A GEOCHEMICAL AND HYDROLOGIC ASSESSMENT OF COAL MINE DRAINAGE IN GLACIATED EASTERN OHIO

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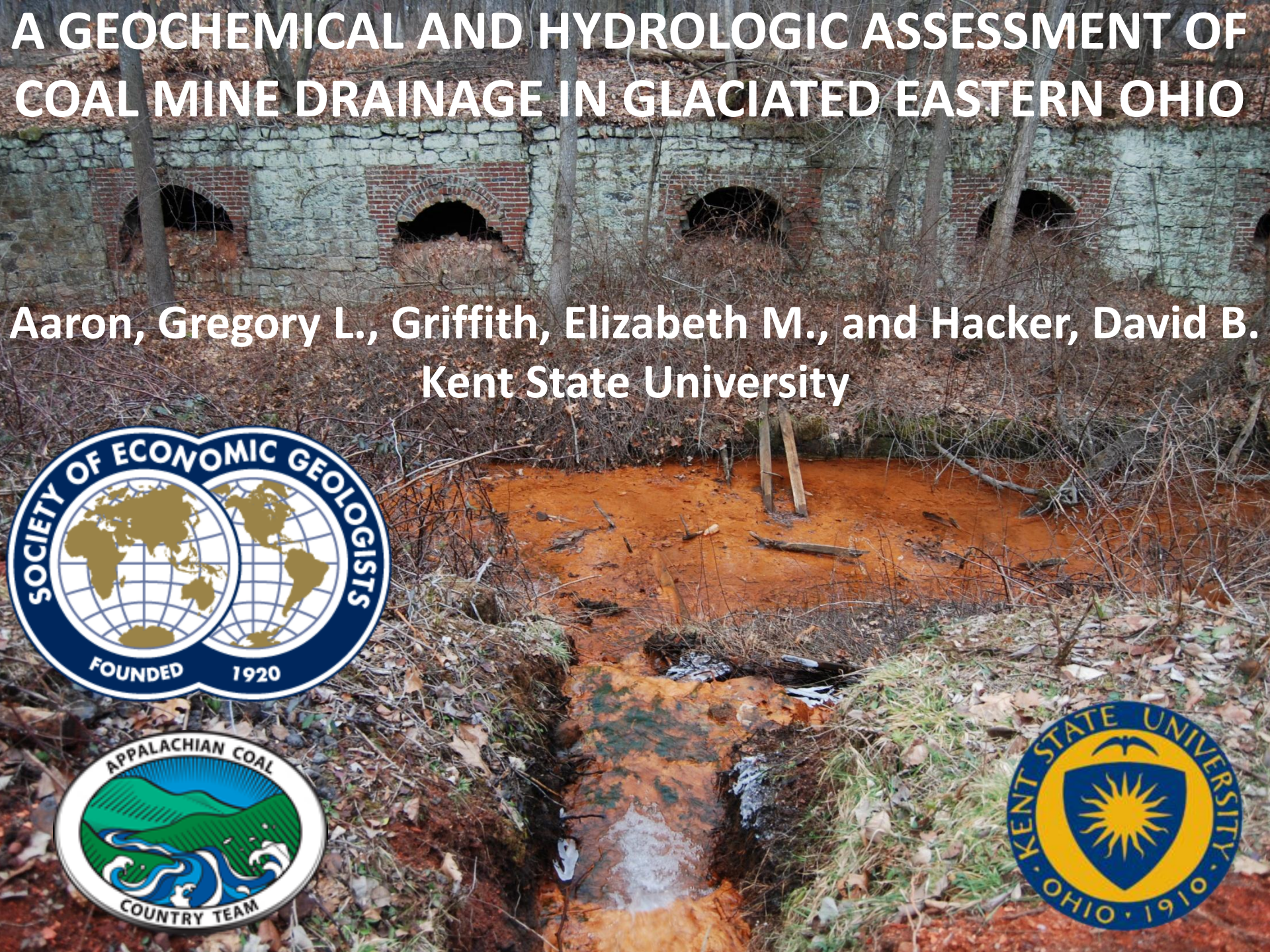
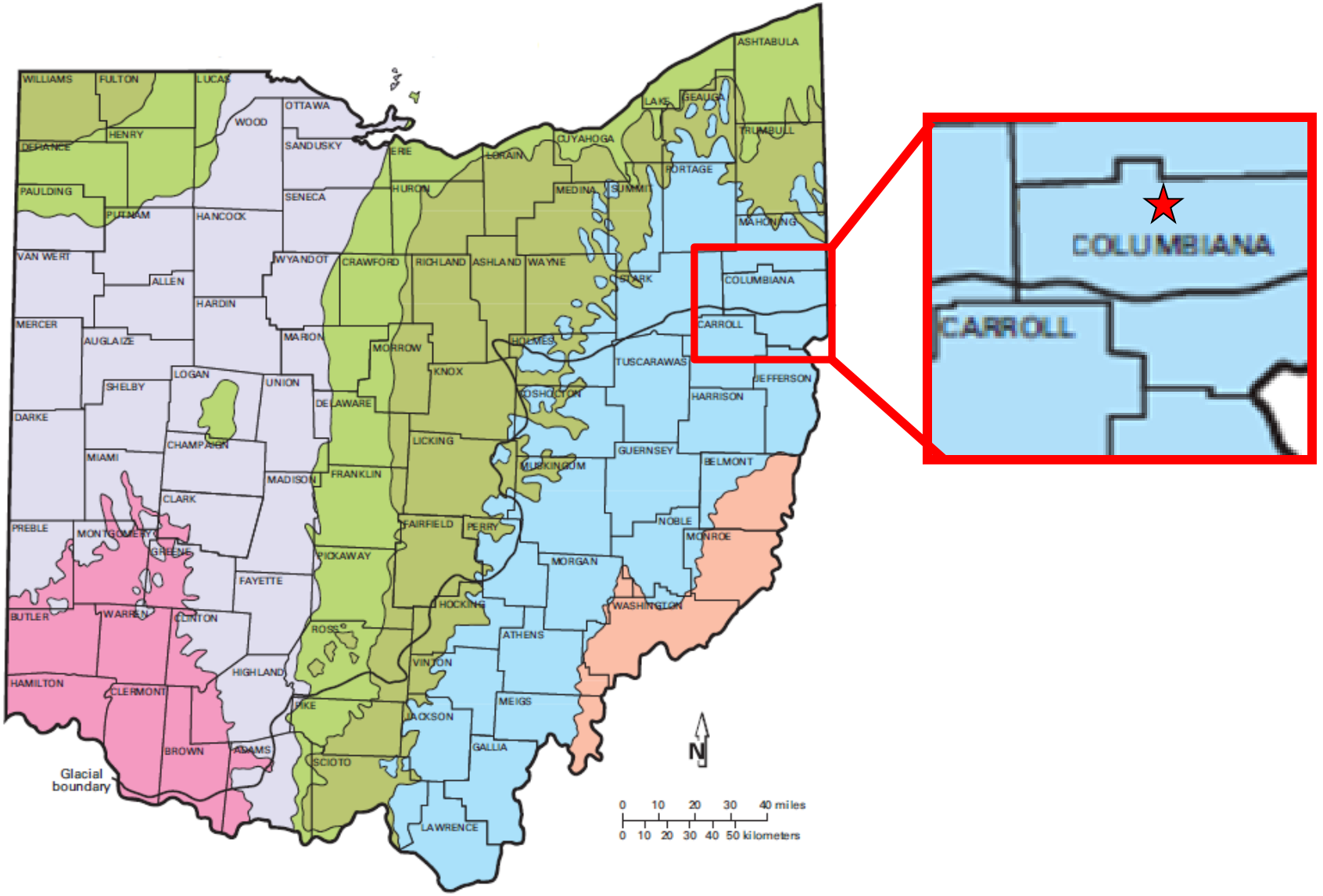
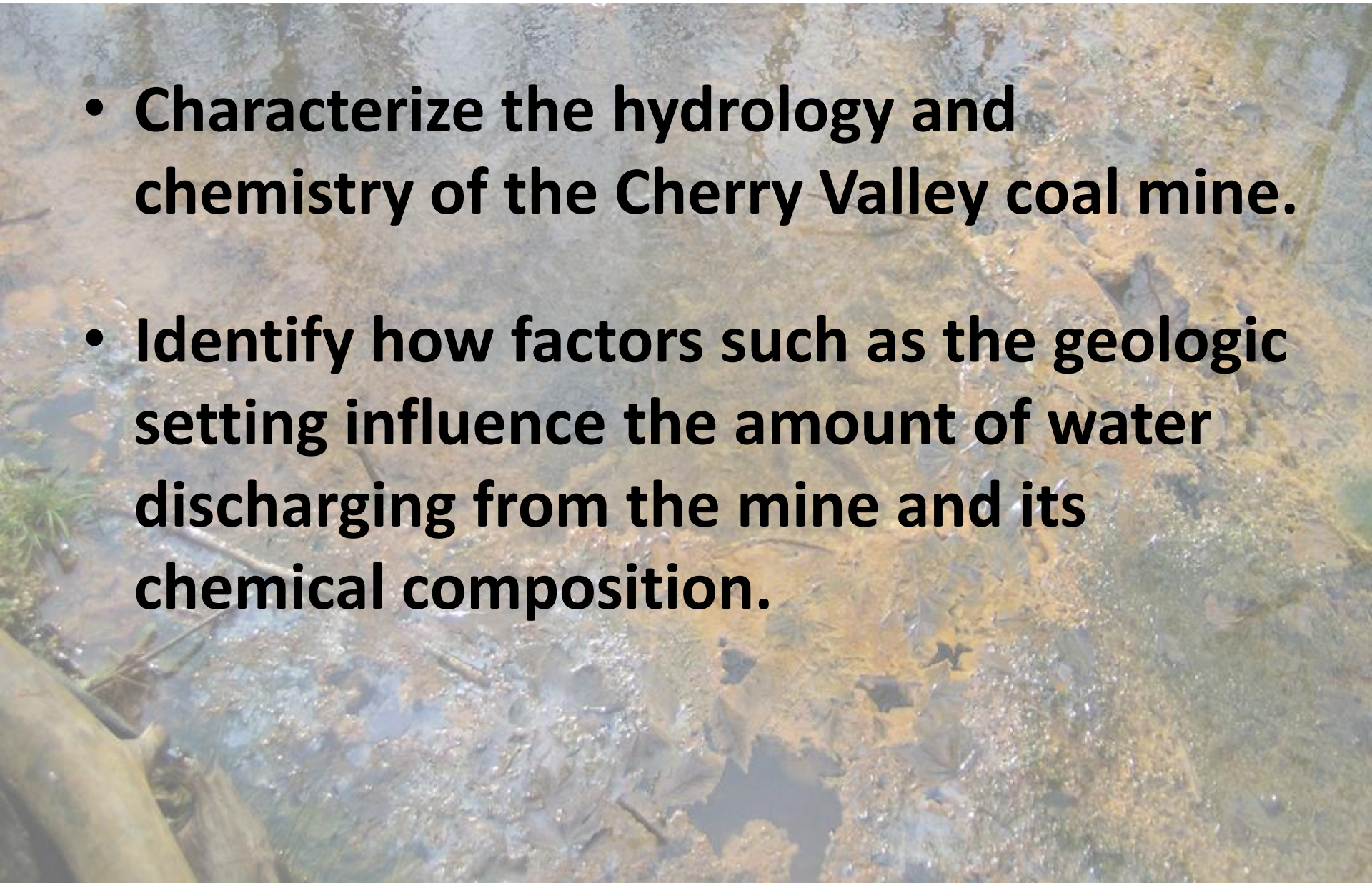


