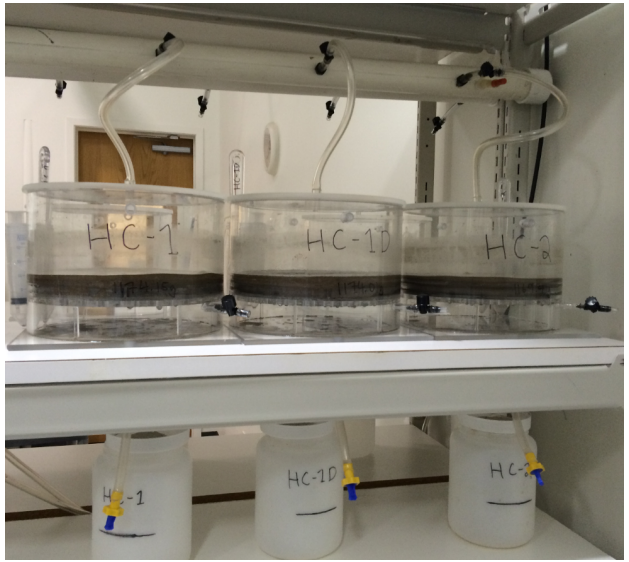
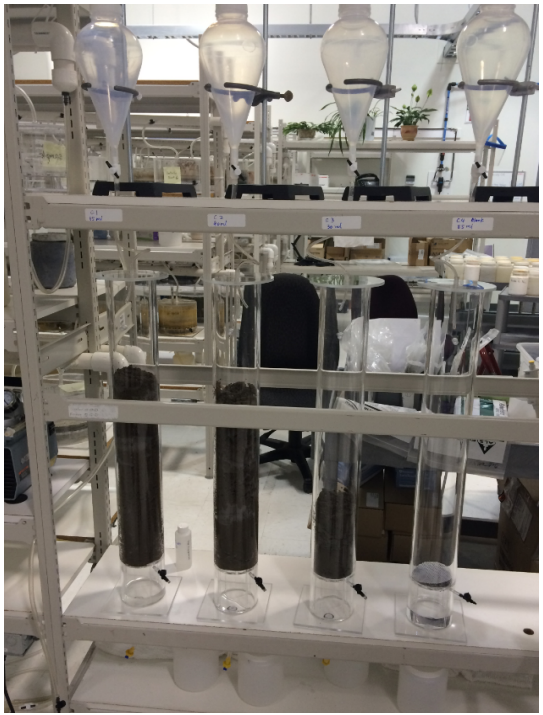
2016 Updates: Kinetic Testing and Field Sampling

Kinetic testing



Humidity cells

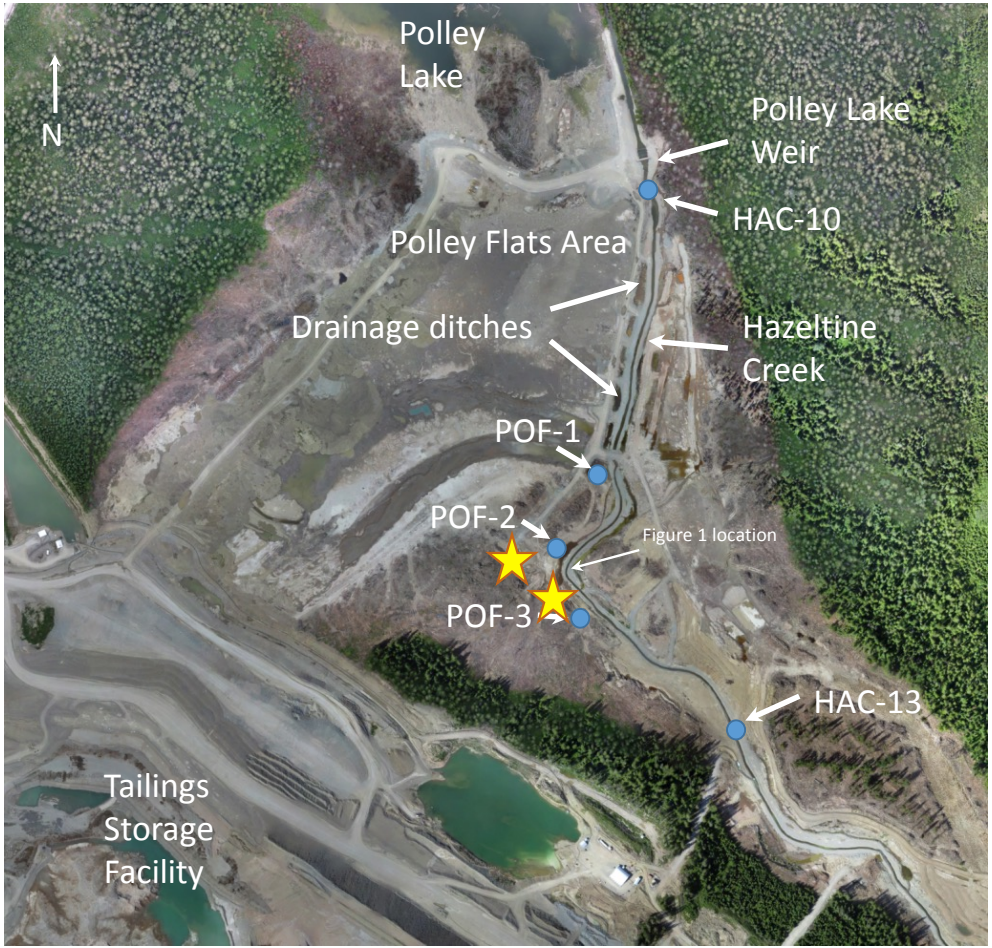
- 1 kg of material
- 500 mL of water
- Dilute (2 kg/L)



Column Tests

- 4 kg of material
- 400 mL of water (10 kg/L)
- Closer to mine site solids-water ratio

