

# **An updated view of the Grimshaw Gravels Aquifer: *Subsurface architecture and groundwater age dating***

**Greg Hartman, Jeanette Klassen, Brian Smerdon**

Grimshaw Gravels Groundwater Forum  
11 January 2018



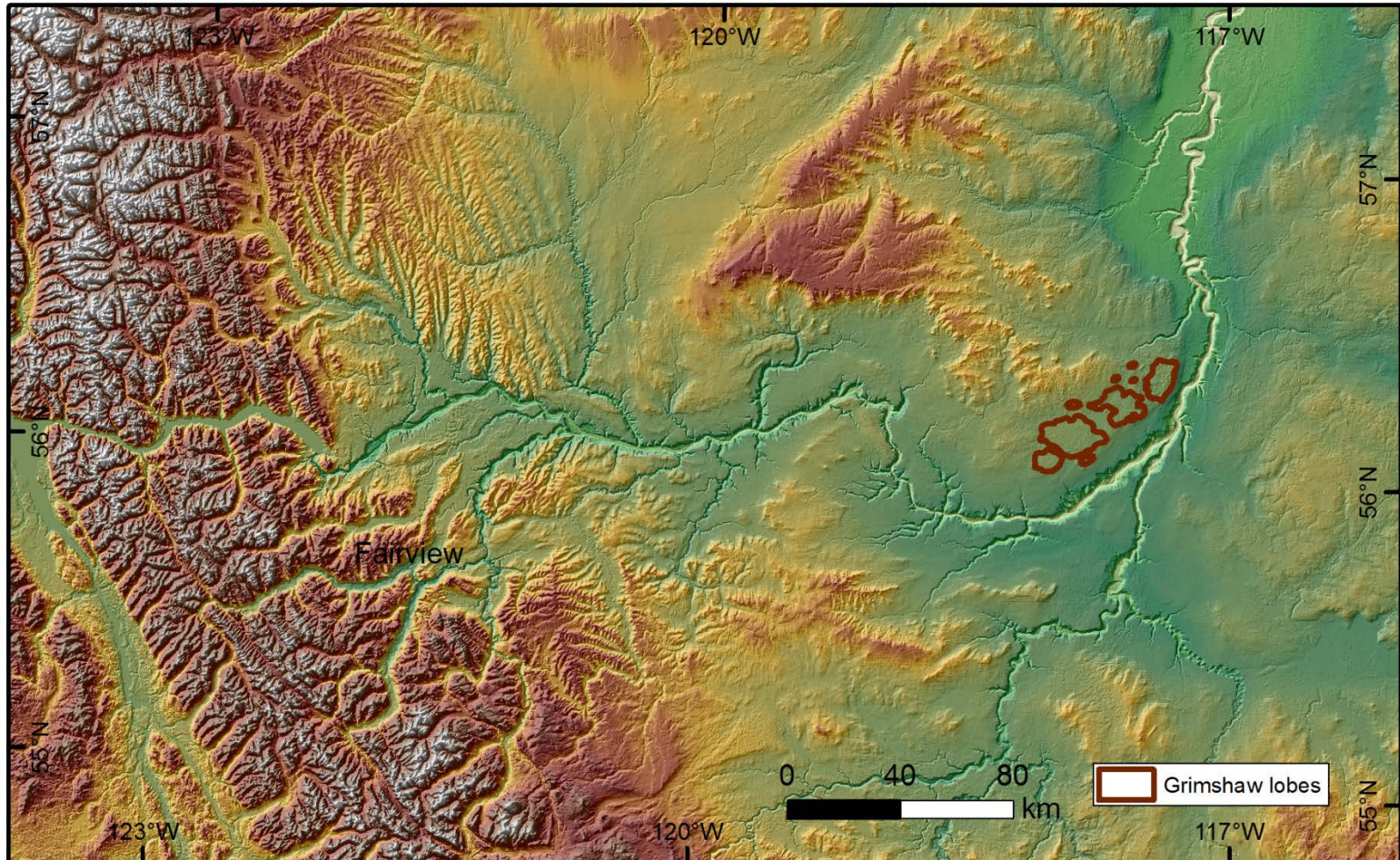
# Outline

- 》 Geological history of the Peace River Lowland
- 》 Provincial Groundwater Inventory Program (PGIP)
- 》 Hydrogeology of the Grimshaw gravels
  - Groundwater flow
  - Groundwater chemistry
  - Groundwater circulation and residence time

# Geological History of the Peace River Lowland

- 》 The bench-like physiography of the Peace River Lowland is the product of successive generations of paleo-Peace Rivers
- 》 Each generation of paleo-river excavated a valley and deposited gravel and sand at successively lower elevations
- 》 The remnant gravel deposits left by these ancient rivers comprise important aquifers and aggregate deposits throughout the modern Peace River Lowland

# The bench-like physiography of the Peace River Lowland contrasts against the surrounding uplands



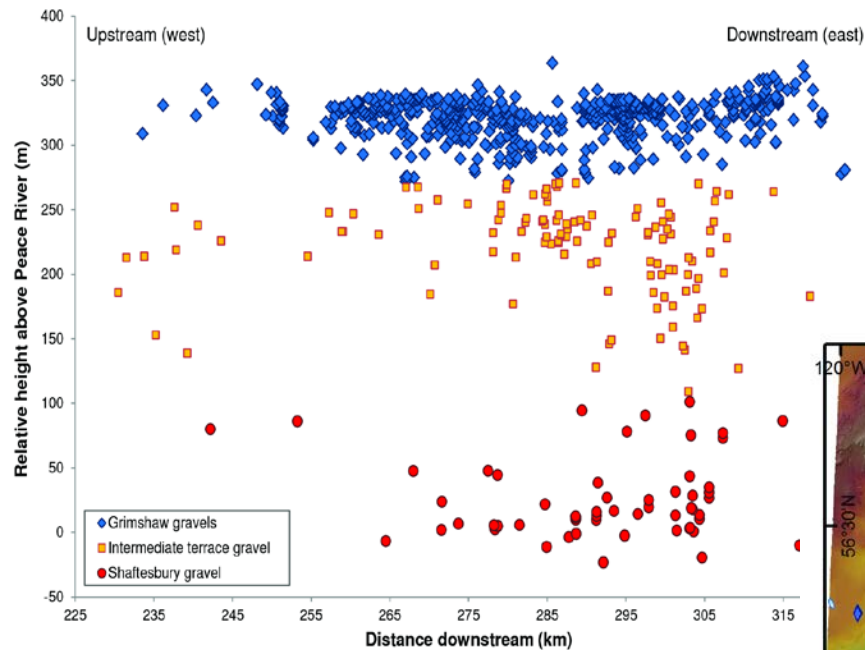
# The bench-like physiography of the Peace River Lowland (flat areas at different heights)