Cherry Valley Coke Ovens
Village of Leetonia, OH



Purpose of the Study



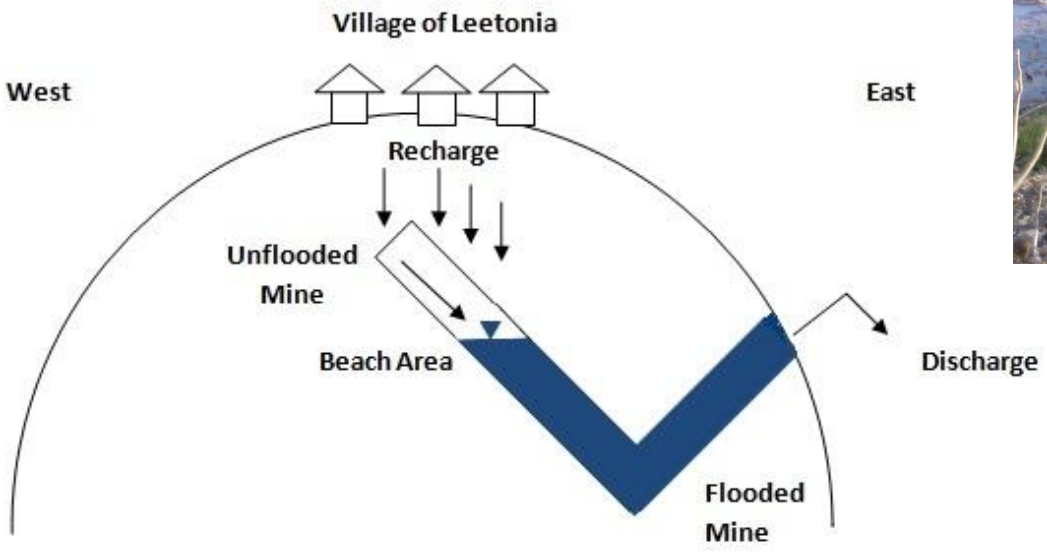
- Characterize the hydrology and chemistry of the Cherry Valley coal mine.
- Identify how factors such as the geologic setting influence the amount of water discharging from the mine and its chemical composition.

