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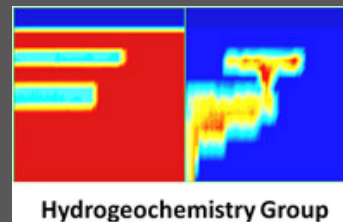


## Groundwater in Northeast British Columbia

Dirk Kirste

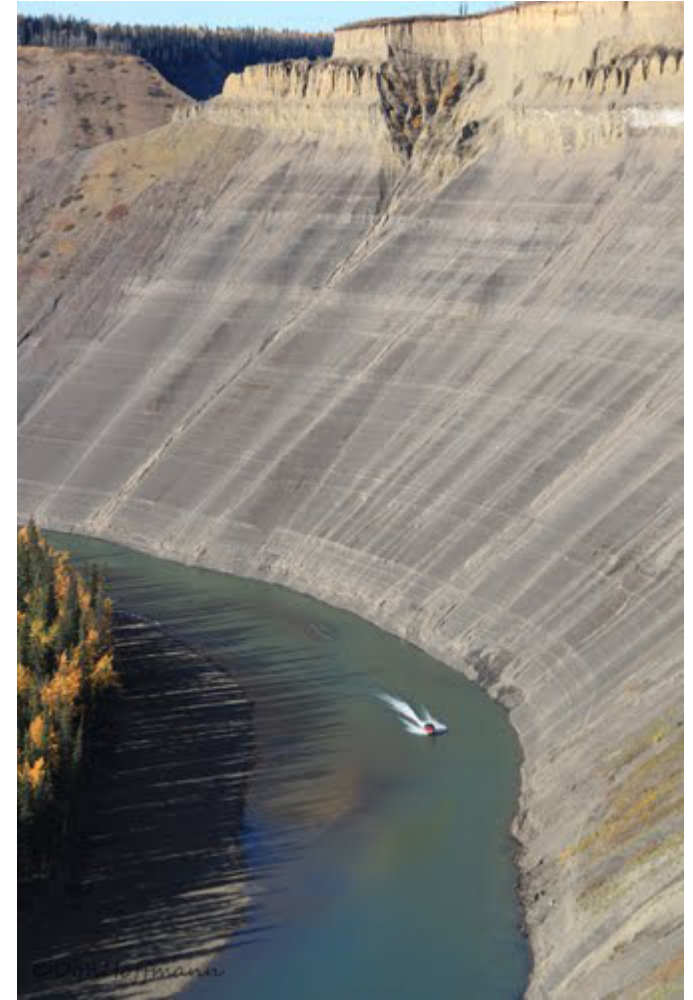
Simon Fraser University

March 7, 2018



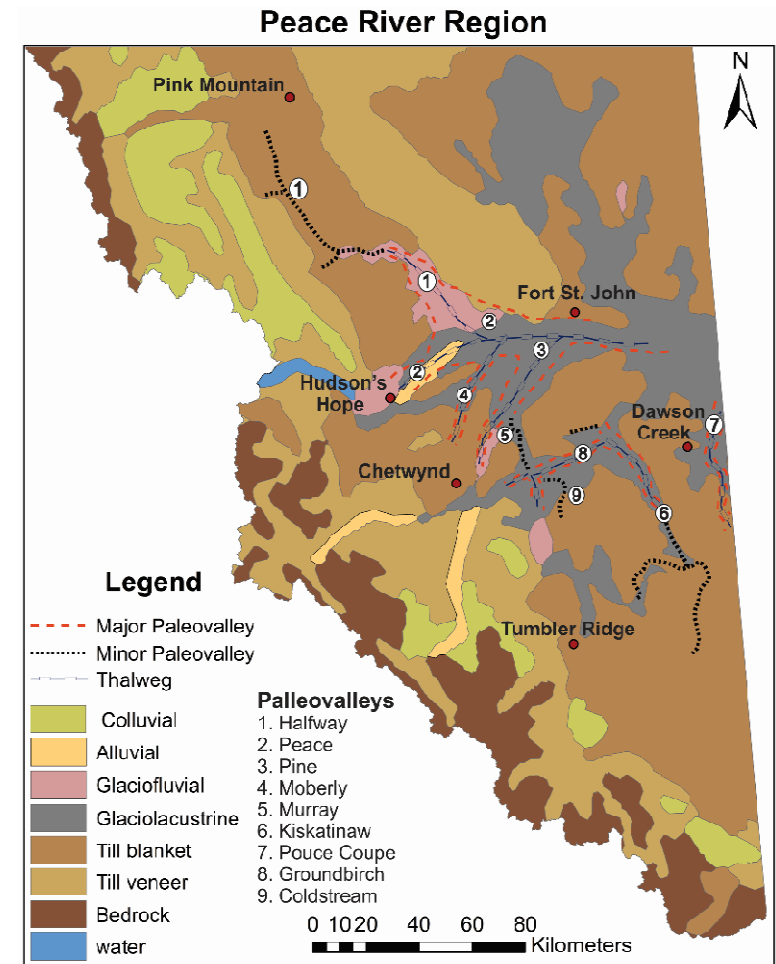
# Regional Aquifer Characterization

- **Research Goals**
  - develop a conceptual hydrogeologic model of the shallow surficial and sedimentary bedrock aquifers in the region
  - develop our understanding of the water resources and aquifer vulnerability