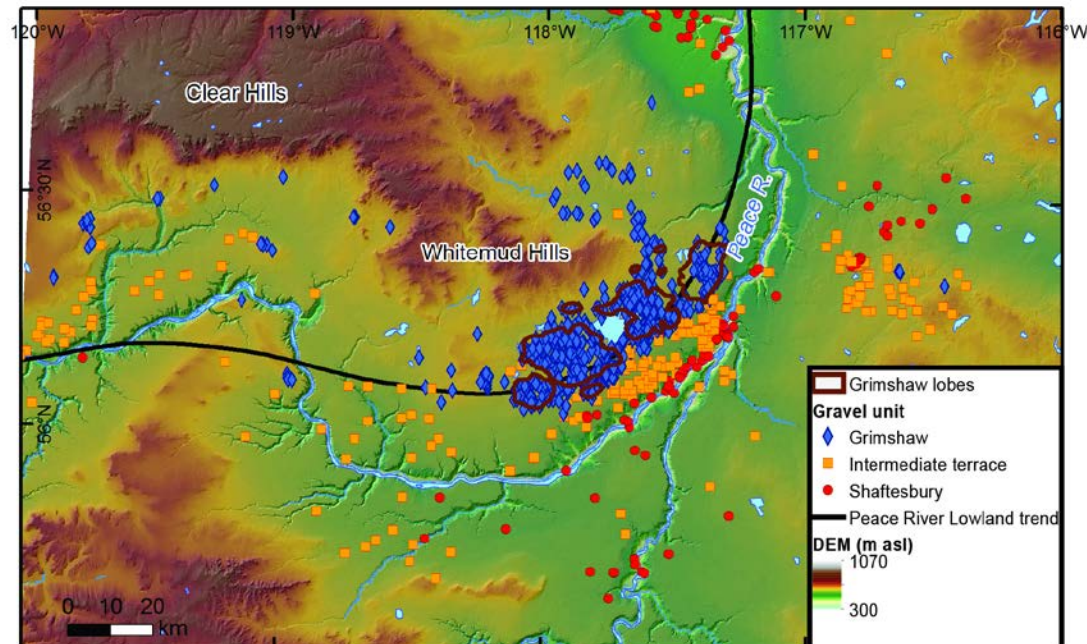
The origin of these benches is indicated by overlying gravel and sand deposits



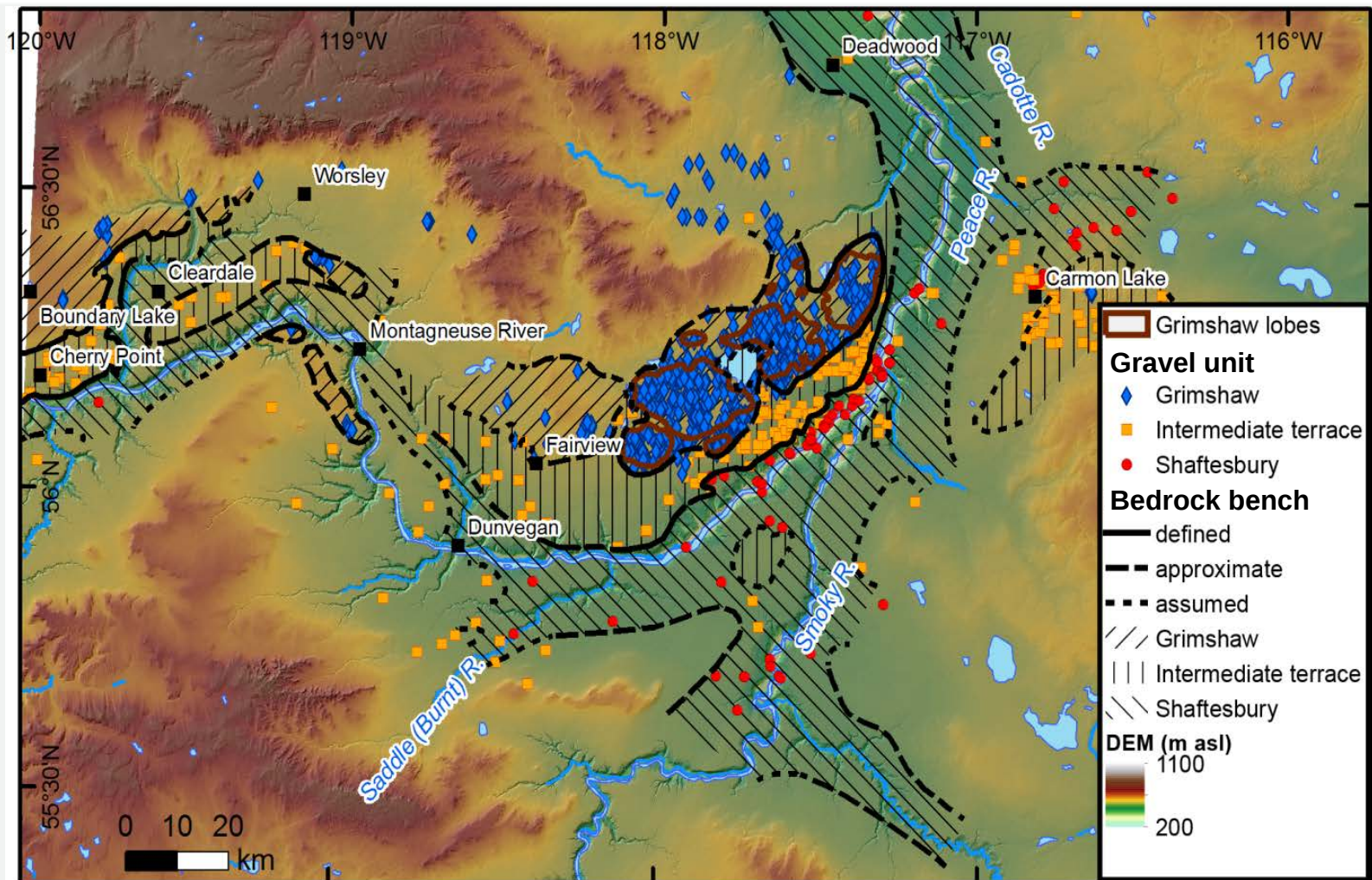
# Three main elevation groups of gravel tops indicate three levels of river incision



Three gravel units at mean heights of 320 m, 220 m, and 25 m above the modern Peace River