Field Sampling



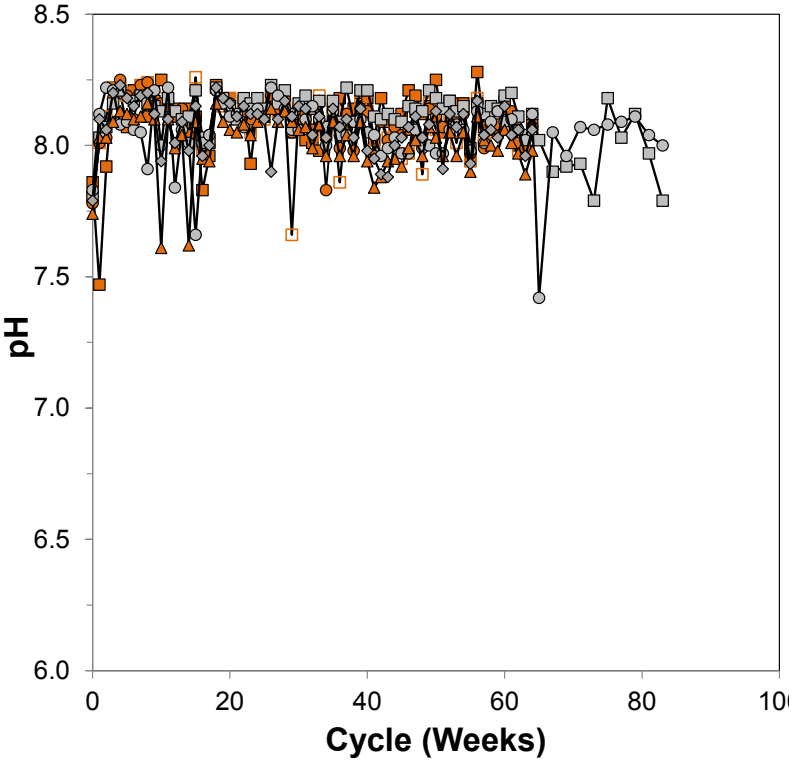
Field Sampling

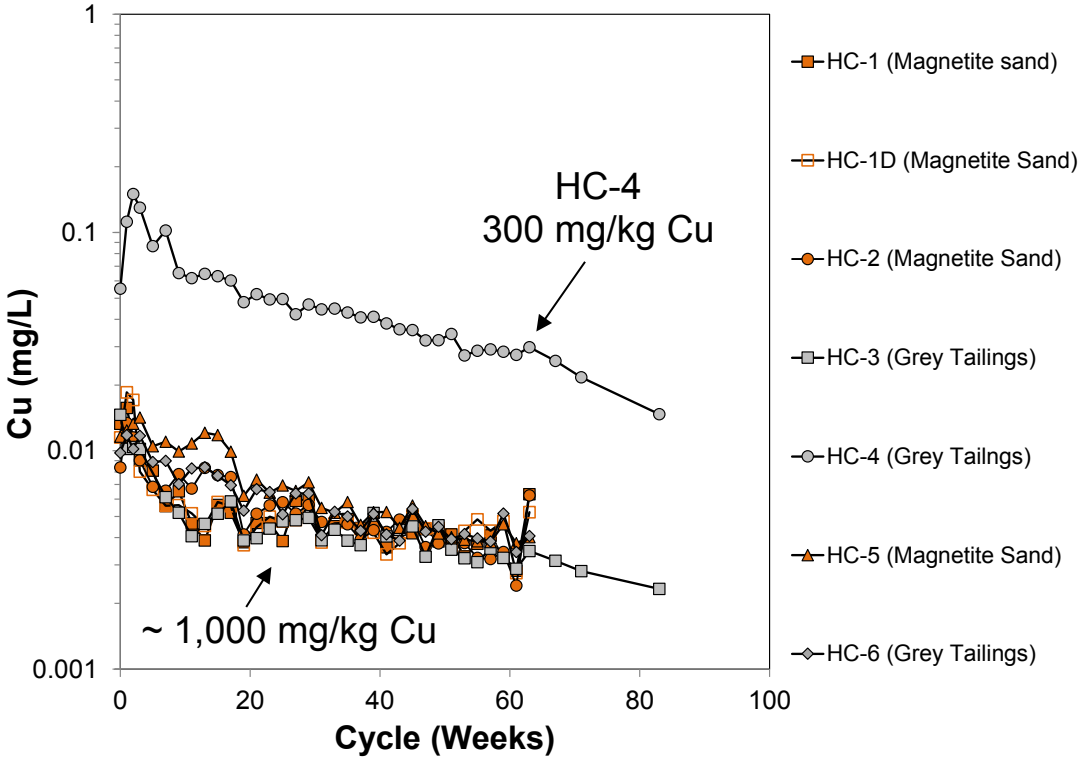
Laboratory Results

pH, Copper, and DOC Focus

- The following slides focus on pH, copper, and dissolved organic carbon (DOC) only
- This is because of questions around copper leaching brought forward by the BC MOE based on water quality results around the “Polley Flats”
- All regulated elements are being monitored in laboratory tests and field stations – to be reported subsequently