Characterizing the Sites

- **Hydrologic Characterization**
  - **Flow rate of discharge**
  - **Conservative tracer (Chloride)**
- **Chemical Characterization**
  - **In situ and lab measurements**
- **Measurements and water samples were taken every two weeks from May 2011 to May 2012.**

Site Description

- **Middle Kittanning Coal Seam**
  - **Mined 1870 through 1905**
  - **Slope entry, water pumped out**
  - **~48 meter thick overburden (max)**
  - **Shale and Sandstone w/ Till Cap**
- **Water has been discharging from the mine entry since at least the 1950's.**



Abandoned Mine Map Overlay with LIDAR Hillshade

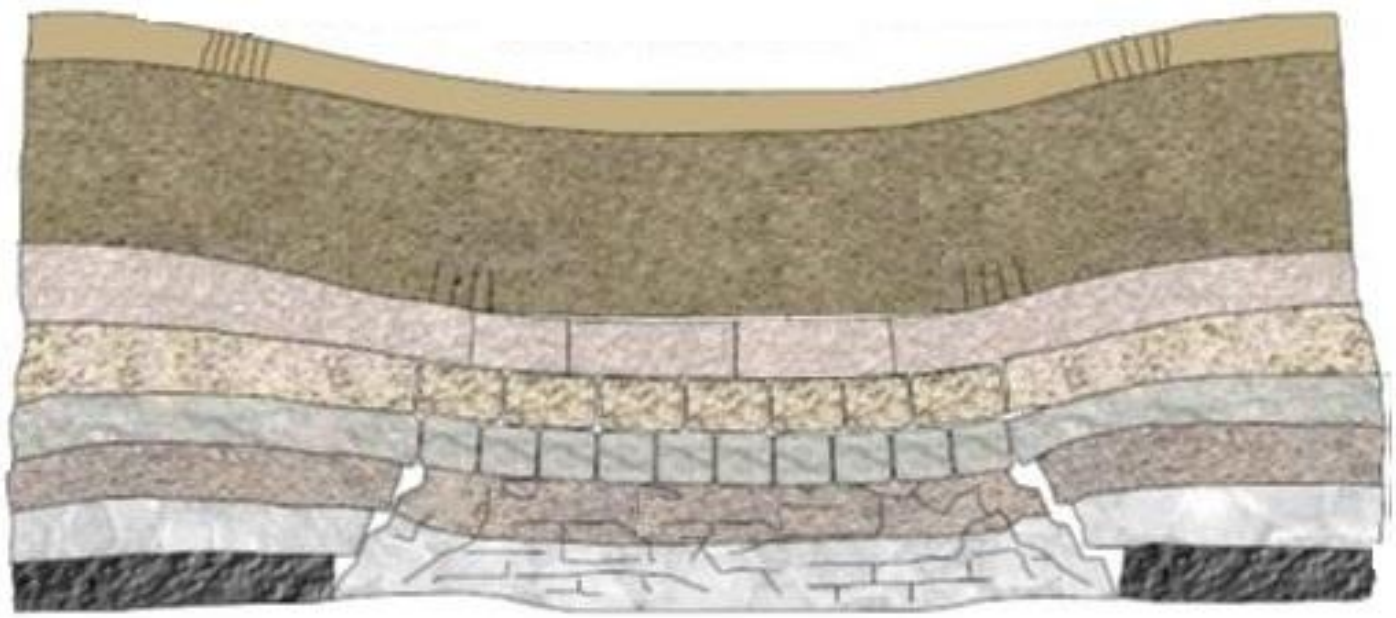
0 40 80 160 Meters

N

Google Image from April 2012

Hypotheses Tested

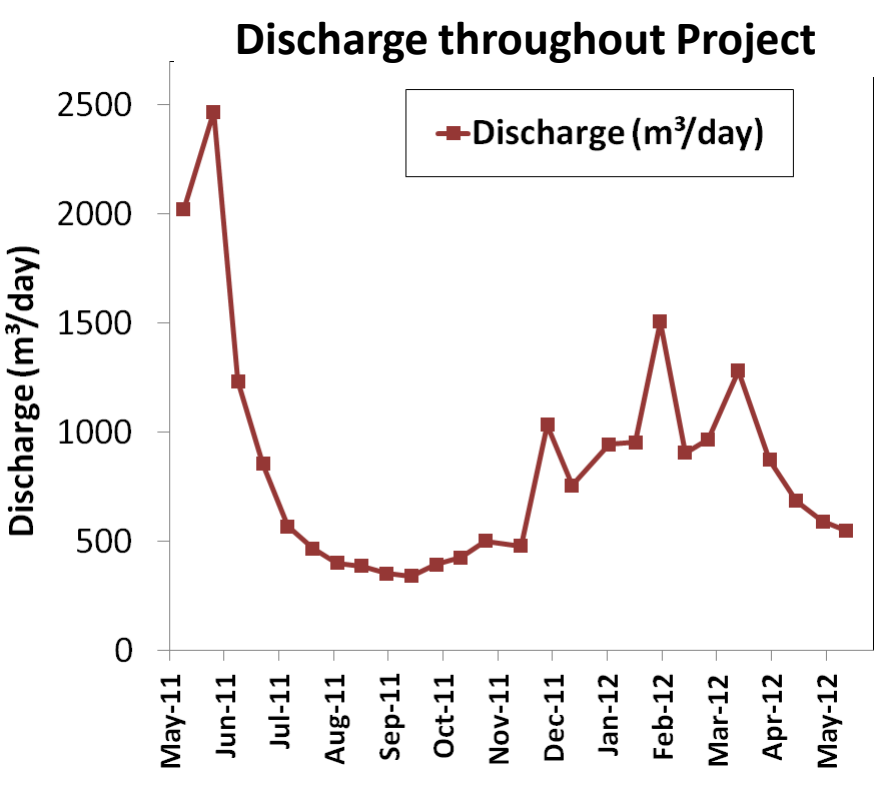
Subsidence fractures provide a pathway for recharge into the mine from the surface and shallow subsurface.

