Hydrogeochemical and Isotopic Investigation of the Mine Water in the 1B Mine Pool of the Sydney Coal Field, Nova Scotia, Canada

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Introduction

- The Sydney Mine Coal Field
  - Abandoned after mining operations ceased due to poor economics
  - Set in motion the flooding of the mine workings
  - Monitor the quality of the water that was being discharged
- 1B Mine Pool:
  - System of interconnected mine workings, tunnels and boreholes classified on the basis of mine plans and water level data (JWEL, 1993)
  - Geology of the study area, particularly the stratigraphy and mineralogy, has major implications for the mine water chemistry

Geological Setting

- Sydney Basin
  - Early to late carboniferous
  - Sedimentary rocks
- Sydney Mines Formation
  - Principal coal resources
  - Key coal seams (1B Mine Pool): Emery, Phalen, Harbour, Hub seams.

Site Location

Objectives

- Regional variation within the 1B Mine Pool
- Origin: Strata contributes largely to this effect
- Residence time
- Seawater intrusion

Sampling

- Lab Analysis
  - Trace Elements + REE
  - Major ions
  - Sr (87Sr/86Sr) isotopes
  - Sulfur (34S) isotopes
  - 2H Isotopes
  - 18O Isotopes
  - CFCs
  - Tritium (%)
- Field Parameters
  - pH, Electrical Conductivity, Temperature, TDS, Redox potential
  - Ferrous iron and Total iron
  - Oxygen Content
  - Acid and Base capacity
Field Results: Summary

- pH [-] 4.98 - 7.36
- El. Cond. [µS/cm] 190 - 8143
- Redox [mV] 137 - 458
- O₂ [mg/L] 0.21 - 9.28
- O₂ [%] 2.2 - 90
- TDS [ppm] 125 - 6757
- Fe Total [mg/L] 0.03 - 1468
- Fe²⁺ [mg/L] 0.02 - 301.67
- Acidity [mol/L] 0.02 – 28.91
- Alkalinity [mol/L] 0.23 – 10.28

1B Pool Mine Water Chemistry

- Ca – SO₄ type water
- Acidity and alkalinity
- net-alkaline water (14 sampling locations)
- net-acidic water (16 sampling locations)
- Relatively high concentrations of Al, Mg, Mn, Na, S0₄

Deuterium and Oxygen

Geochemical Modeling

- 107 samples (1AOF, B-211, B-212, B-213, B-215, B-216, B-217)
- Minlith algorithm
  - estimating mineralogical composition of sedimentary rocks
- PhreeQ Modeling
  - equilibrium phases (concentration, saturation index) and rainwater (pH=5.2, temp=9°C)
  => "mine water"

PhreeQ Modeling

- "Mine water": B212-01
  - Description of solution
  - Distribution of Species

Geochemical Modeling Results (i)

Principal Component Analysis: Al, Cl, Mn, HPO₄, P, K, S SO₄
Geochemical Modeling Results (ii)

Principal Component Analysis: Al, Cl, Mn, HPO₄, P, K, SO₄

Work in progress

- Re-evaluate the geochemical model
  - Effect of dilution
  - Interaction with water from overlying strata
- Analyze data from sampling program
  - Residence time - Sulphur isotopes, Tritium and CFCs
  - Sr isotopes - seawater influence

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