Kinetic Testing – Humidity Cell Results





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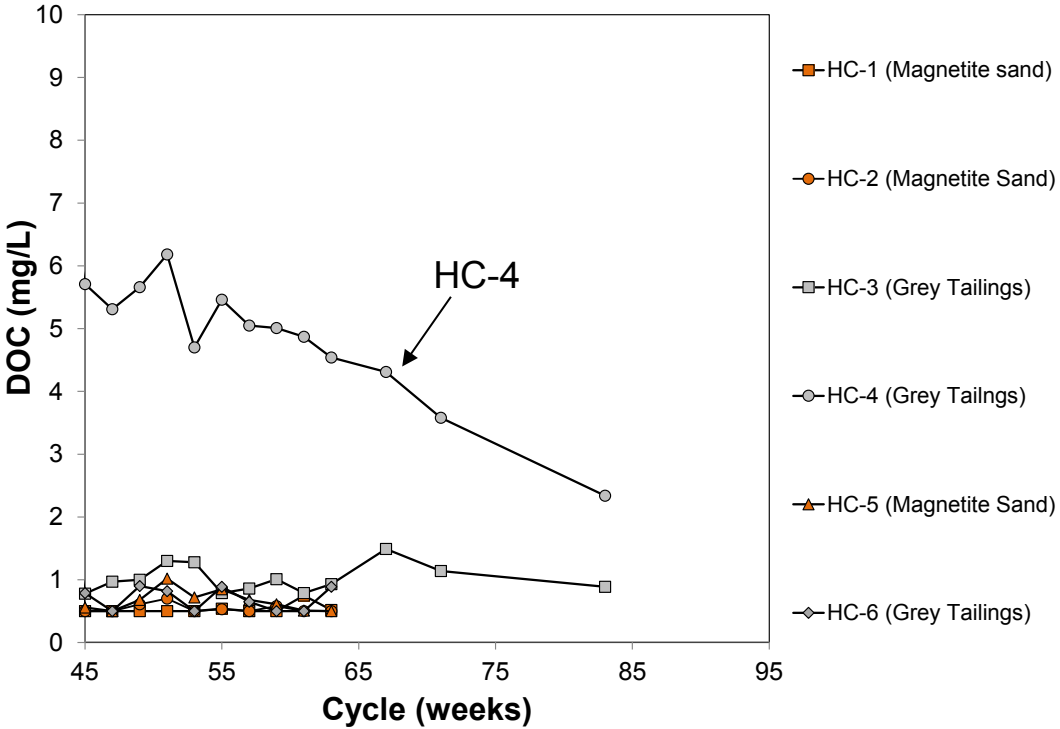
Kinetic Testing – HC DOC Results



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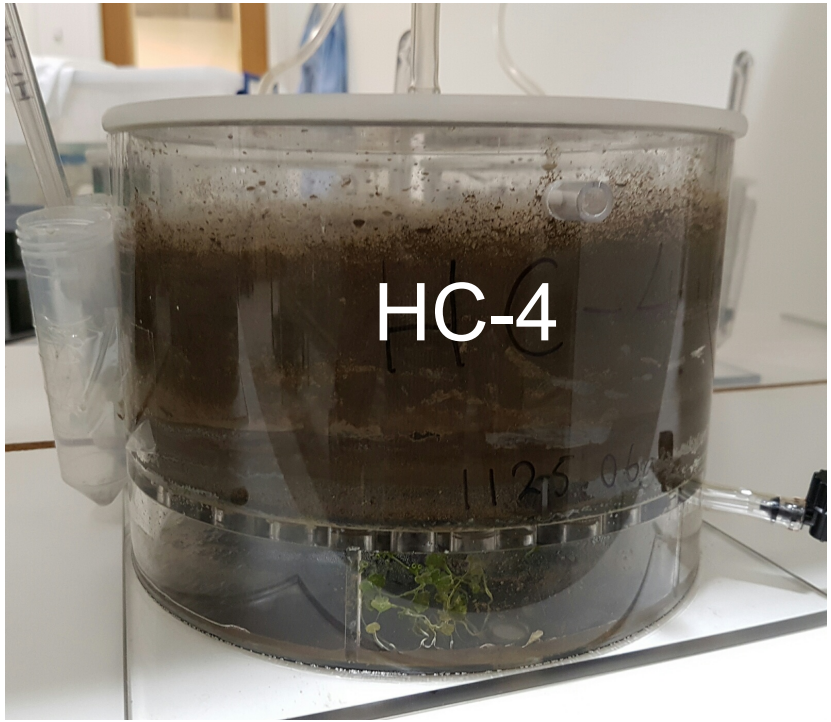
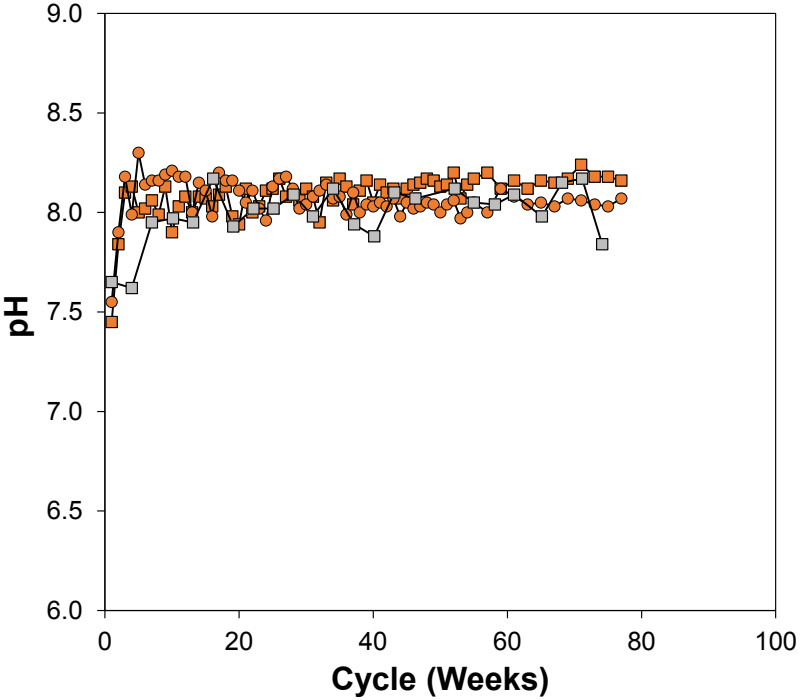
Kinetic Testing – HC DOC Results