# Regional mapping of gravel deposits (and underlying bedrock benches)



# Evidence of glacial damming of the paleo-Peace River

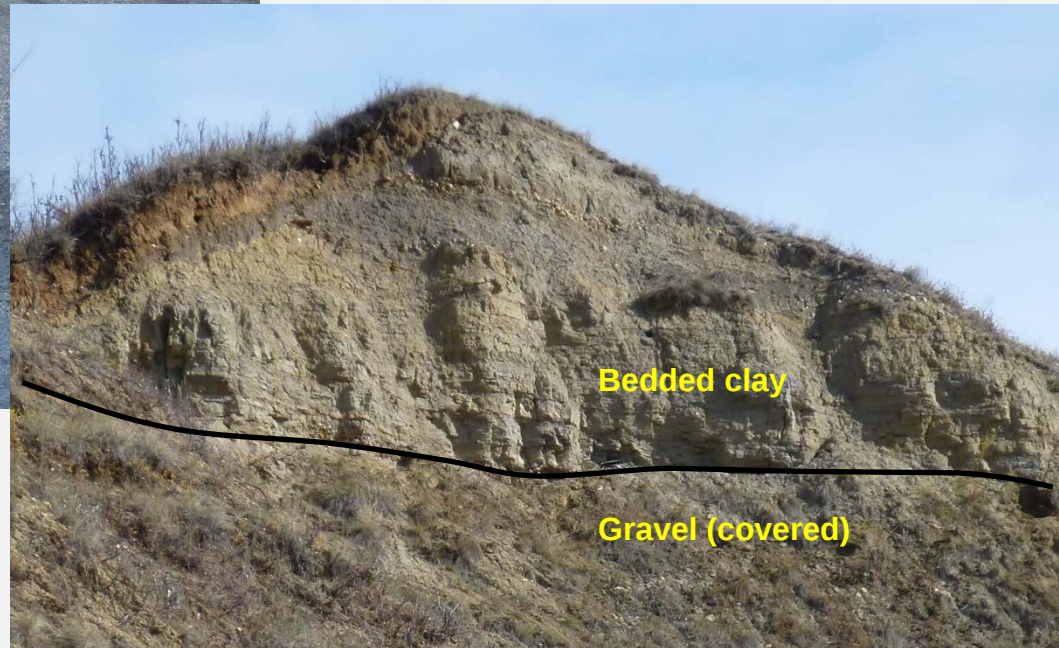


Delta top-sets

Delta foresets

Glaciolacustrine sediment overlying Old Fort gravel (equivalent to Terrace gravel) near BC-AB border

Deltaic foresets in Grimshaw gravel near Weberville



Bedded clay

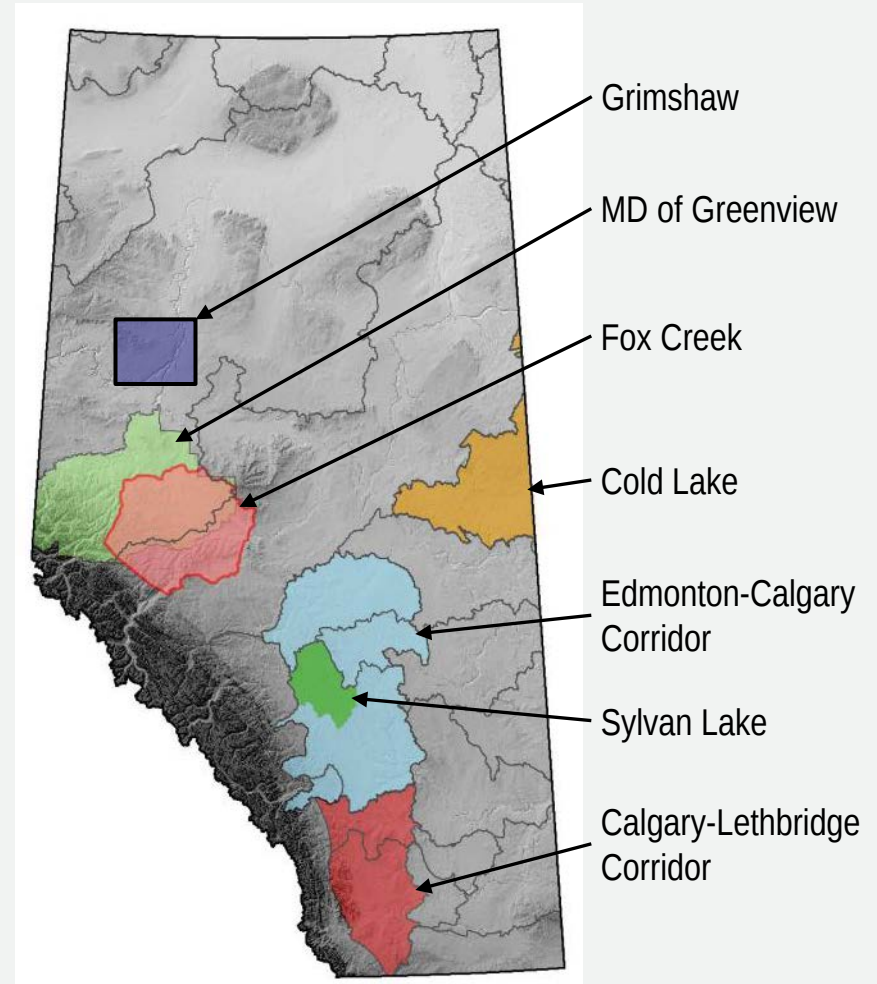
Gravel (covered)

# Regional Geological Interpretation

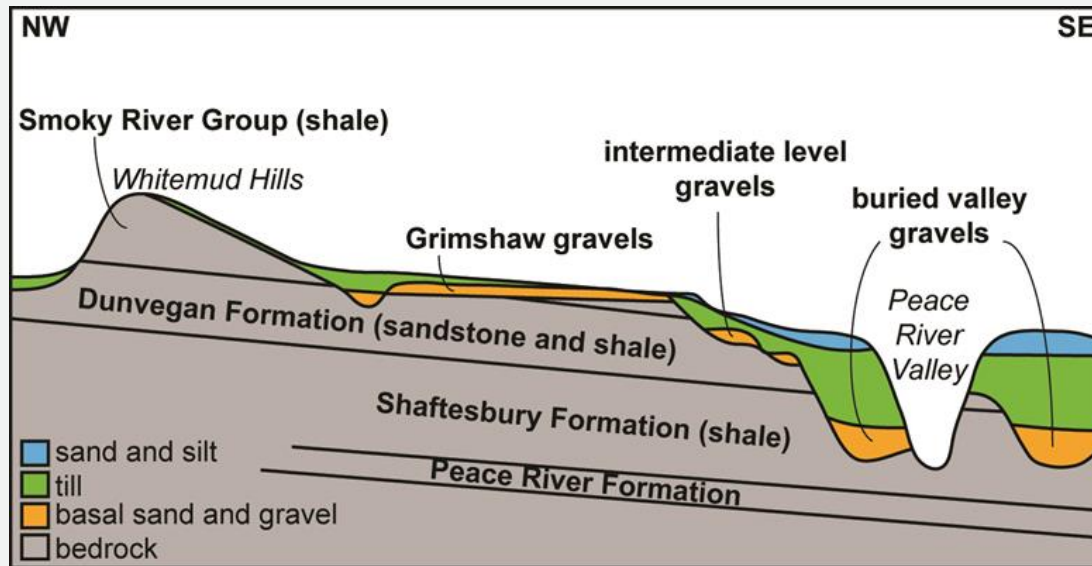
- 》 Three benches at successively lower elevations throughout the Peace River Lowland in Alberta and BC indicate stepwise incision of Peace River Valley
- 》 Radiocarbon dating of fossils recovered from the lowest bench (the buried Shaftesbury Valley) returns mid-Wisconsinan ages (~20,000 to 30,000 C<sup>14</sup> years BP)
- 》 Sites within the two higher benches bear evidence of damming by Laurentide glaciation
- 》 Each bench appears to have been carved following a separate Laurentide glacial event