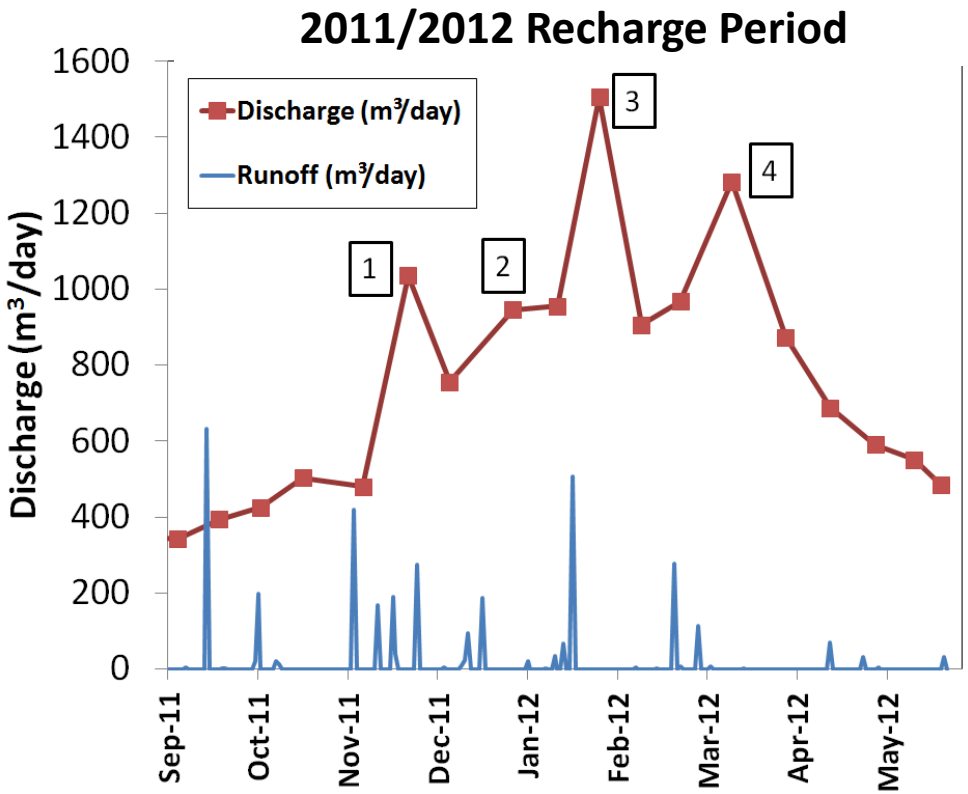


Fractured Zone (10-24x Mined Thickness)

Hydrograph Analysis

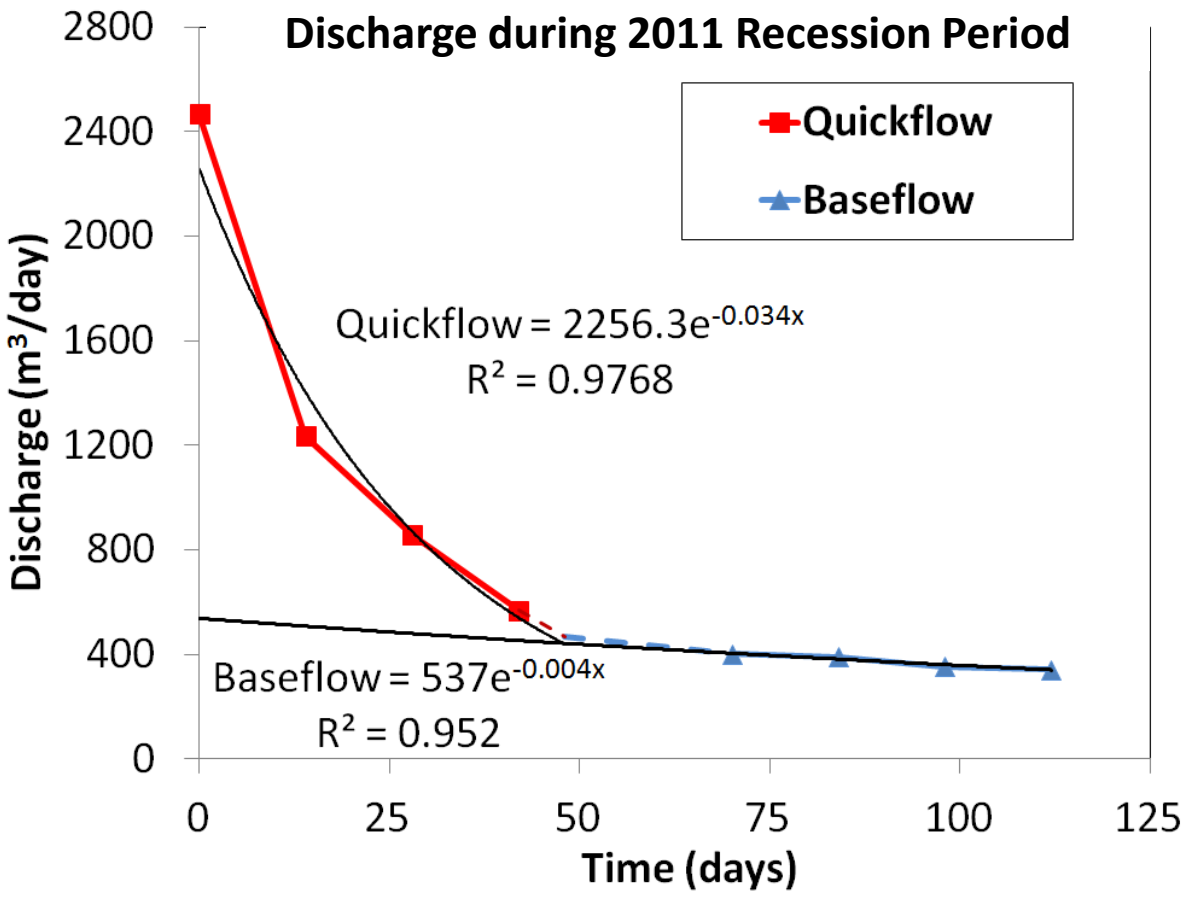
- Recession started in late May in 2011 but late March in 2012.
- Peak discharge in 2011 = 2468 m^3/day
  - March, April, and May precipitation: 44.7cm
- Peak discharge in 2012 = 1506 m^3/day
  - March, April, and May precipitation: 17.7cm
- Four distinct quickflow events during the 2012 recharge period.