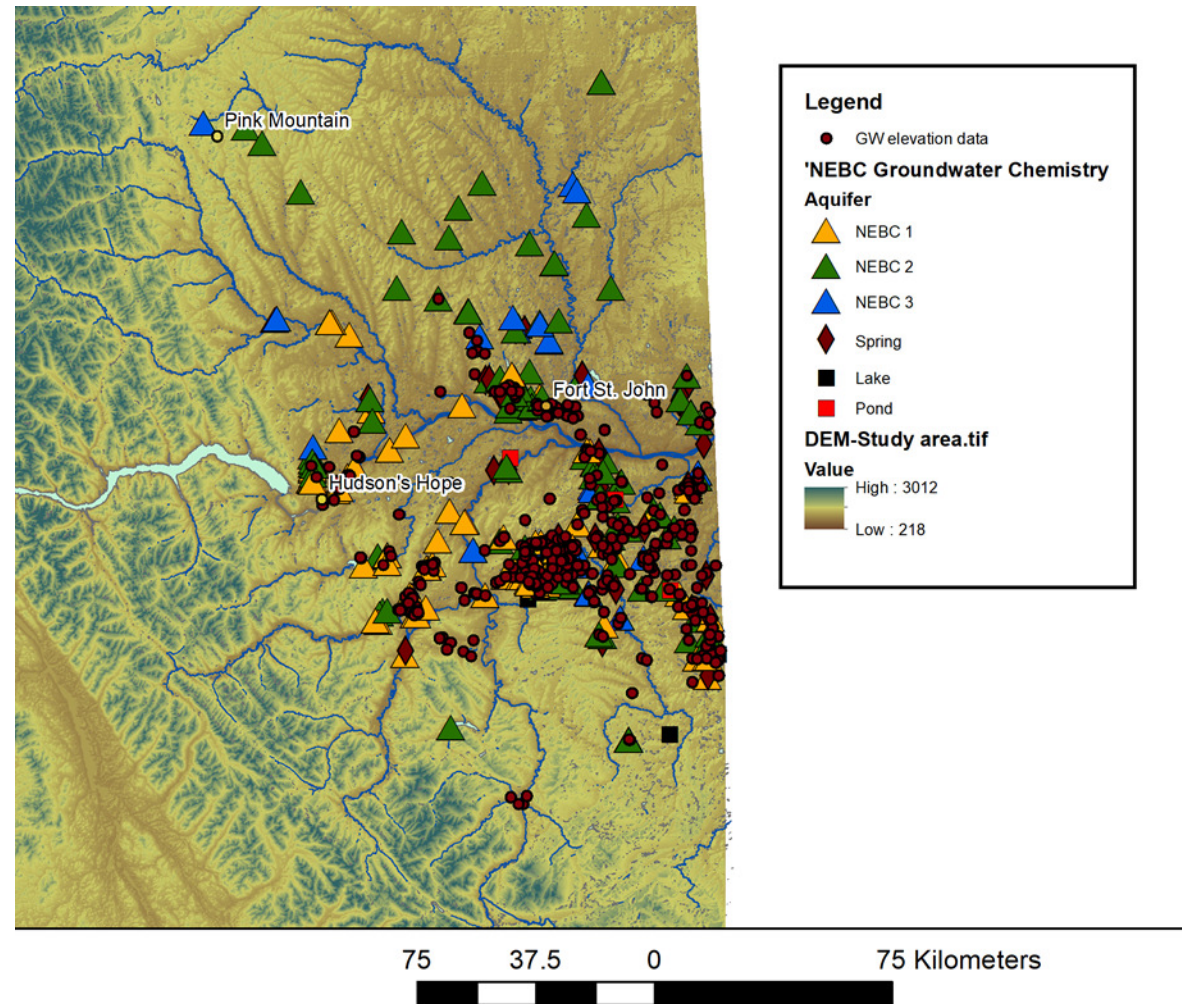
# Research Objectives

- To develop a hydrogeochemical framework for defining sediment vs. bedrock sourced groundwater
  - Physical and chemical methods
- To determine the mean residence time of groundwater sourced from sediment and bedrock aquifers
  - Quantitative and qualitative approach
  - Implications for vulnerability of groundwater



