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## ARD & Metal Leaching Prediction Testing: Current Practices

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# Agenda

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- *Background on ARD/ML*
- *Objectives of an ARD/ML Test Program*
- *Components of an ARD/ML Test Program*
- *Resources for information*

# What is Acid Rock Drainage/Metal Leaching?

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- *Natural reaction to ground disturbance*
- *Exposed sulphide minerals oxidize to generate acidity; bacterial involvement*
- *Sulphides of most concern : pyrite & pyrrhotite*
- *If acidity > neutralization: acidic drainage results (usually with metal leaching)*
- *Biggest environmental issue facing the metal & coal mining industry today*
- *Near-neutral pH ML issues (Cr, Cd, Cu, Mo, SO<sub>4</sub>, etc)*



# Objectives of an ARD/ML Test Program

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- *Predicting the potential future drainage chemistry*
- *Determining the influential properties & processes*
- *Predicting the timing of changes in drainage chemistry*



# Components of an ARD/ML Test Program

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*Phased approach works best:*

- 1. Sample preparation*
- 2. Characterization – geochemical & mineralogical*
- 3. Static testing – acid base accounting & water extractions*
- 4. Kinetic testing – humidity cell & column tests*

# Sample Preparation

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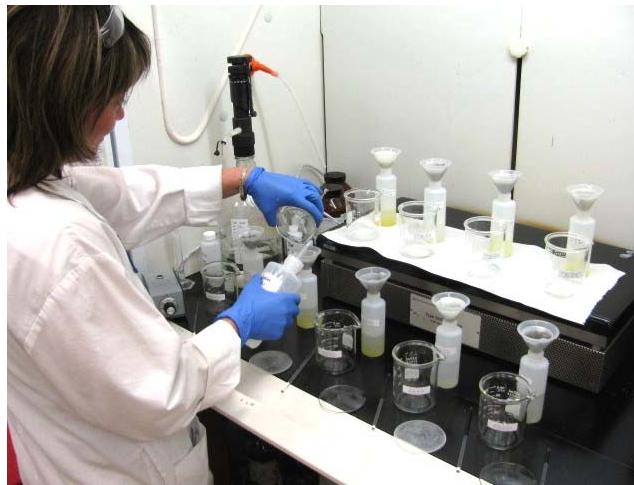
- *Sample prep often overlooked*
- *Proper methods: splitters/dividers and mixing techniques*
- *Steel type options: C, Cr-Mo, Cr, Mn & W carbide steel*



# Characterization - Geochemical

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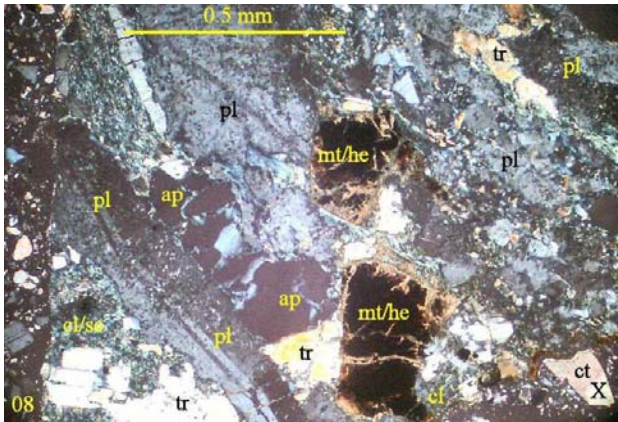
- *Total or trace metals: aqua regia & 4 acid*
- *WRA: ICPMS (wet & LA) or XRF give major oxides & LOI*
- *XRF does not suffer from matrix effects*