Hydrograph Analysis

- Separation of the quickflow and baseflow using a method for developed for karst springs.
- Applied to the recession period of 2011 (112 days from May 28th through September 17th)
- Analysis showed:
  - 80% Baseflow
  - 20% Quickflow

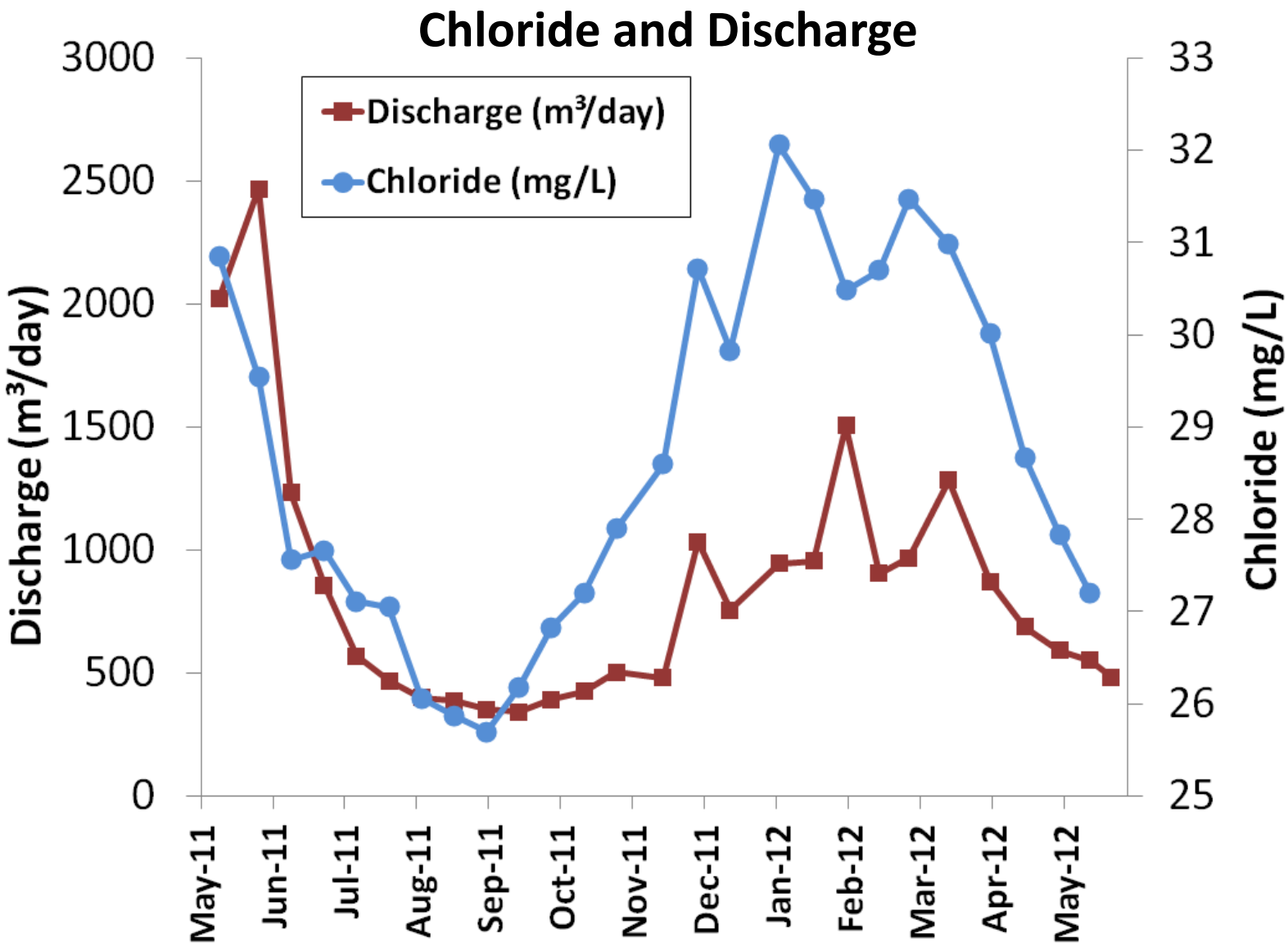


Chloride Analysis

- Shallow groundwater is contaminated by road salt
- Simple mixing results:
  - Discharge: 46% Shallow, 54% Deep
  - Main Entry: 97% Shallow, 3% Deep
  - Mine Drain: 64% Shallow, 36% Deep

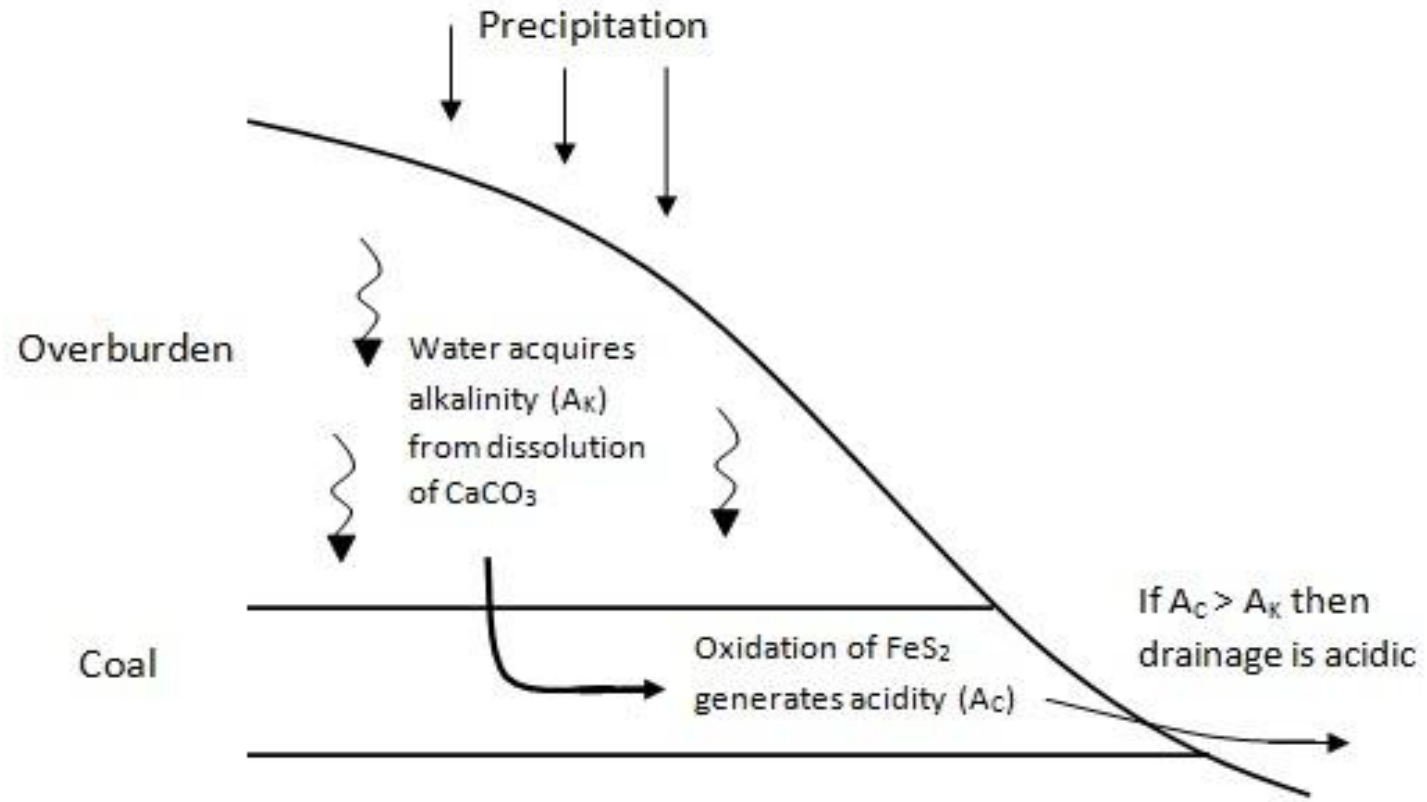
Chloride concentrations of the mine discharge and wells					
	Mixing Components		Mixing Result		
Location	Shallow	Deeper	Discharge	Main Entry	Drain
Chloride (mg/L)	56.2	5.8	32.8	54.6	38.5