Kinetic Testing – Column Results



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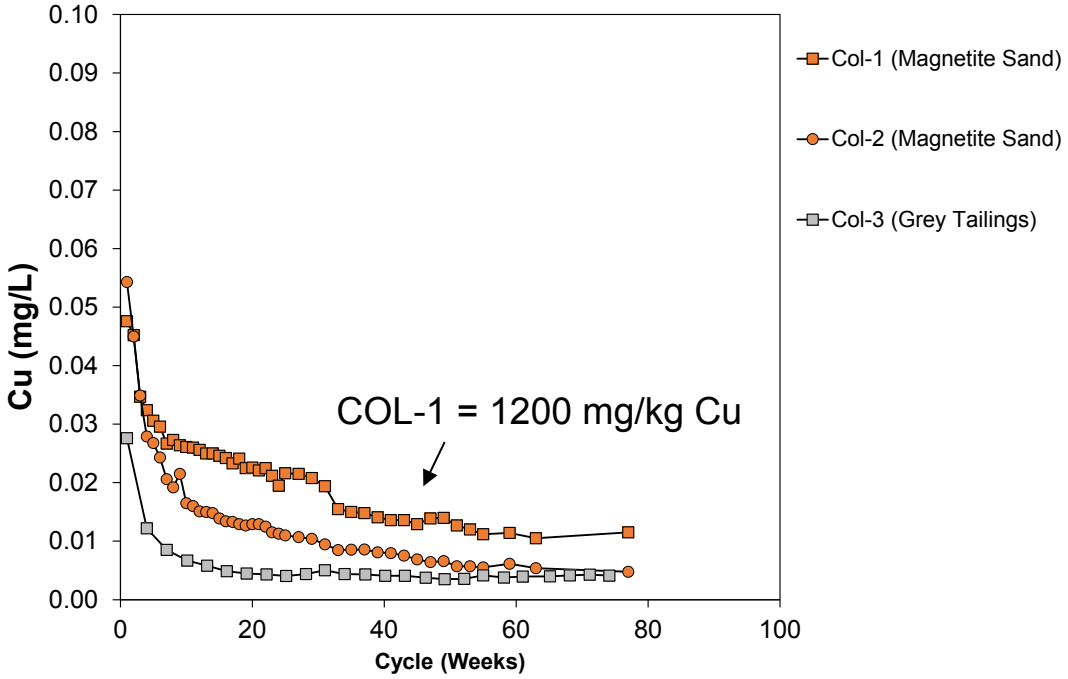

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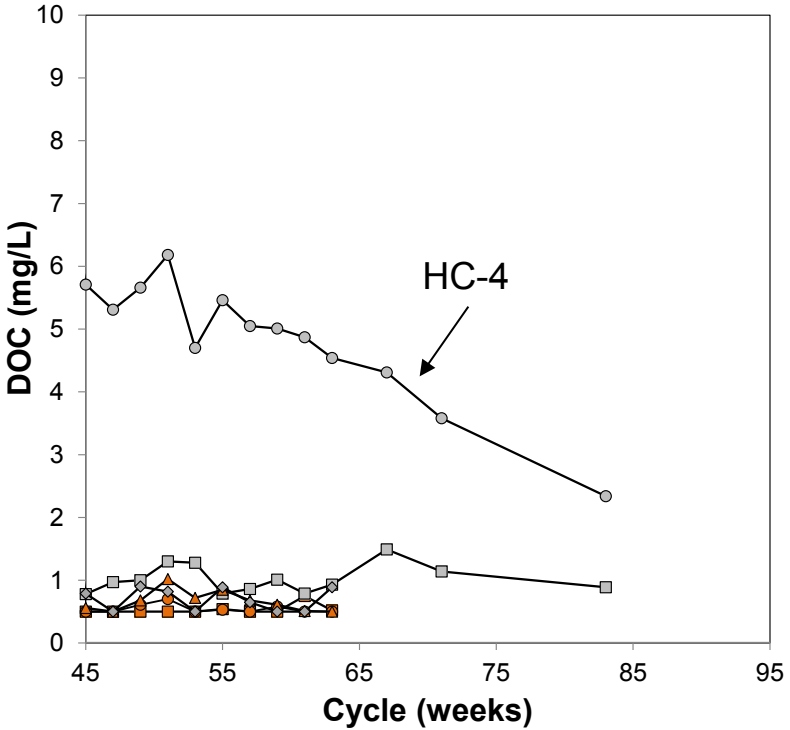
Kinetic Testing – HC + Column DOC Results



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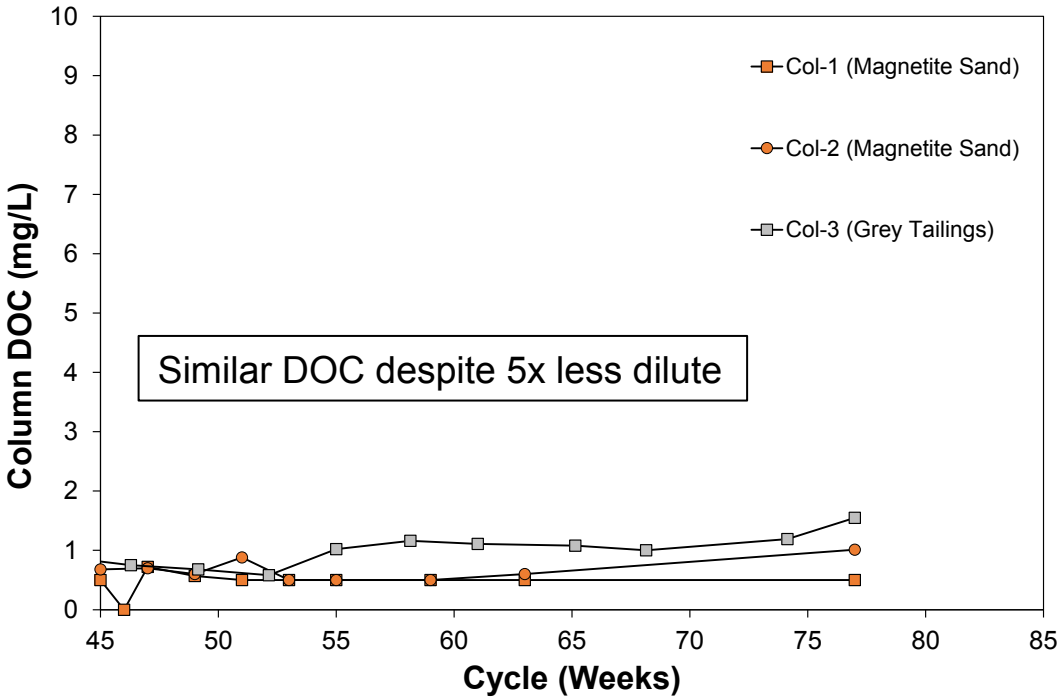