# Provincial Groundwater Inventory Program

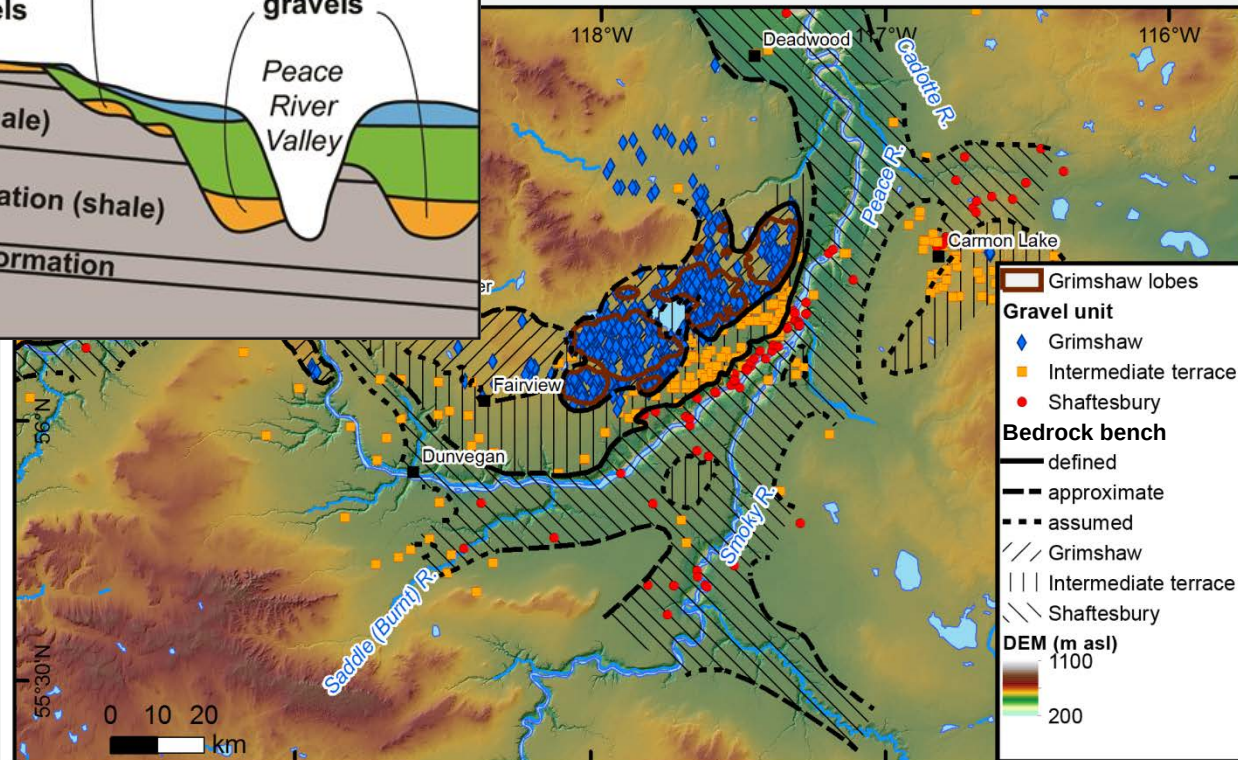
- › Characterize Alberta's groundwater resources
  - › Regional-scale mapping and inventory
  - › Provide geoscience basis for hydrogeological assessments
- › Ensure geoscience is meaningful at the 'regional' scale
  - › Land-use planning regions
  - › ~20,000 km<sup>2</sup>



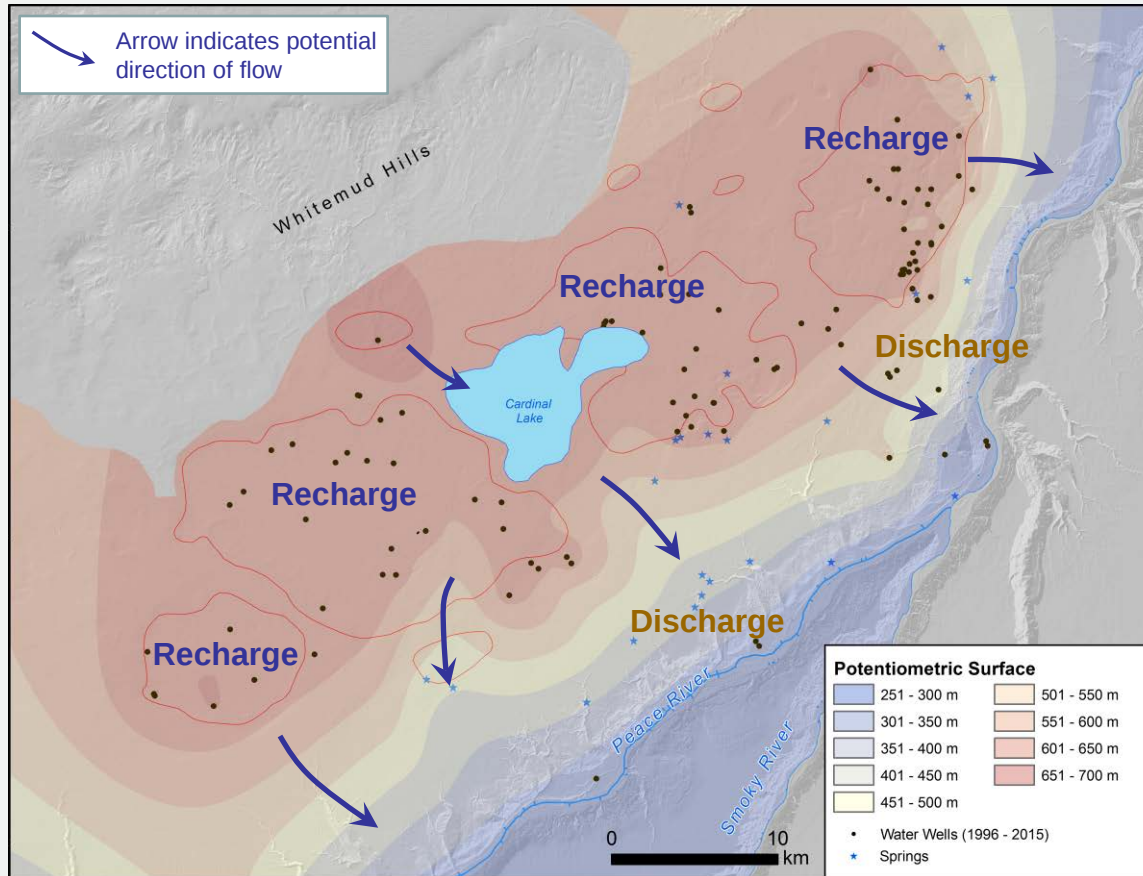
# *Terraced system* rather than *single aquifer*