Chloride Analysis



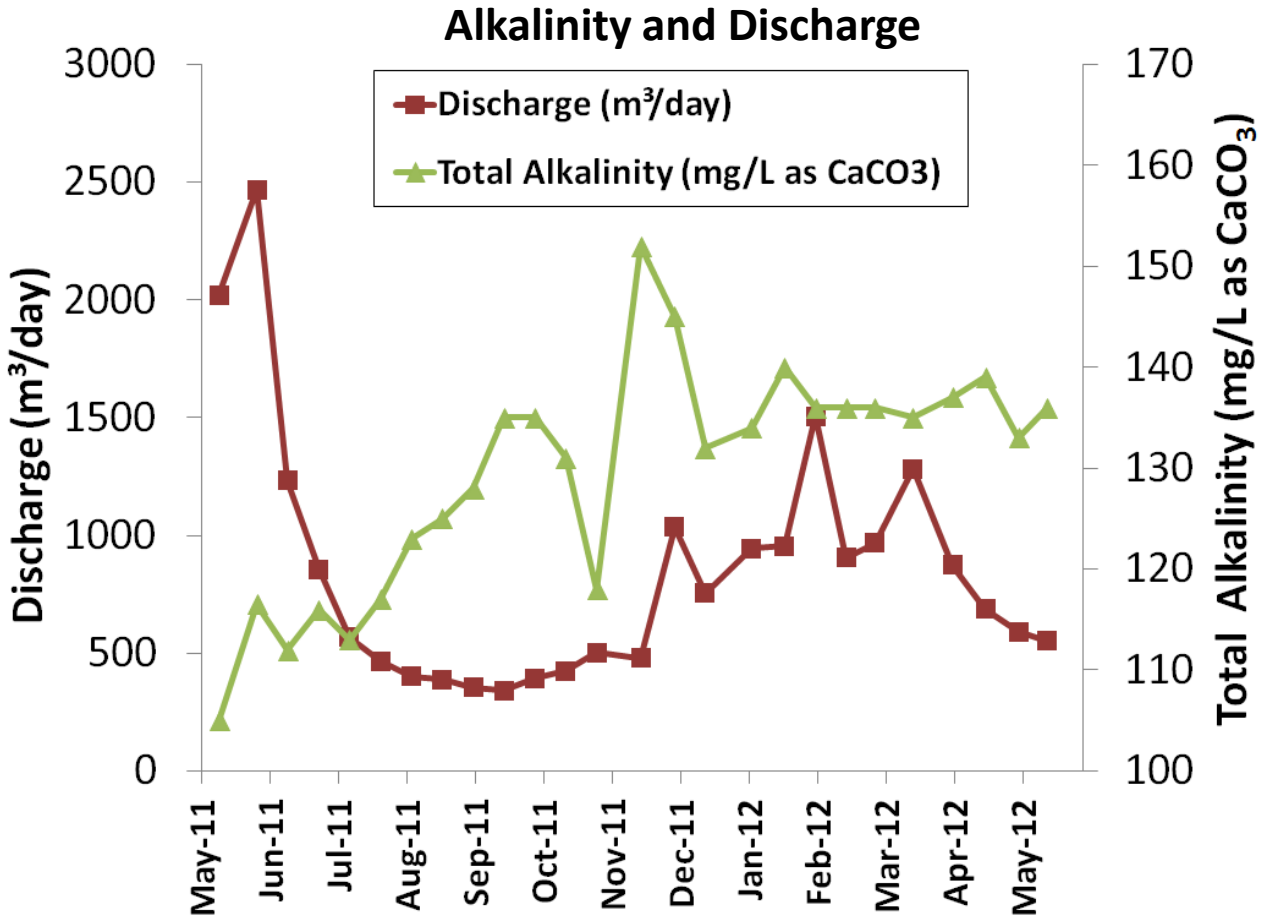
Hypotheses Tested

The surface sediment in glacial deposits provide sufficient alkalinity to naturally buffer the acidity produced by oxidation reactions within the mine.



pH and Alkalinity

- Circumneutral pH (6.20 to 6.68), Alkalinity > 100 mg/L as $CaCO_3$
- Glacial Till = 208 mg/L alkalinity as $CaCO_3$
- Main Entry = 115 mg/L alkalinity as $CaCO_3$