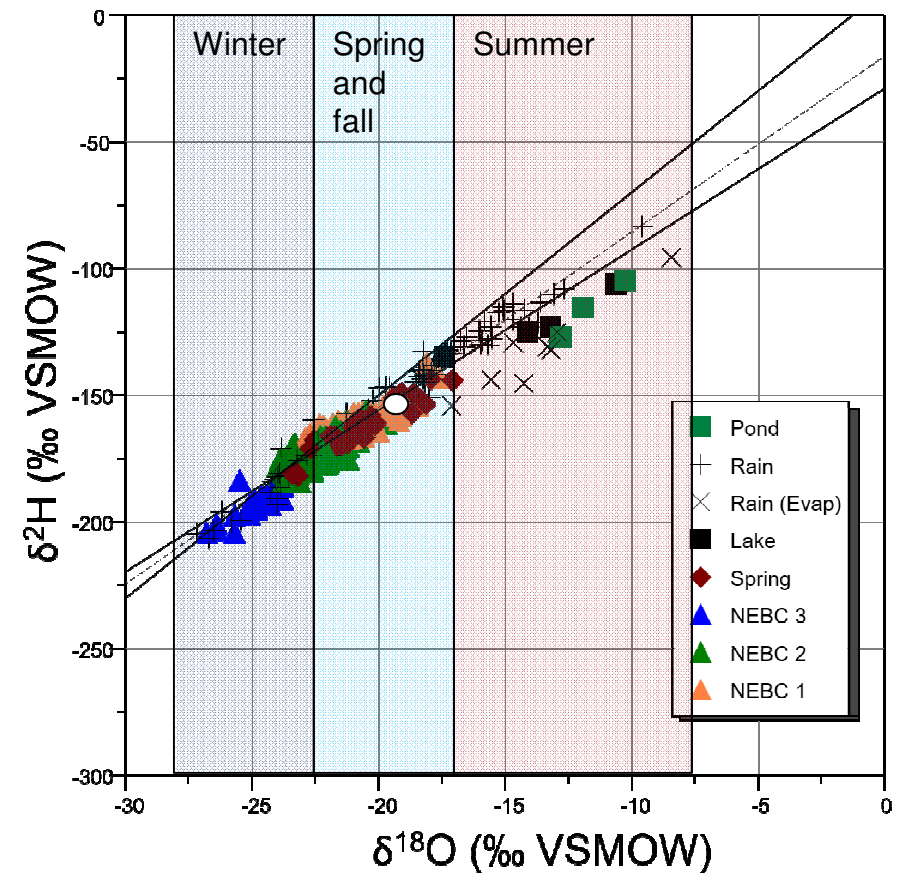
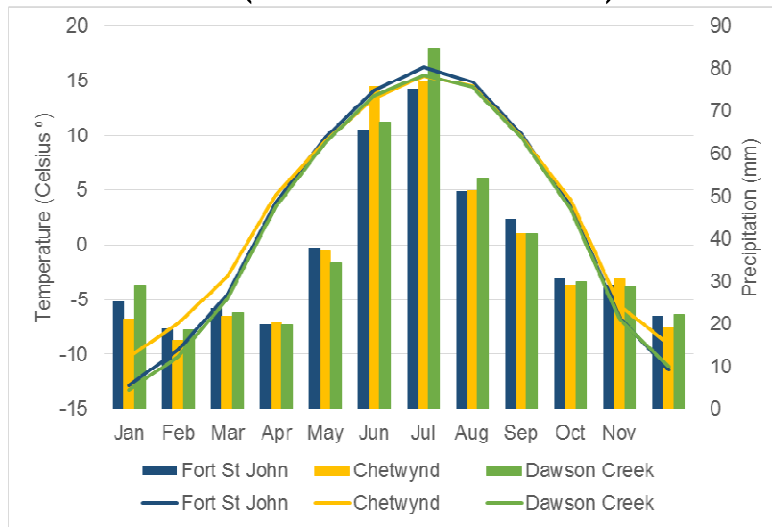
# Aquifer Characterization Using Hydrogeochemistry

- Rain and snow chemical and isotopic composition
- Groundwater chemistry data from a large area
- Many sampled from within areas defined by the existing aquifer polygons
- Most wells sampled did not have drillers logs for lithology
- 60+ dissolved components
- Stable and radioactive isotopes
- Dissolved gases
- Mineralogy, sequential extraction for trace element distribution and CEC and composition from core