➤ Helps explain spatially varying water availability and quality

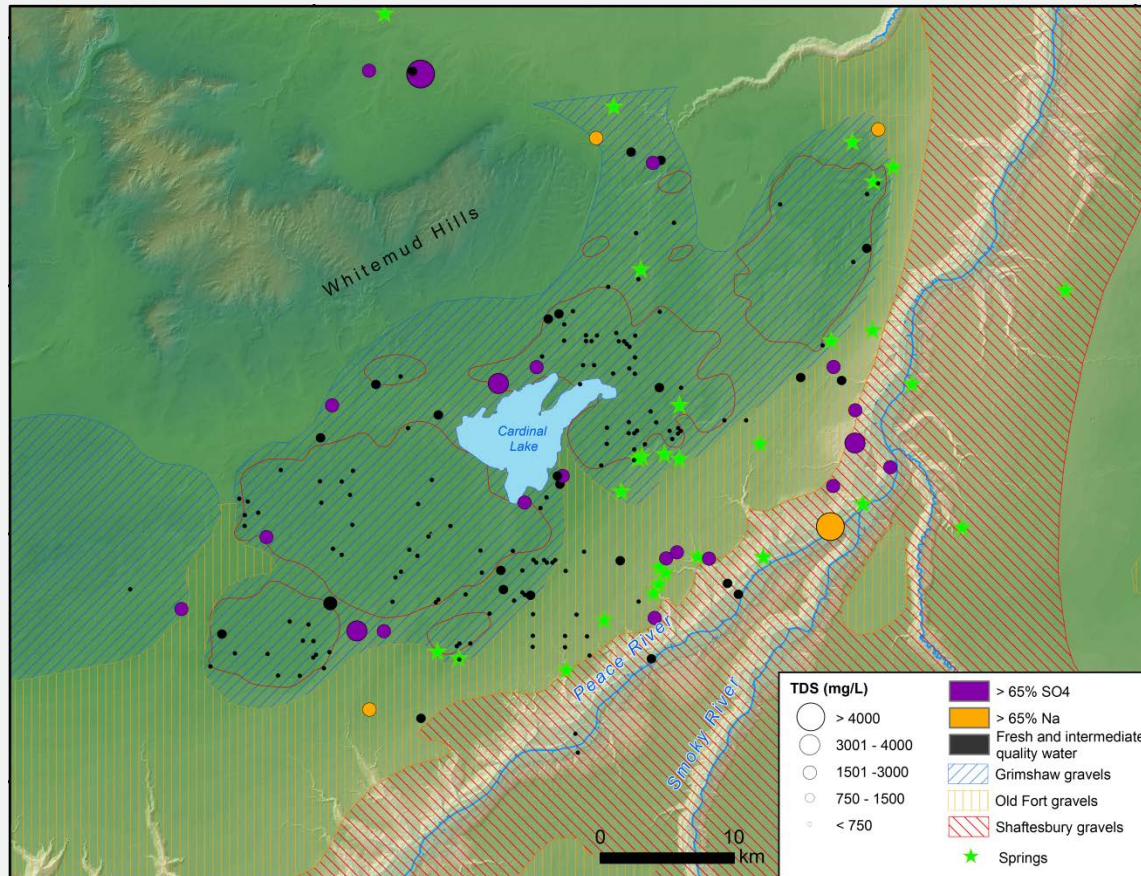


# Groundwater Flow Direction



- › Estimated from water well records
  - › Alberta Water Well Information Database
  - › Groundwater level at time of completion
  - › 1996 to 2015 period
- › Hydrogeological conditions
  - › Lower gradient across Grimshaw gravels
  - › Higher gradient across Old Fort and Shaftesbury gravels