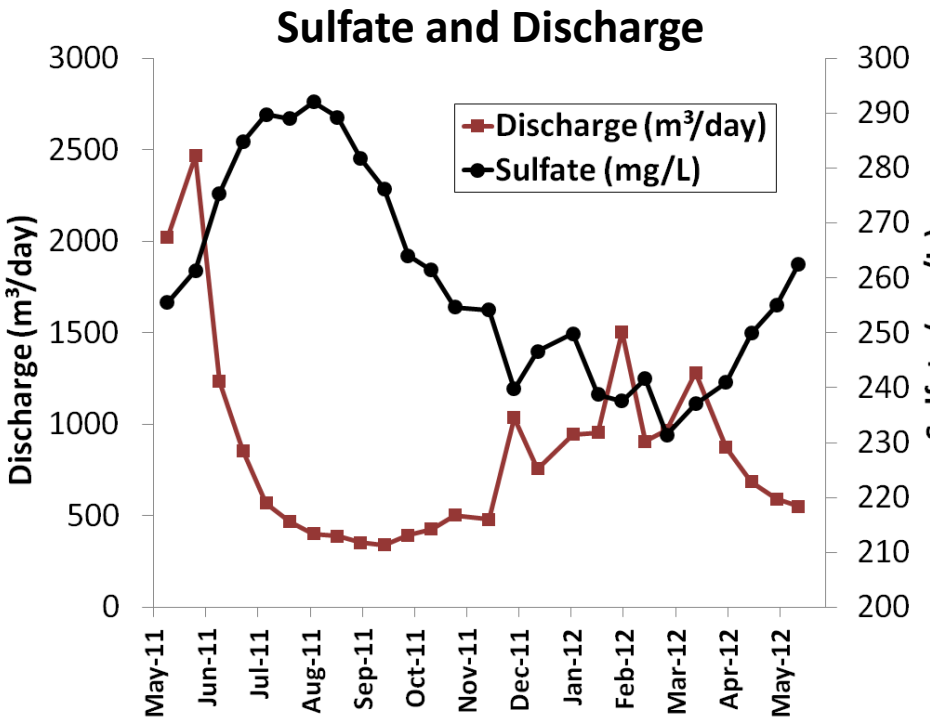


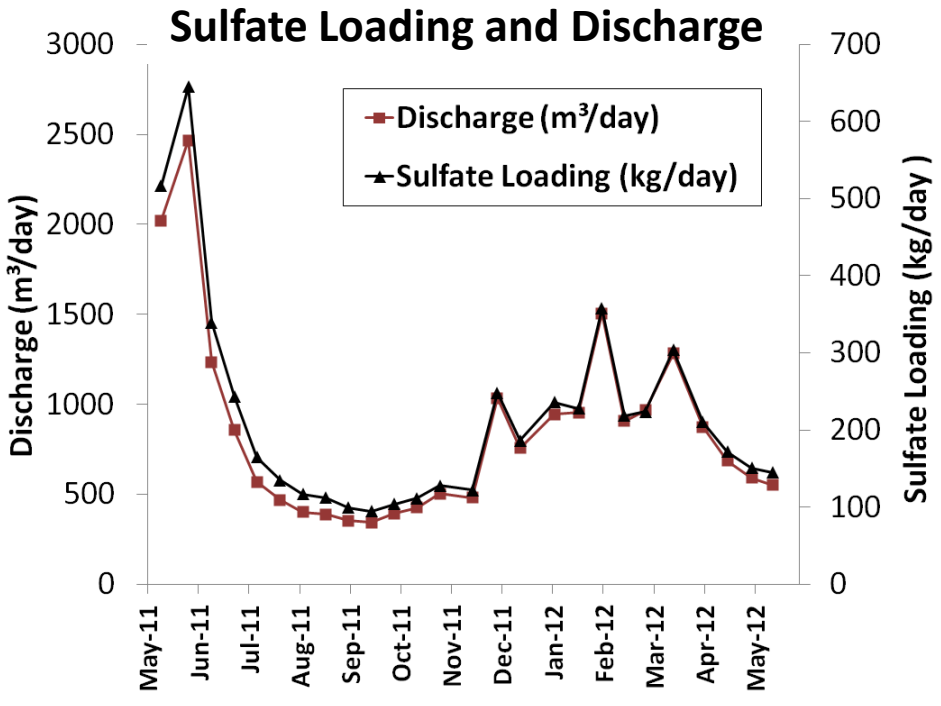
Hypotheses Tested

The magnitude of the discharge rather than changes in concentration controls the loading of dissolved species throughout the year.

Sulfate

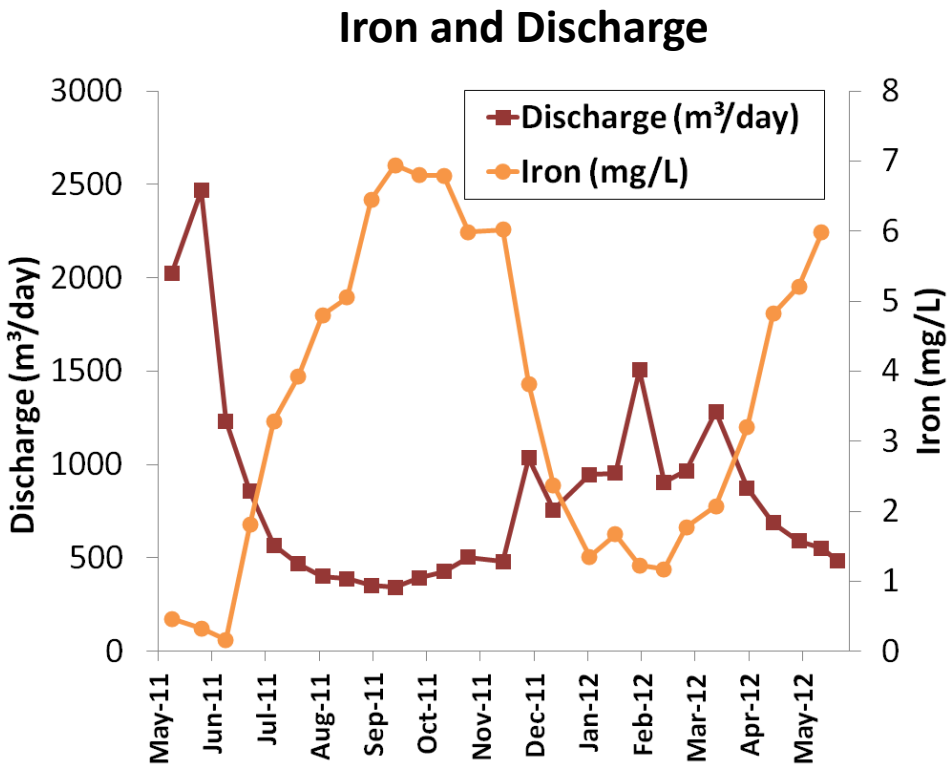
- Sulfate concentrations vary from 231 to 292 mg/L
- Sulfate increases during recession due to:
  - End of dilution effect
  - Longer residence time
  - Flushing effect
- Sulfate loading is controlled by discharge.