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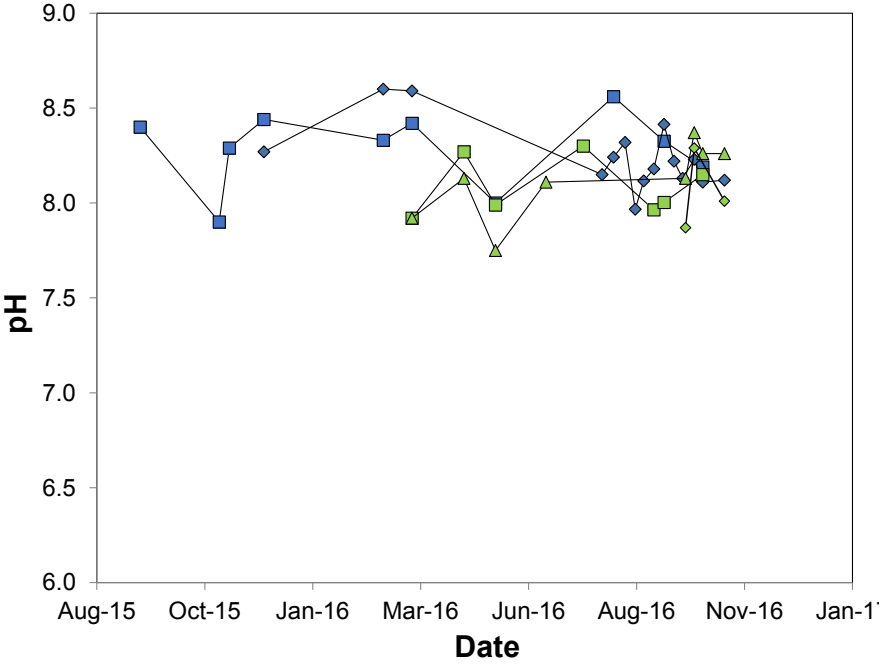
Field Results

Field Results: “Polley Flats” & Hazeltine Creek – pH and Copper



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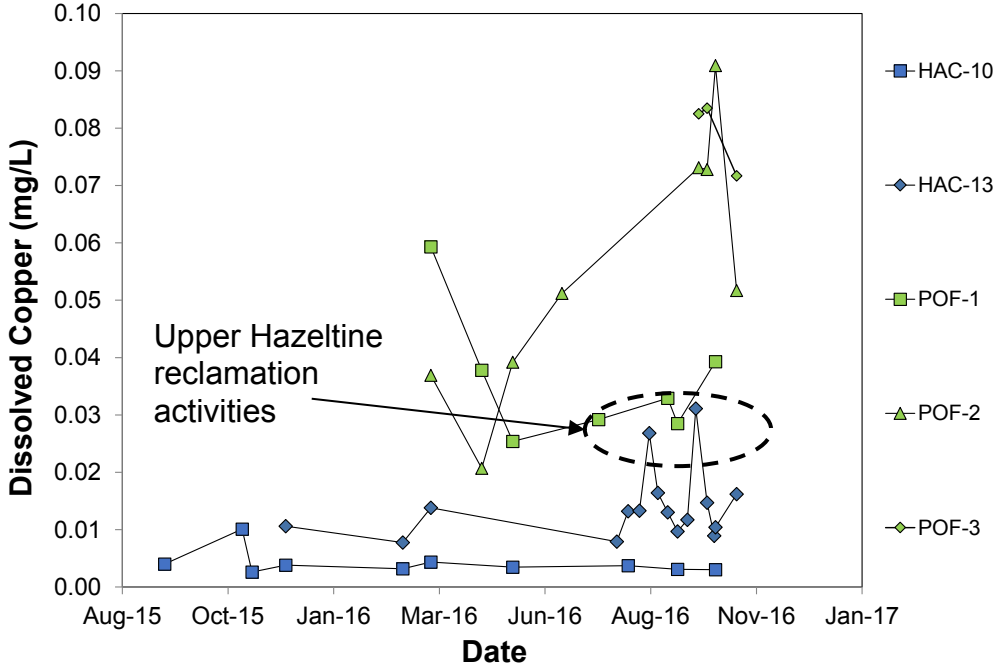

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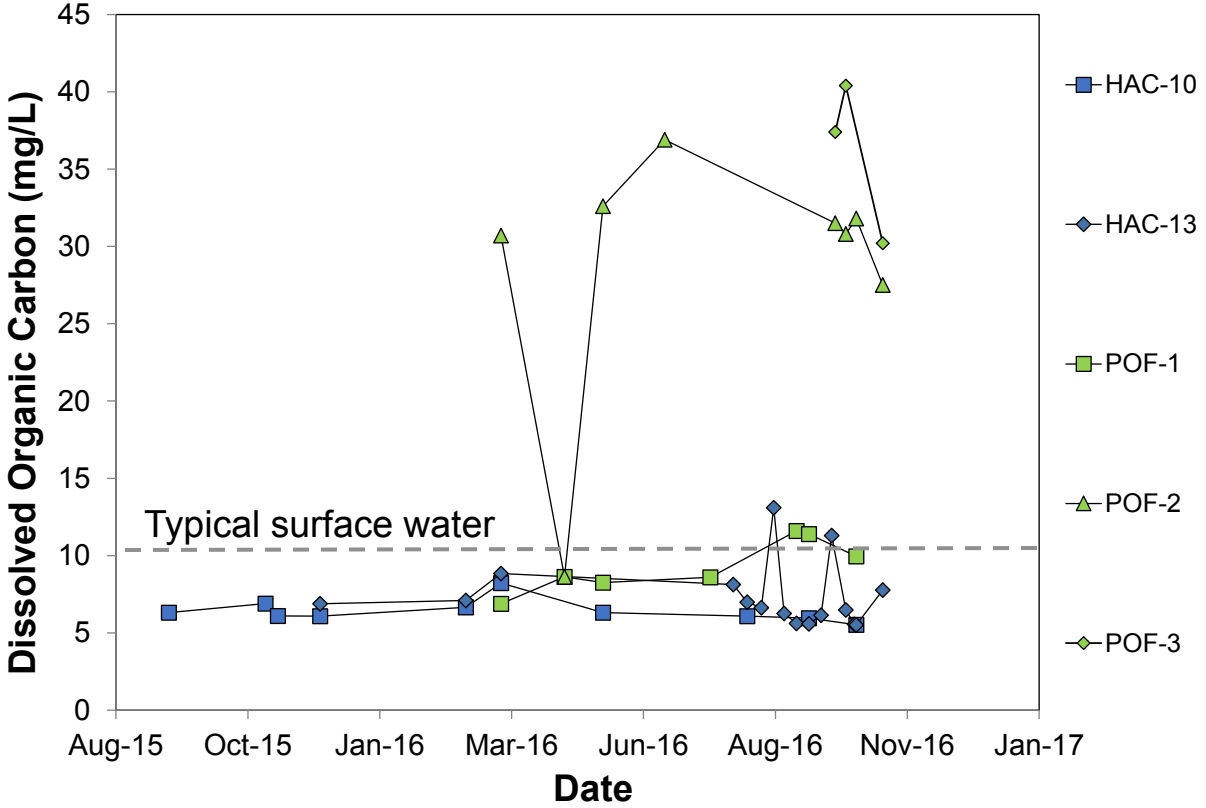
Field Results: “Polley Flats” & Hazeltine Creek – DOC