# Characterization - Mineralogy

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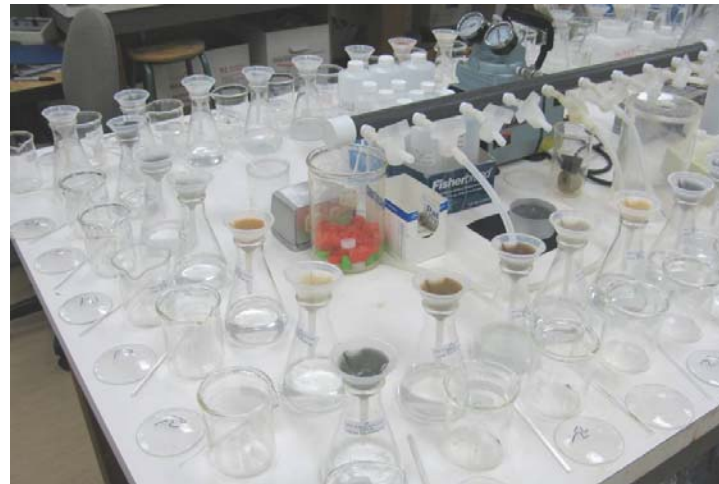
- *Mineralogy by Rietveld XRD, optical microscopy or SEM*
- *Identify & quantify mineral composition, mode of mineralization & grain boundary relationships of minerals present*
- *RXRD: DL ~0.5%, interferences & not applicable to non-crystalline minerals*



# Static Testing Components

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- *Acid Base Accounting (ABA) including S speciation*
- *Net Acid Generation (NAG) Testing*
- *Water Extractions & Sequential Extractions*



# Static Testing - ABA

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- *Acid Base Accounting (ABA) = paste pH, S speciation, TIC, NP, MPA & NNP*
  1. *Total S = sulphate S + sulphide S (partial speciation)*
  2. *Total S = sulphate S + sulphide S + insol S (full speciation)*

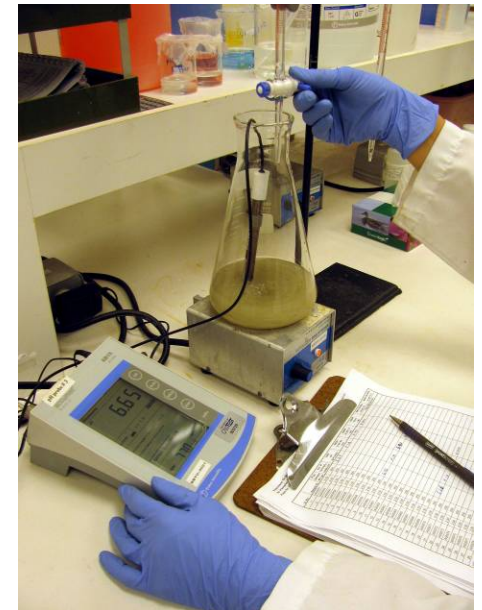
*Choose methodology based on mineralogy*
- *BC Research Initial Test & Confirmation Test*
- *Newmont pyrolysis/roasting methods*



# Static Testing – NAG

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- *Single Addition NAG (SANAG) – pH & acidity measured*
- *Sequential NAG – repeating SANAG on same solids*
- *Kinetic NAG – measure pH & temperature*
- *NAG Extract Analysis – based on SANAG*



# Static Testing – Water Extractions

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- *MEND Shakeflask Extraction – 1:3 S:L & -9.5 mm*
- *SPLP (EPA Method 1312) – 1:20 S:L & -9.5 mm*
- *Meteoric Water Mobility Procedure – 1:1 S:L & -5 cm*



# Kinetic Testing – Humidity Cell Tests

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- *Long term weathering studies (>6 months) which generate weekly water samples*
- *Examines NP depletion, sulphide oxidation & leaching rates (loadings)*
- *Humidity cell test methods: MEND & ASTM*
- *Analysis includes pH, EC, Eh, acidity, alkalinity, sulphate, dissolved metals, TDS, anions, etc.*
- *Ion balance check should be provided*

# Custom Kinetic Testing

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- *Column leach tests simulate subaerial or subaqueous disposal*
- *Test conditions: aerobic, anoxic, reduced temp, reduced infiltration, etc.*
- *SAD column tests: aerobic/anoxic (N or Ar), surface & pore WQ, complex operation*



# Resources for ARD Testing Info

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- <http://www.abandoned-mines.org/mend-e.htm>  
(Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials; MEND Report 1.20.1, Dec 2009)
- <http://technology.infomine.com/enviromine/ard/home.htm>
- <http://maxxam.ca/services/acid-rock-drainage>
- Me! Email me at: [tohearn@maxxam.ca](mailto:tohearn@maxxam.ca)