# Groundwater Chemistry



› Alberta Water Well Information Database

› Grimshaw gravels

› Good water quality

› 630 mg/L average total-dissolved-solids

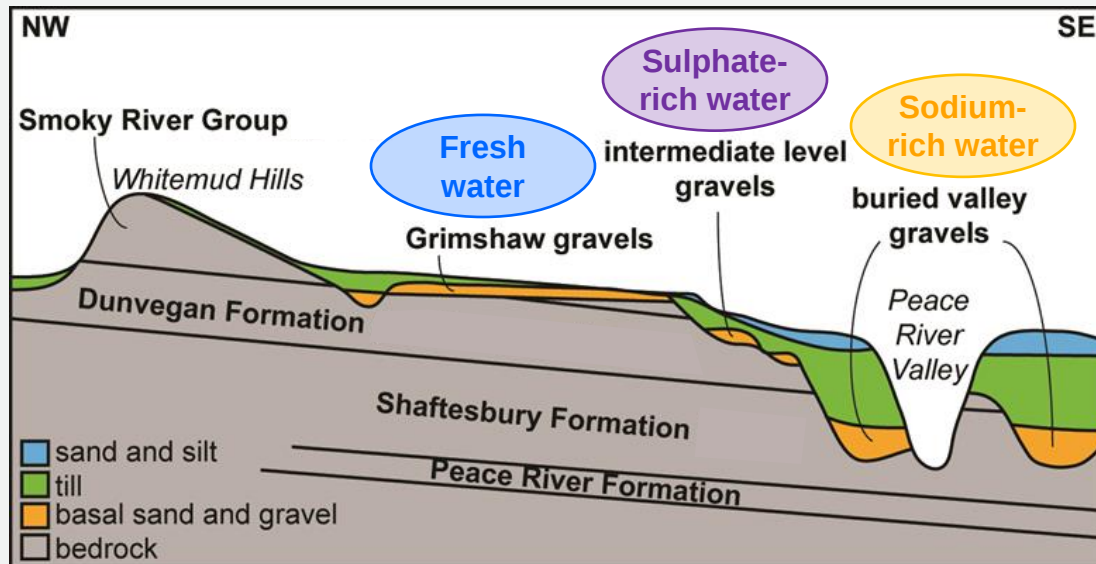
› Old Fort and Shaftesbury gravels

› Lower water quality

› 1365 mg/L average total-dissolved-solids

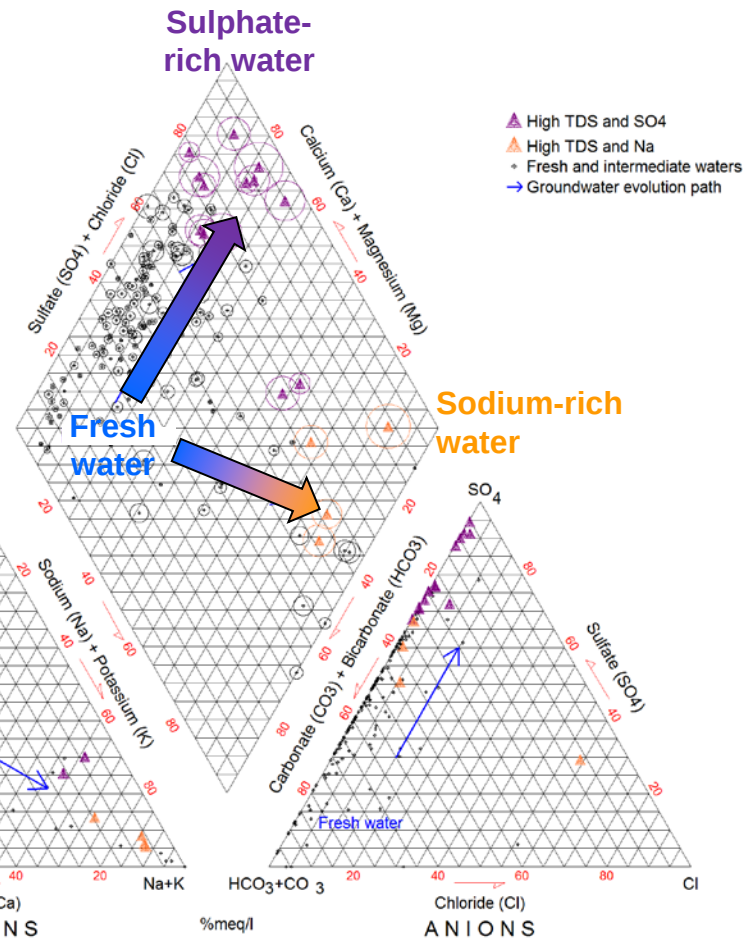
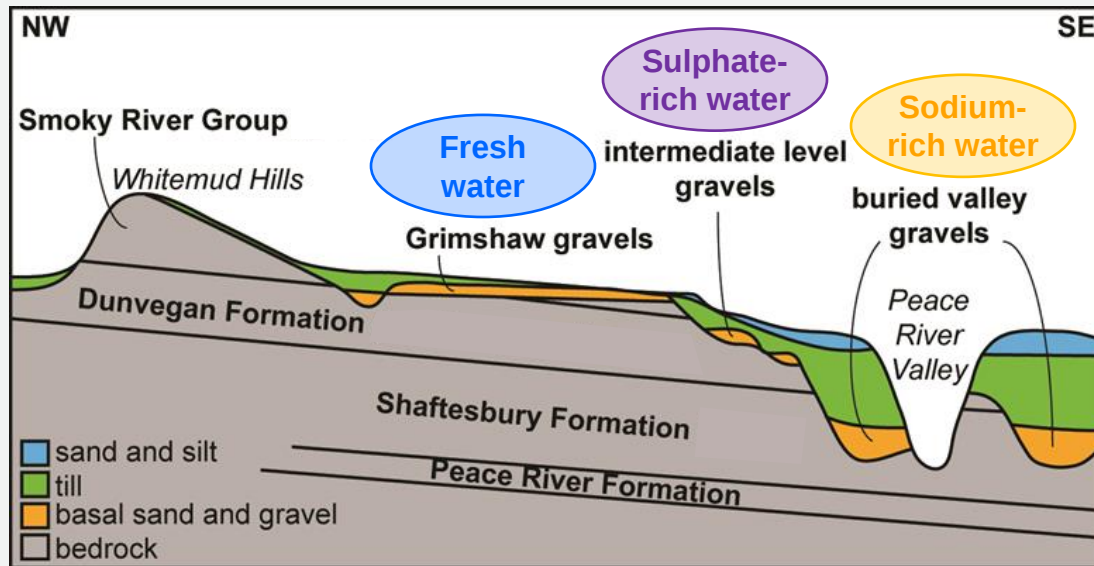
› Higher concentrations of sulphate and sodium

# Groundwater Chemistry



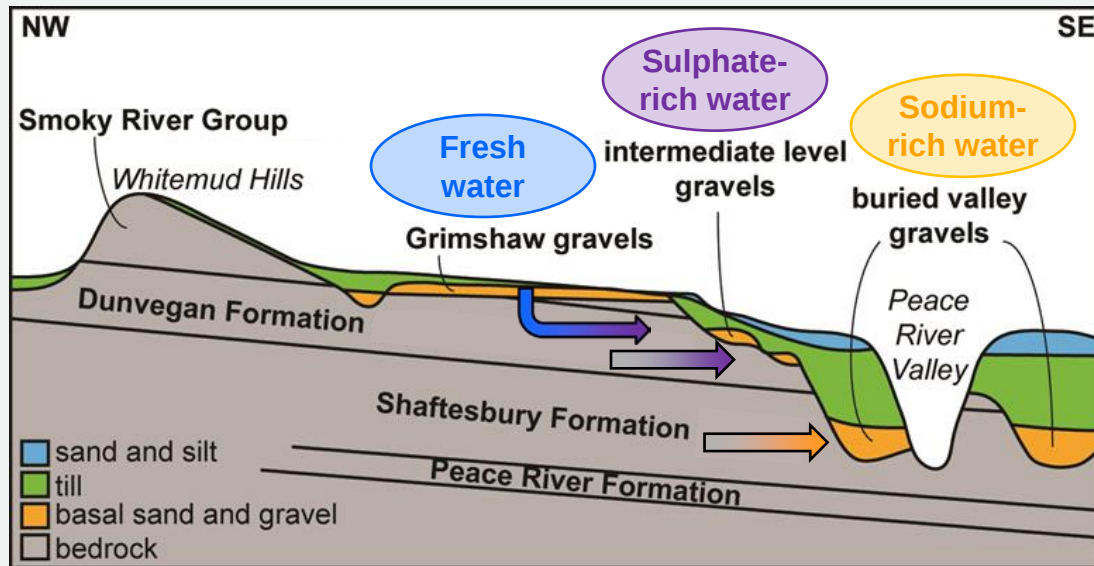
- Groundwater chemistry evolves with more time in the subsurface
- Higher sulphate and sodium can inform groundwater flowpaths