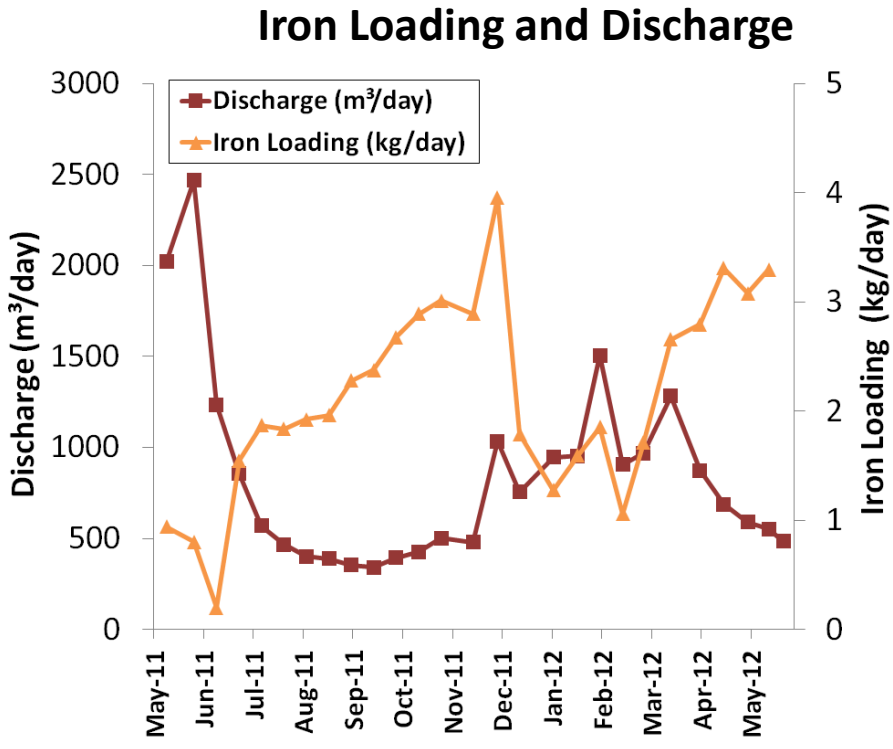




Iron

- Iron concentrations vary from 0.2 to 6.9 mg/L
- Factors limiting the amount of dissolved iron:
  - High pH – Low ferric iron (Fe^{+3}) solubility
  - High Alkalinity – Precipitation of siderite ($FeCO_3$) inside the mine
- Iron loading is controlled by concentration





Conclusions

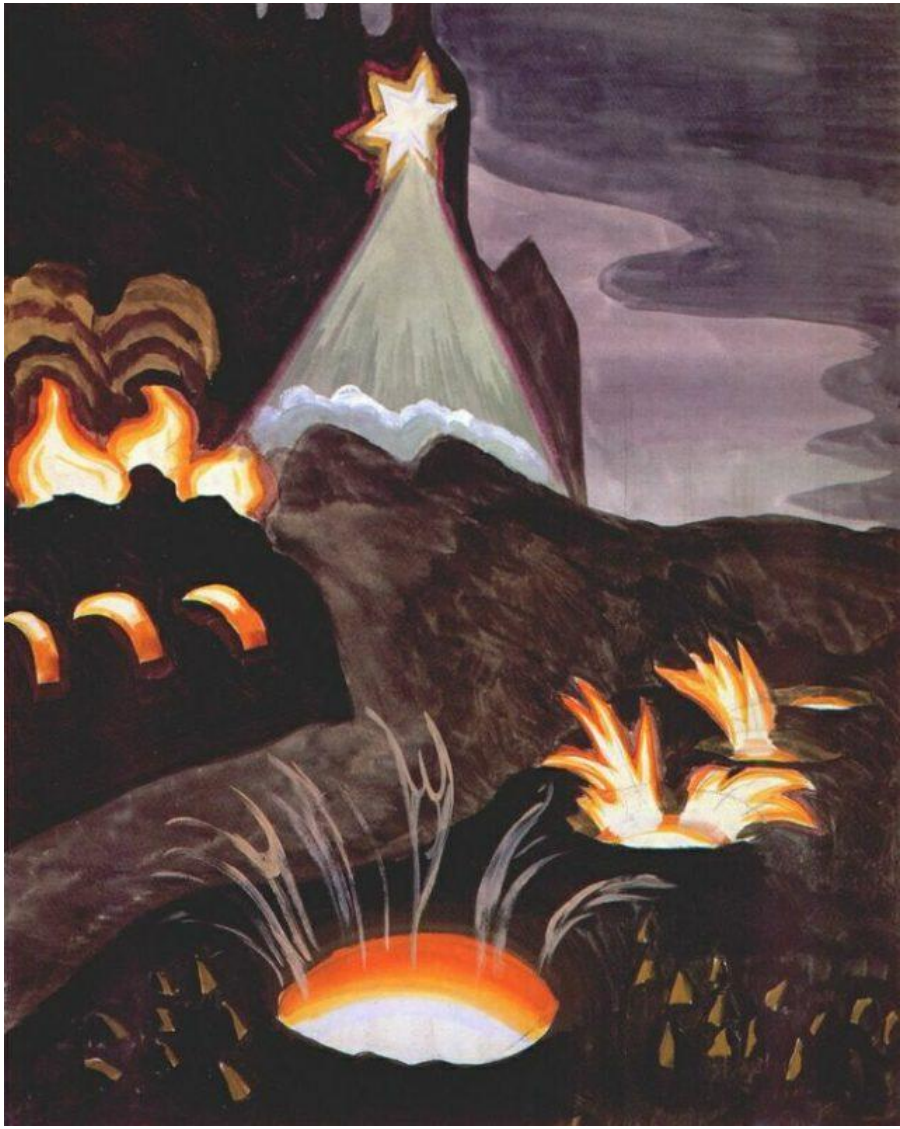
- Fractures bring water from the glacial till to the mine.
- The alkalinity from the glacial till is sufficient to buffer the acidity produced in the mine.
- The discharge rather than concentration controls the loading for all dissolved species except iron.

Acknowledgements

- Thank you to every who made this study possible:
  - My adviser, Dr. Elizabeth Griffith
  - Thesis Committee Members: Dr. David Hacker and Dr. Donald Palmer
  - Everyone at Kent who assisted me:
    - Nick Bonini, Inoka Hasanthi Widanagamage, John Holsinger, Evaline Johnson, and Timothy Eyerdom who went on sampling trips.
    - Merida Keatts provided technical support.
    - Michael Glassmeyer provided the LIDAR data.
  - Ohio Department of Natural Resources
    - Tamara Richards, ODNR Hydrologist
  - Appalachian Coal Country Team
  - Little Beaver Creek Land Foundation
    - Lisa Butch
  - The Village of Leetonia
  - Funding provided by:
    - Society of Economic Geologists from the Hugh E. McKinstry Fund
    - Gamma Zeta chapter of Sigma Gamma Epsilon at Kent State University

Questions?

Coke Ovens at Twilight, 1920
Watercolor by Charles Burchfield



Star and Fires, 1920
Watercolor by Charles Burchfield