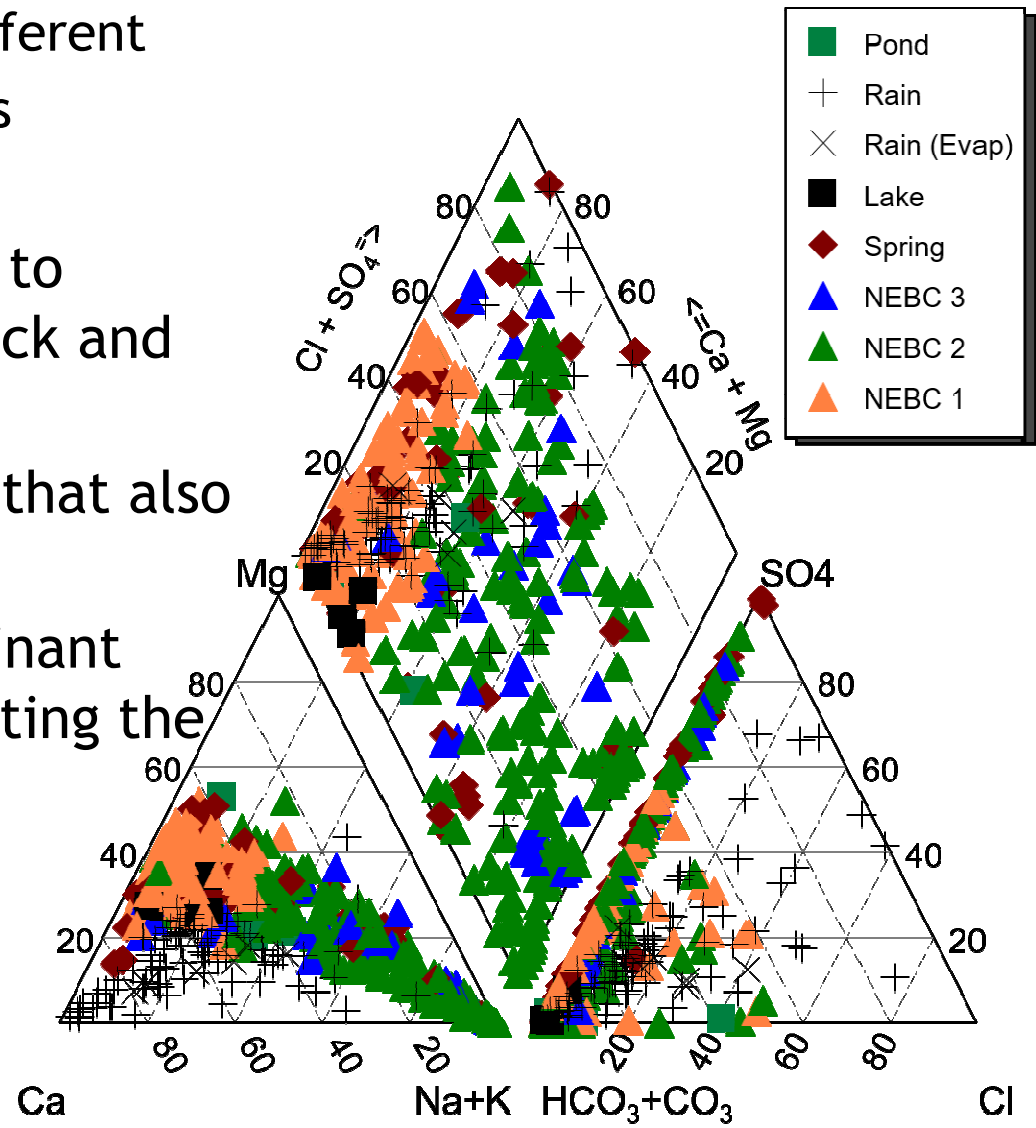
# Aquifer Recharge

- Are aquifers recharged locally?  
Year round? Recently?
  - Local recharge for sediment aquifers
  - Recharge is dominated by spring/fall precipitation
  - Some groundwater is either recharged by winter precipitation or is quite old (colder climate)



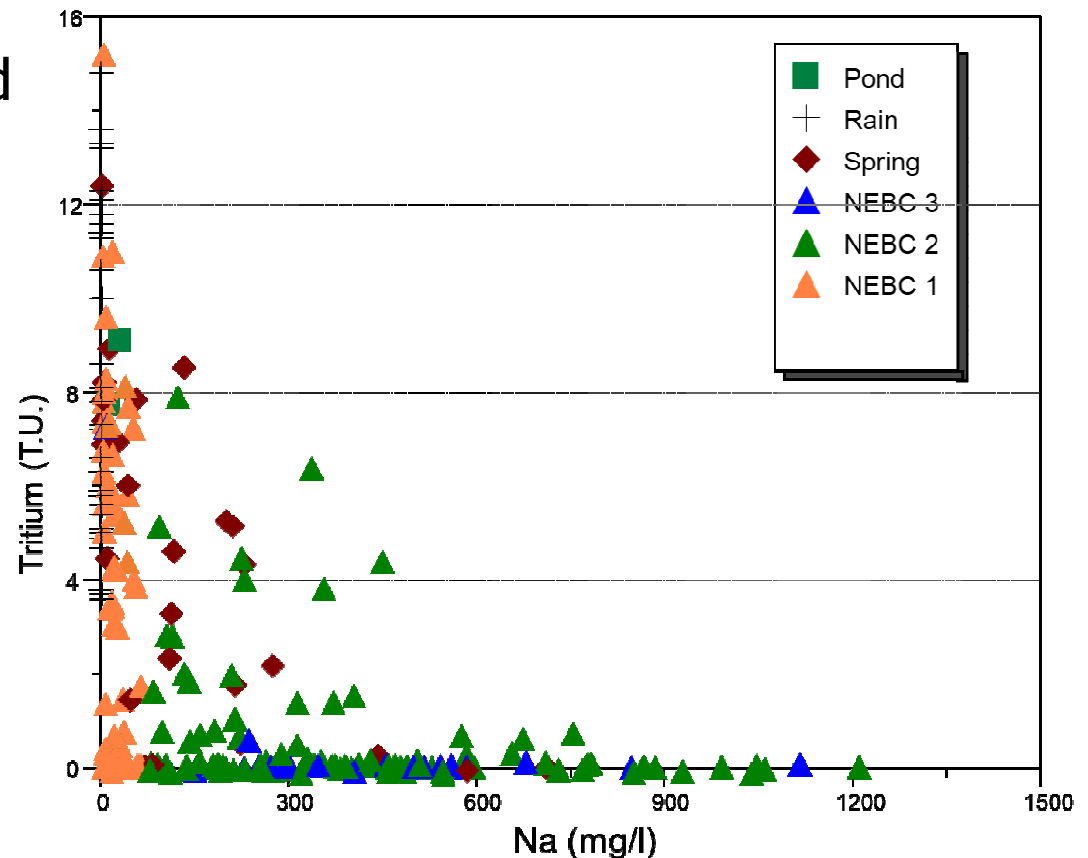
# Aquifer Characterization Using Hydrogeochemistry