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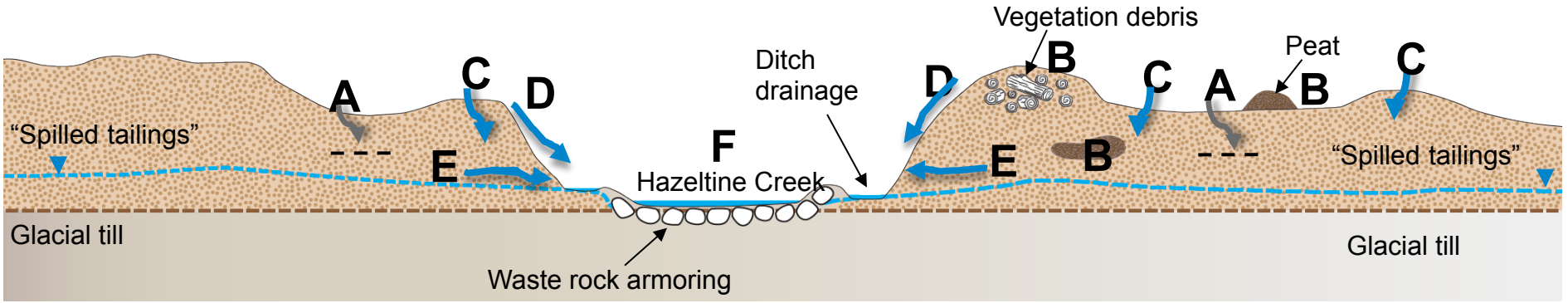
Copper Geochemical Model (aka what the heck is going on?)

Copper Geochemical Conceptual Model

- Subaerial tailings are exposed to the atmosphere and copper sulphides are oxidizing
- Neutral pH predicted based on an excess of carbonate buffering – this continues to be supported by monitoring data
- Variable copper leaching depending on sample and environment with carbon potentially impacting solubility