# Groundwater Chemistry Evolution



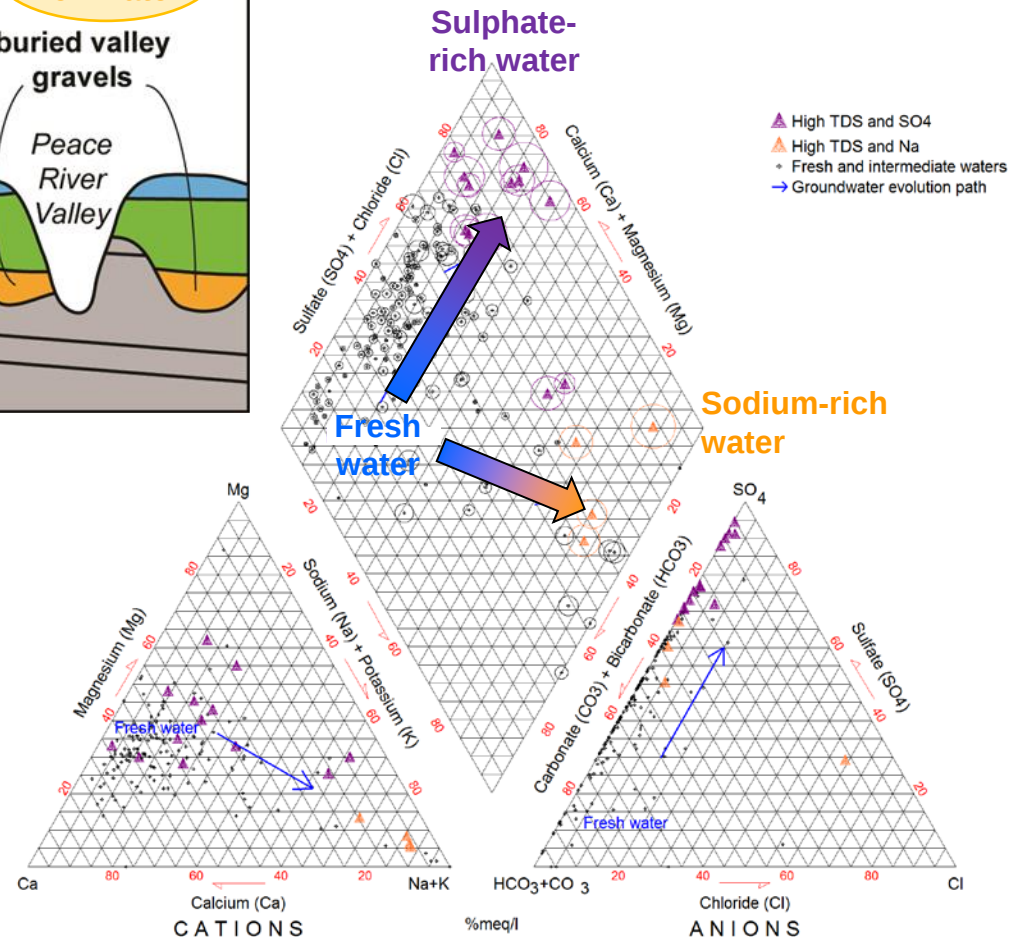
- › Evolution of groundwater chemistry
  - › Interaction with sediments
  - › Mixing of different waters

# Groundwater Circulation

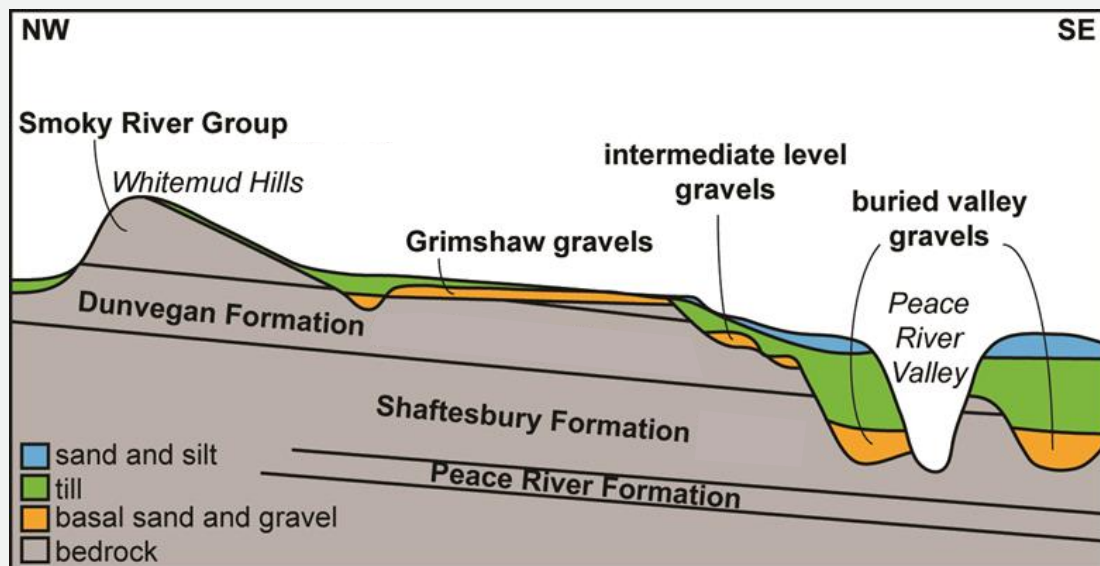


➤ Old Fort and Shaftesbury gravels water quality controlled by bedrock

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# Groundwater Residence Time



