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

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Grimshaw Gravels Groundwater Forum
11 January 2018

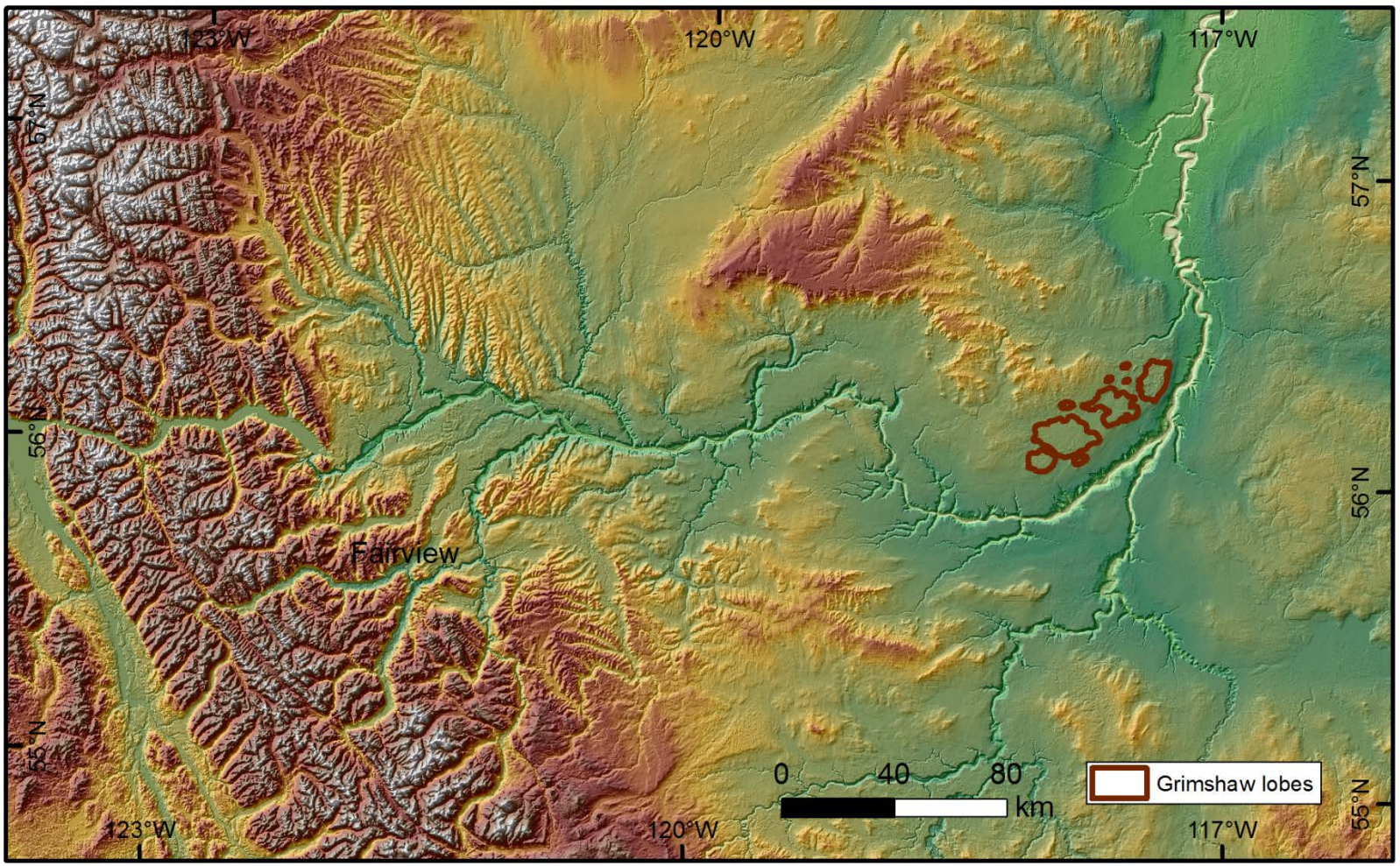
Outline

- 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