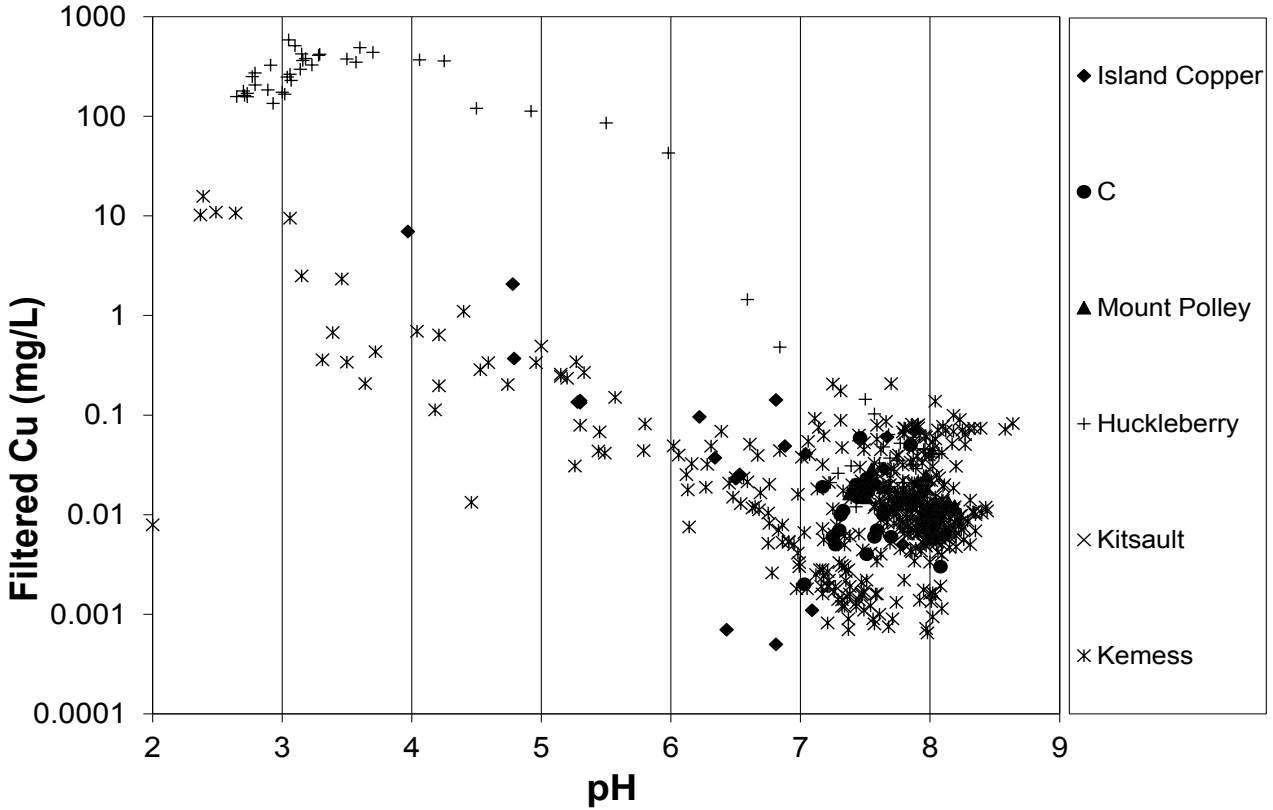
Copper Geochemical Conceptual Model



A. Oxidation of sulphides, diffusion of oxygen, potential oxygen diffusion limitations
B. Organic acids likely complex* with copper
C. Infiltration and transport of oxidation products, carbonate reaction, CO_2 released
D. Run-off to ditches
E. Till interface likely directs water laterally to become seepage or groundwater
F. Above sources may partially report to HAC or to groundwater

Copper solubility considerations

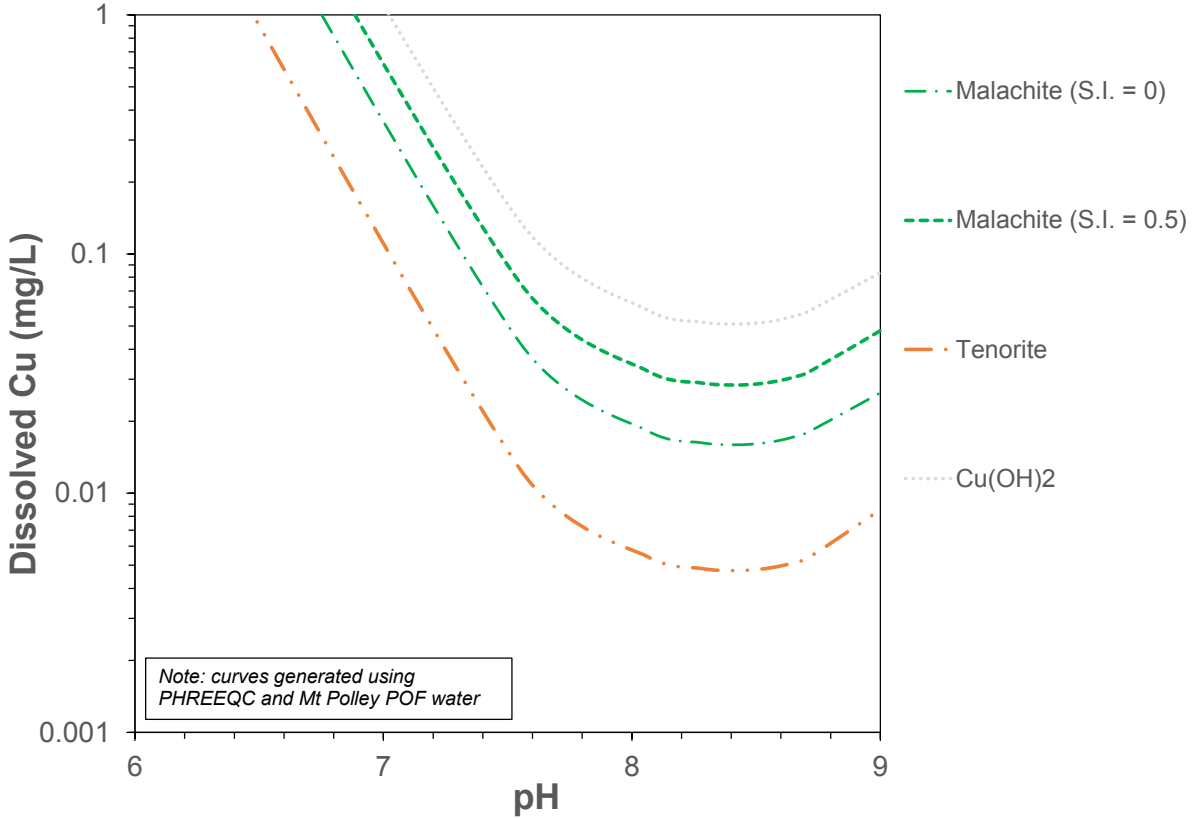
- Copper at neutral pH is relatively insoluble compared to acidic conditions



Modified from Day and Rees (2009)

Copper solubility considerations

- First principles predicts relationship between copper and pH



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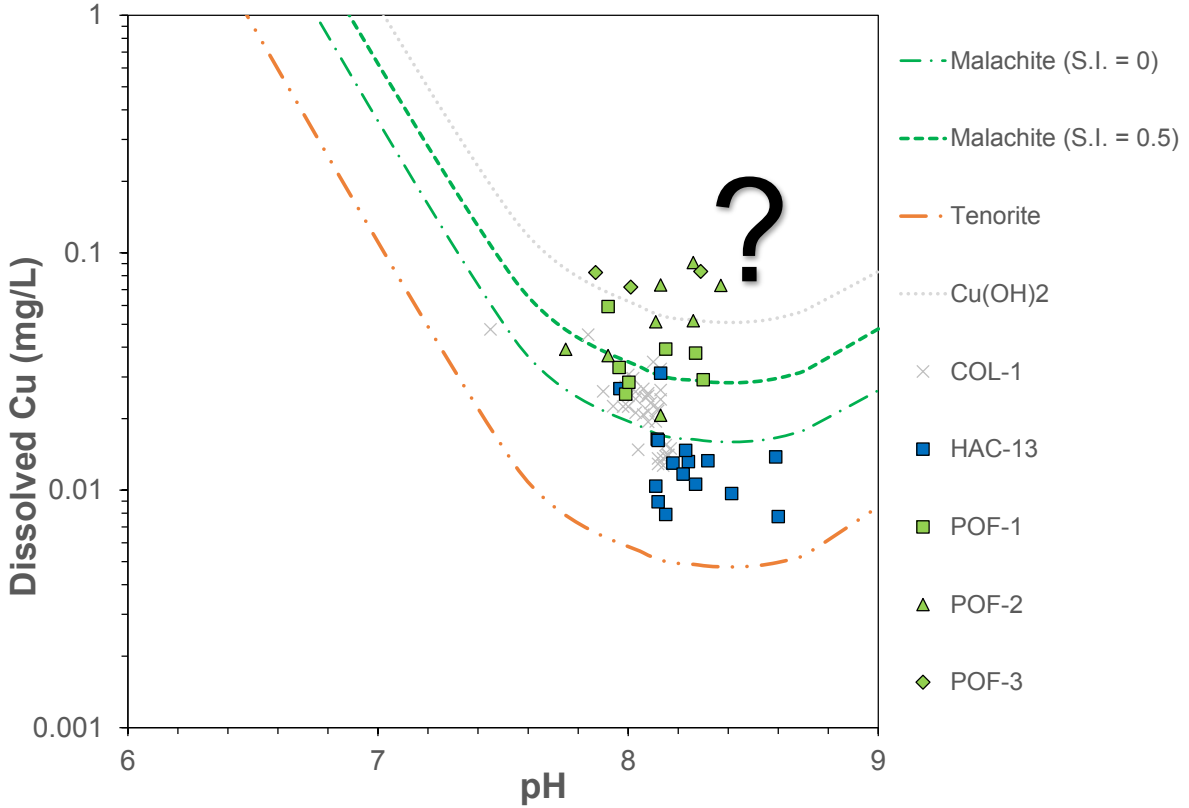
Copper solubility considerations