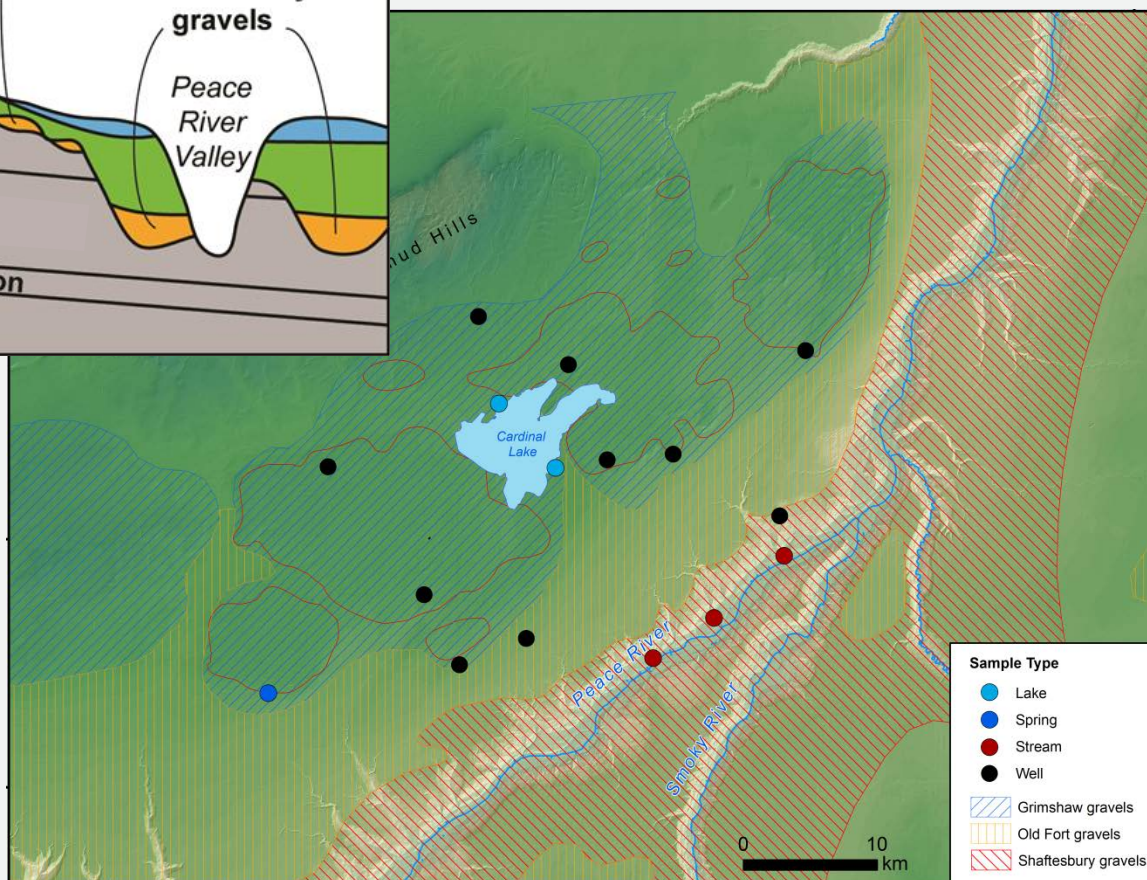
## Environmental tracers

- Stable isotopes ( $^2\text{H}$ ,  $^{18}\text{O}$ )
- Tritium ( $^3\text{H}$ ), Radiocarbon ( $^{14}\text{C}$ )

## September 2017 sampling

- 10 wells
- Whitelaw Spring
- Cardinal Lake
- 3 streams (groundwater discharge)

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# An Update View

- Geological history sets the stage
  - Three successively lower benches throughout the Peace River Lowland in Alberta and British Columbia
- Terraced gravel deposits represent an aquifer system rather than a single aquifer
  - Provides some explanation for wide range of water quality
  - Each gravel deposit interacts with underlying bedrock
- Groundwater within each gravel deposit has unique mixture of sources
  - Grimshaw gravels: Recharged locally; good water quality
  - Old Fort gravels: Mix of local recharge and Dunvegan groundwater; higher TDS and sulphate
  - Shaftesbury gravels: Discharge from Shaftesbury groundwater; higher TDS and sodium

# Upcoming Reports

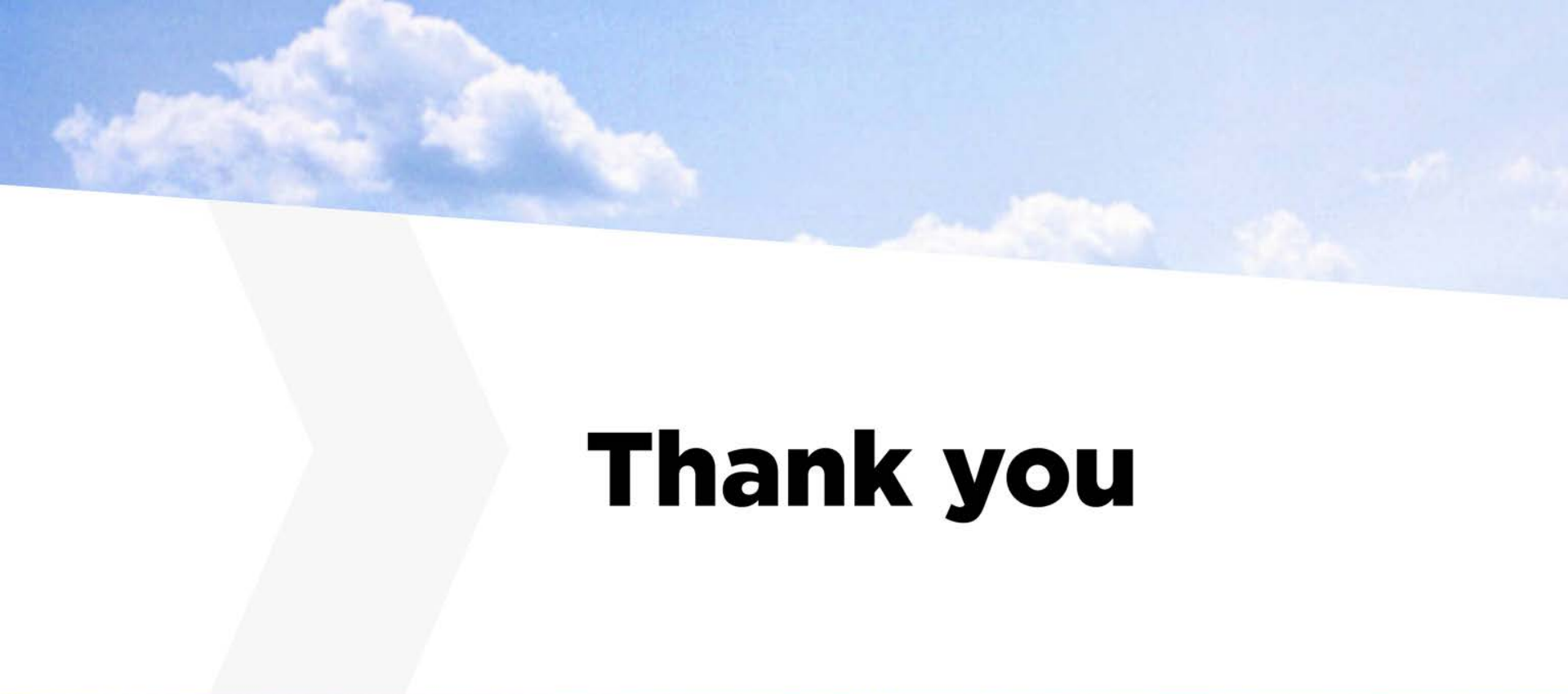
<http://ags.aer.ca/>

## › AGS Open File Report on the Geology

- › Final stages of publication → *on the website soon!*
- › Slomka, J.M., Hartman, G.M.D., and Klassen, J. (2017): Architecture and geometry of basal sand and gravel deposits including the 'Grimshaw gravels', north-western Alberta (NTS 84C and 84D); Alberta Energy Regulator, AER/AGS Open File Report xx

## › AGS Open File Report on the Hydrogeology

- › In preparation; compiling results from water sampling
- › Klassen, J. and Smerdon, B.D. (2018): Hydrogeological Characterization of the Grimshaw Area; Alberta Energy Regulator, AER/AGS Open File Report xx



**Thank you**