- Chemistry of the groundwater sourced from the different aquifer types is different
- Major, minor and trace elements
- 388 samples analyzed
- We can use water chemistry to differentiate between bedrock and sediment
- Supported by wells sampled that also have drillers logs
- We can understand the dominant geochemical processes affecting the composition of the water



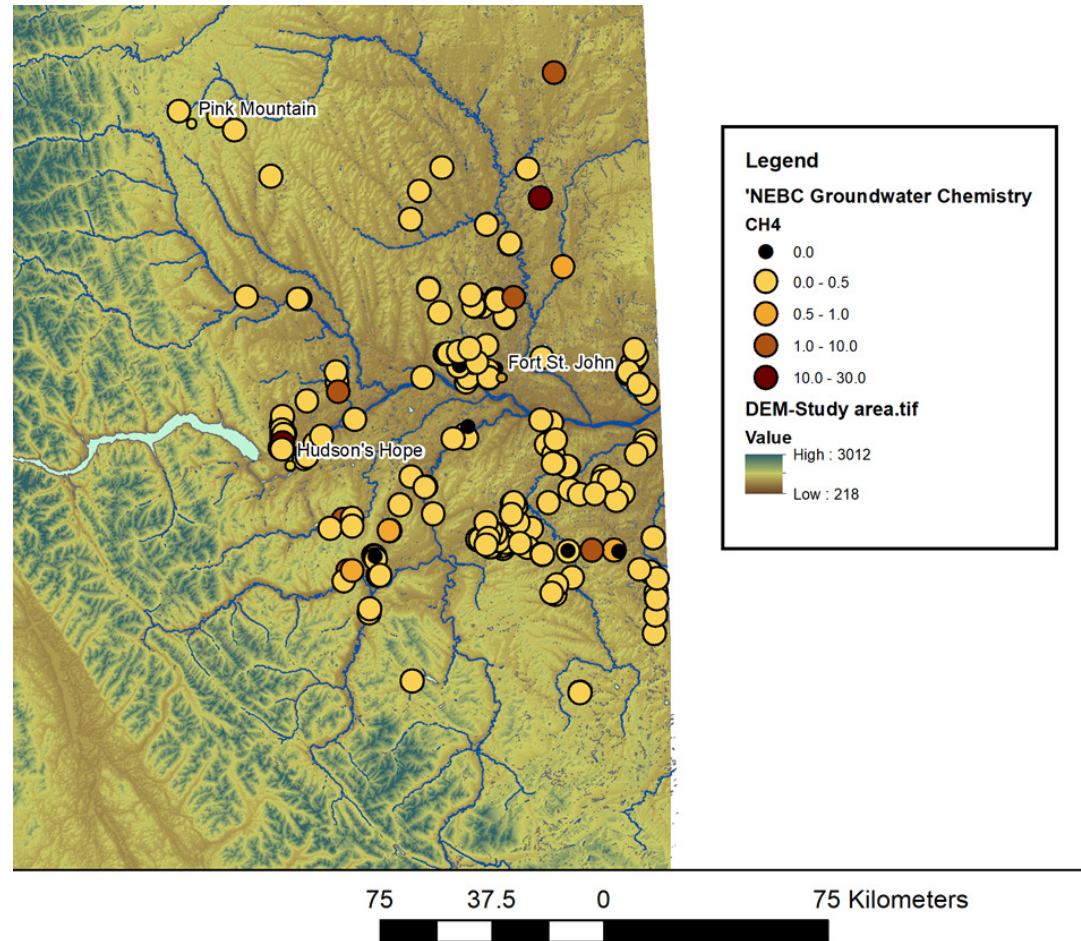
# Groundwater Age - Mean Residence Time (MRT)

- Are the groundwaters young?  
Old? Mixed?
  - Most of the groundwater in the sediment aquifers is less than 50 years old
  - Most of the groundwater in the bedrock aquifers is older than 50 years with MRT ranging from 100's to 1000's of years
  - Springs are a mix



