Convective Flow Monitoring and the Influence of Cover Material

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BC MEND ARD/ML WORKSHOP
Soil, Geomembrane and Non-Traditional Dry Covers

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Technical Panel

- Technical Panel formed to investigate the incident and generate lessons for industry

- Kim Bellefontaine
- Ricci Berdusco
- Bruce Dawson
- Daryl Hockley
- Al Hoffman
- Diane Howe
- Walter Kuit
- Dr. John Meech
- Mike O’Kane
- Clem Pelletier
- Mark Phillip
- Andy Robertson
- Dr. Ward Wilson

MEMPR and Consultant    Teck and Consultants    U.B.C.    Independent
Presentation Outline

- Project Background
- Gas Trap and Convective Flux Measurements
- Premature Snowmelt Area Characterization
- Convective Flux and Gas Composition Changes
- Conclusions
Sullivan Mine Incident

http://www.mediaroom.gov.bc.ca/sullivan_mine/sullivan_mine.htm
Premature Snowmelt Areas (PSAs)
PSAs and Vents

Premature Snowmelt Area

Pore Gas Vents
Surface Pore Gas Vent Survey

- Understand magnitude of pore gas venting
- Gas Traps placed on surface of dumps
  - Jan 2009 (18 – North, South & No. 1 Dumps)
  - Feb 2009 (20 – No. 1 Dump)
  - April 2009 (20 – No. 1 Dump)
- 4 Gas Trap Classes
  - Control
  - Normal
  - Biased
  - Uber-biased
Gas Trap Assumptions & Design

- Gas trap acts as a Continuously Stirred Tank Reactor.
- The initial gas composition measured is the composition of the pore gas entering the gas trap over the test period.
Gas Flux Test Results

- **Oxygen**
- **Carbon Dioxide**

![Graph showing gas composition over time](image)
Flux Results at Toe
Flux at Crest

Likely lower than expected due to spring cover conditions
Spring Cover Conditions – 5 cm

Volumetric Water Content

Soil Temperature
Gas Flux Bag Tests
CSTR vs. Bag Test Flux Results

- **O2 Flux**
- **CO2 Flux**
- **Bag Test**

**S24 Gas Flux (L/m)** vs. **Event**
PSA Characterization

Excavation Locations
PSA Characterization Effort

- **Excavations to waste rock**
- **Temperature**
- **Moisture Content**
- **PSD**
- **Density**
- **Thickness**
Soil Temperature

Temperature (°C)

Depth (cm)

PSA

Non-PSA

Minimum

Average

Maximum
Particle Size Distribution

PSA
Non-PSA
Moisture

- Little difference in moisture content between PSA and non-PSA
- Difference existed between locations on a flat surface (greater moisture content) and those on a slope
Cover Thickness

- Convective vents located in thin cover areas
- 0.3 m
- 0.4 m
- 0.75 m
- Cover material added to 1 m design
Gas Test Flux Results

Oxygen

Pre-Cover Addition

Post-Cover Addition

Carbon Dioxide

S24 Gas Composition (%)

Time (h:mm)

0:00 0:28 0:57 1:26 1:55 2:24 2:52 3:21
Additional Cover Flux Change
BH-3B Gas Composition Pattern

Oxygen composition normally elevated fall to spring.
BH-3B Gas Composition

Oxygen composition has dropped fall 2009.
Oxygen composition normally elevated fall to spring.
Oxygen composition has dropped fall 2009.
Oxygen composition normally elevated fall to spring.
Oxygen composition has dropped fall 2009.
Oxygen reduction site-wide
Conclusions

- Gas traps have been useful tool to measure convective flux
- Measurement of convective flux at both toe and crest have provided an additional confirmation of air flow system
- Waste rock likely has greatest link to PSAs
- Vents linked to thin cover
- Cover construction quality control is important, but sites surveys and observations are helpful
Conclusions

- **Additional cover has reduced pore gas flux by an order of magnitude**
- **Effect of the additional cover appears to nearly site wide**
- **No conclusions on long-term cover performance with respect to air flow**