- POF and HAC copper concentrations appear to be only partially constrained

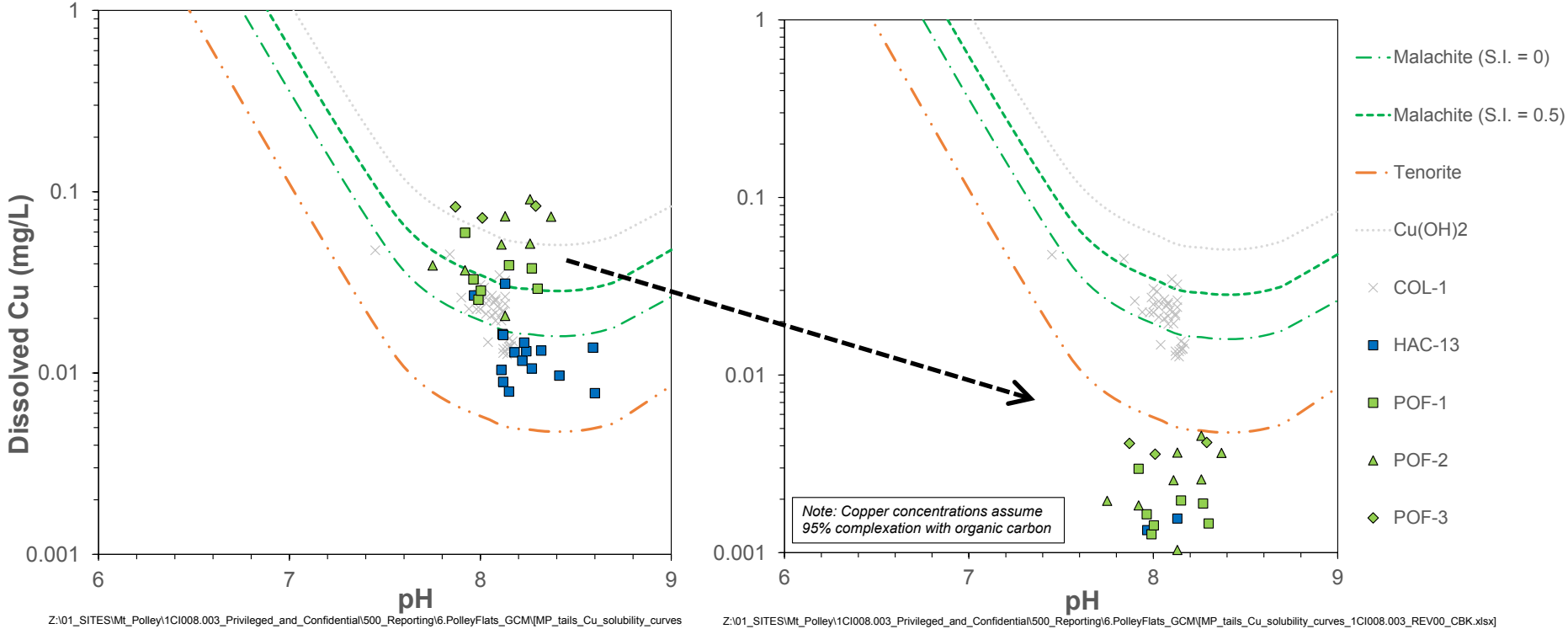
…BUT…



Copper Solubility and DOC Complexation

- The relatively high DOC (40 mg/L versus typical10 mg/L) was likely complexing copper
- Evaluated by Minnow Environmental using the Stockholm Humic Model (Gustafsson 2001)
- Results were that DOC is complexing between 93% and 99% of the copper in the field samples and HC-4
- So, if we assume 95% complexation…..

Copper solubility considerations



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Importance of Copper DOC Complexation

- Copper that is complexed with DOC is less bioavailable than free or ionic copper

- Minnow Environmental are working with a biotic ligand model and HydroQual (v.2.2.3) to establish water chemistry specific guidelines for copper

Implications for Remediation and Reclamation

Remediation and Reclamation

- Ionic or “free” copper is likely well constrained by secondary minerals
- High DOC was found downstream of bogs and is not the “norm” in the “Polley Flats” or tailings pore water in general
- Establishment of vegetation on tailings is not expected to have a negative impact of water quality

Remediation and Reclamation

- Getting water off the tailings and making use of solubility control will likely reduce overall loadings
  - Less water but same concentration = less mass released

Acknowledgments

- Imperial Metals
- Mount Polley Mining
- Minnow Environmental

Thanks for listening!