# Dissolved Gas Samples

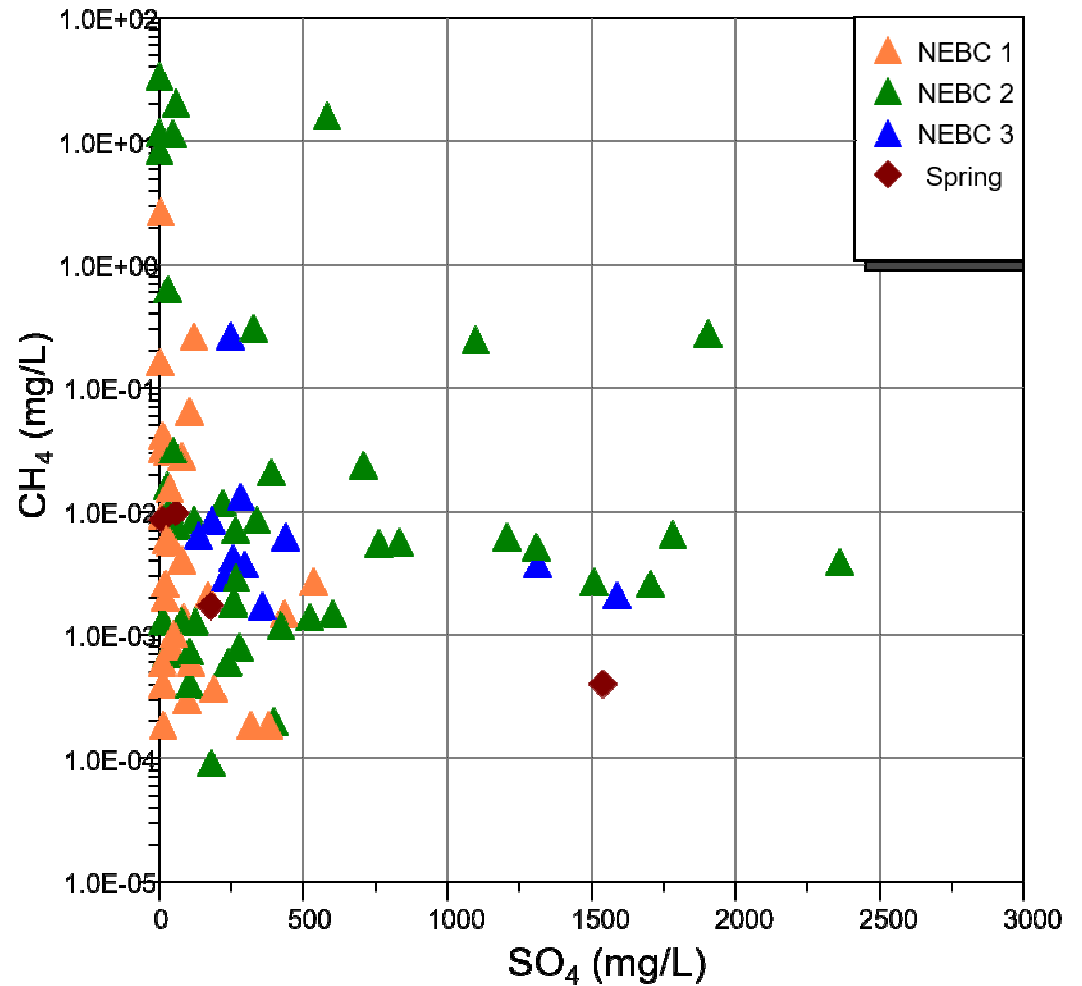
- Chemical and isotopic composition (when possible)
- CH<sub>4</sub> and CO<sub>2</sub> as well as N<sub>2</sub> and O<sub>2</sub> and higher HC's
- 256 samples - not all data for all samples





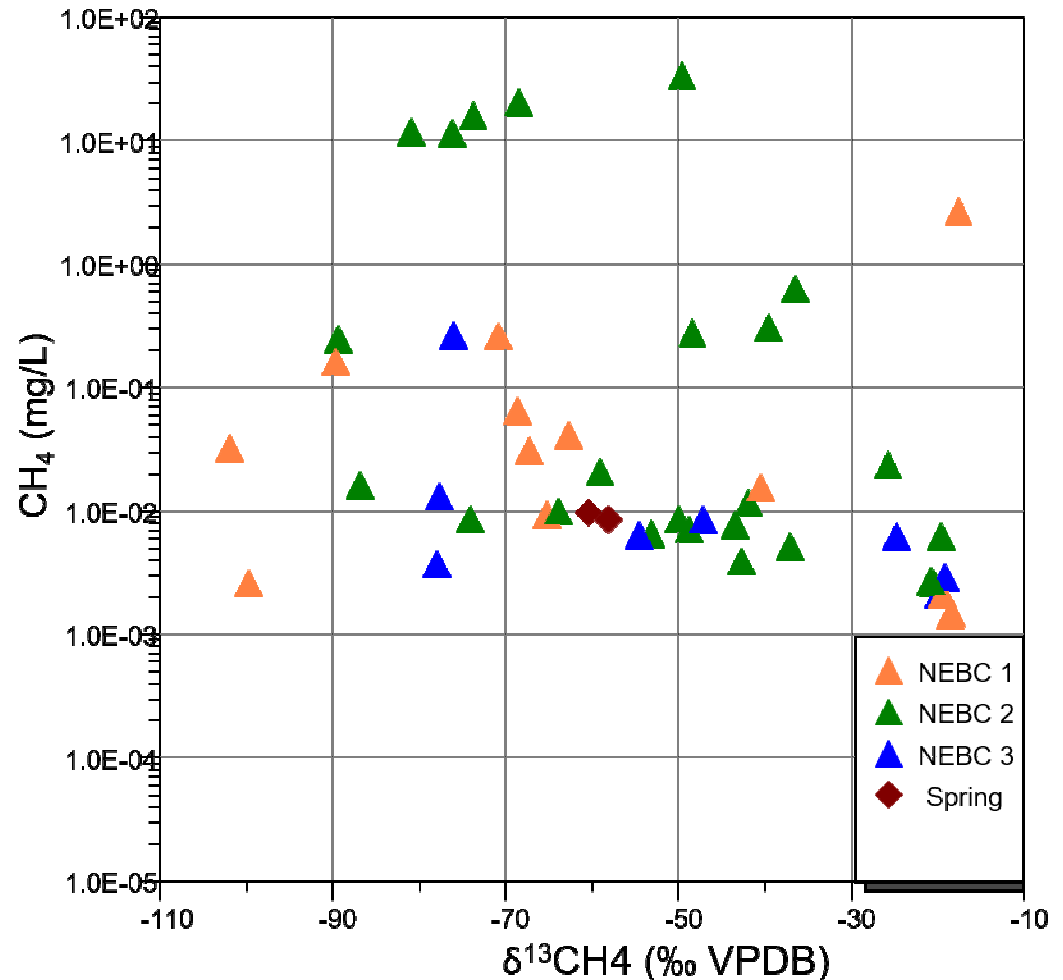
# Dissolved Gas Samples

- Wide range in CH<sub>4</sub> content
- High SO<sub>4</sub> waters tend to have low CH<sub>4</sub>
- SO<sub>4</sub>-CH<sub>4</sub> relationship suggests migrated CH<sub>4</sub>



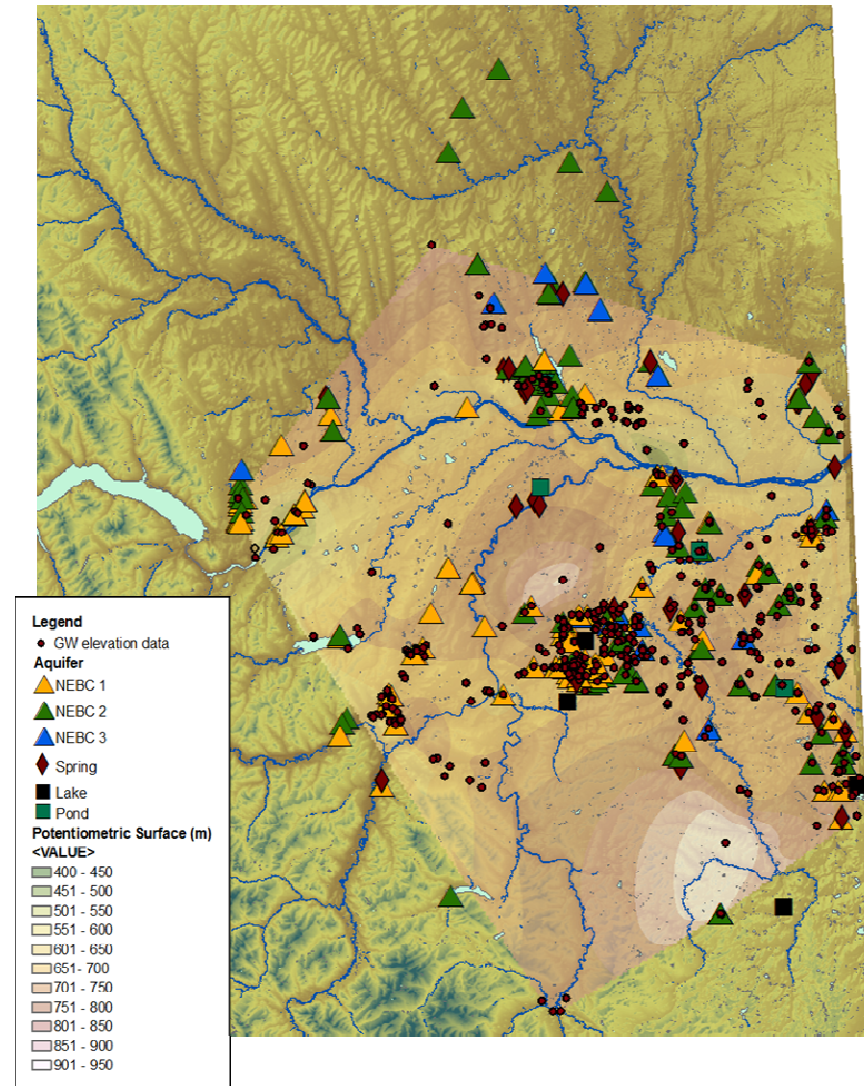
# Dissolved Gas Samples

- Most samples have biogenic origin
- Oxidation of  $\text{CH}_4$  after sampling for some samples gives enriched  $^{13}\text{C}$  composition
- Thermogenic source possible for some  $\text{CH}_4$

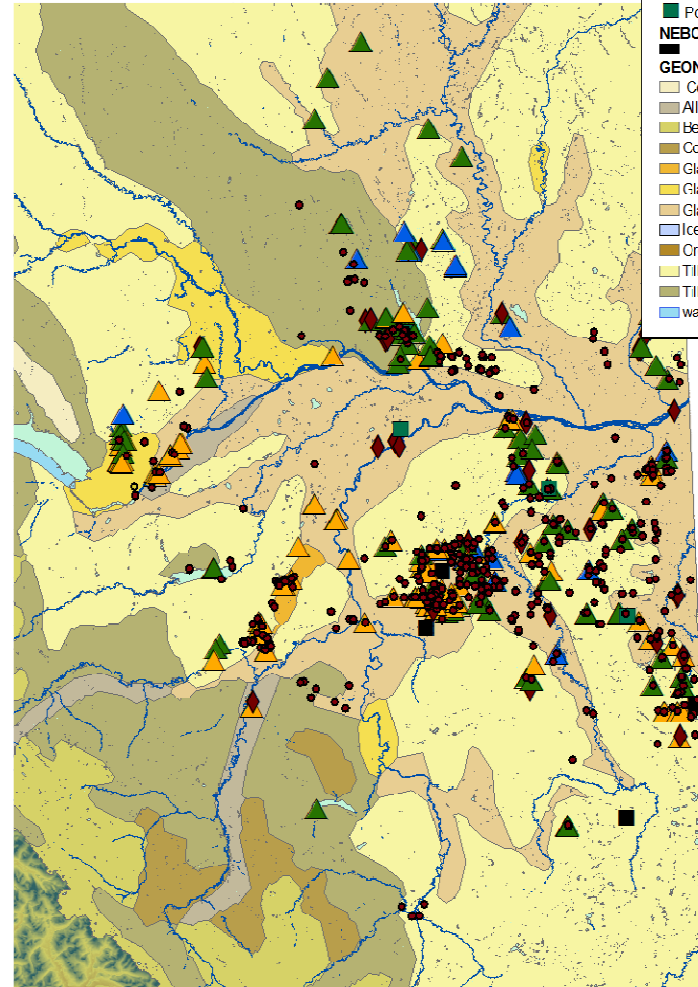
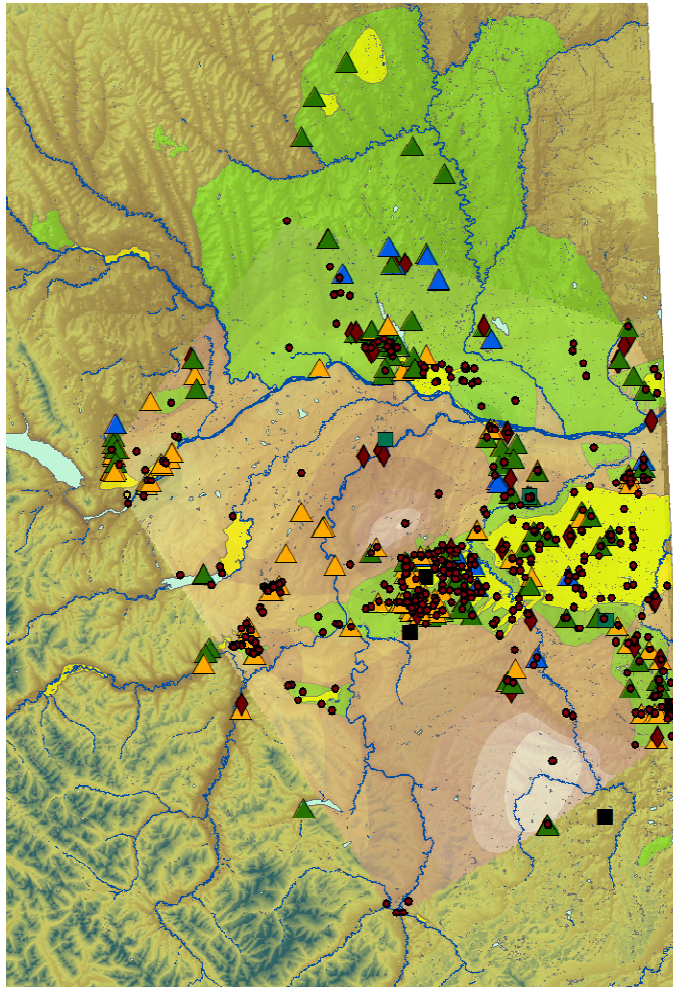


# Groundwater Flow Paths

- Groundwater potentiometric surface largely mimics topography
- Quaternary aquifers tend to be locally discontinuous and poorly connected
- Bedrock aquifers widely distributed with very low fluxes



# Groundwater flow - local/regional



**Legend**

- GW elevation data
- 'NEBC Groundwater Chemistry

**Aquifer**

- ▲ NEBC 1
- ▲ NEBC 2
- ▲ NEBC 3
- ◆ Spring
- Lake
- Pond

**NEBC Surficial Geology**

**GEONAME**

- Colluvial rubble, silt and rubble (carbonate/sed)
- Alluvial stratified silt, sand, clay, gravel
- Bedrock, glacial forms, rock, colluvium, till
- Colluvial rubble, silt and rubble (carbonate/sed)
- Glaciofluvial complex, sand/gravel, includes till
- Glaciofluvial plain, sand/gravel outwash sheets
- Glaciolacustrine, fine silt and clay
- Ice
- Organic deposits, peat > 2 m
- Till blanket, thick and continuous
- Till veneer, thin and discontinuous
- water

# Summary

- Significant number of groundwater samples
- Good regional characterization of water composition
- Relationship between composition and aquifer systems
- Regional and local flow systems
- High  $\text{SO}_4$  from pyrite oxidation
- $\text{NH}_4^+$  content from natural source - oxidation of organic matter
- Dissolved gas  $\text{CH}_4$  and  $\text{CO}_2$  content dataset
- Potential of migrated gas recognized