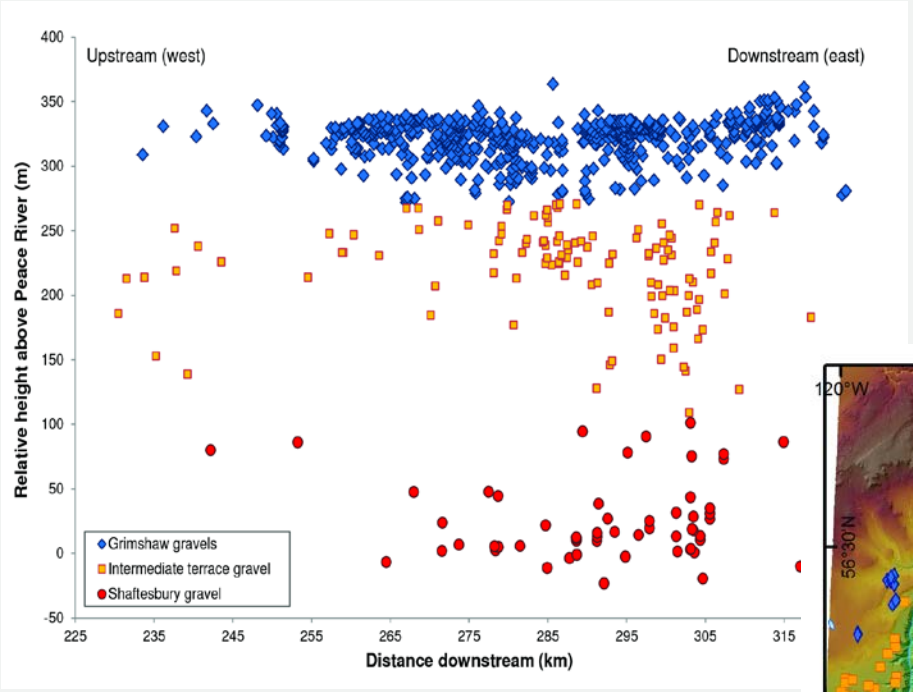
Geological History of the Peace River Lowland

- 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

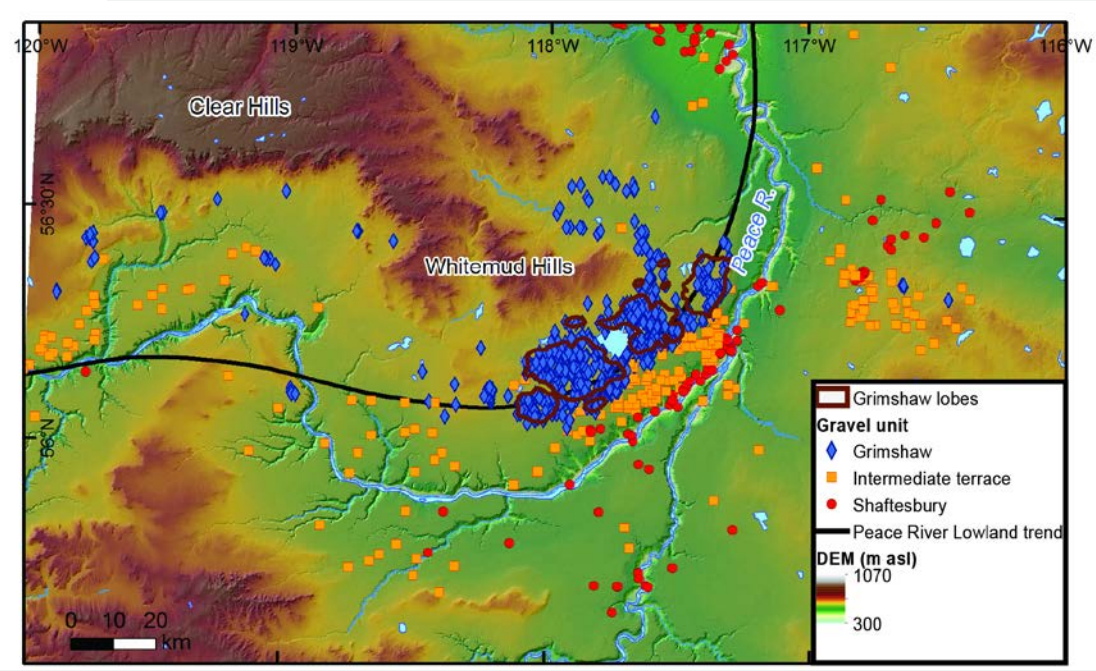
The bench-like physiography of the Peace River Lowland contrasts against the surrounding uplands



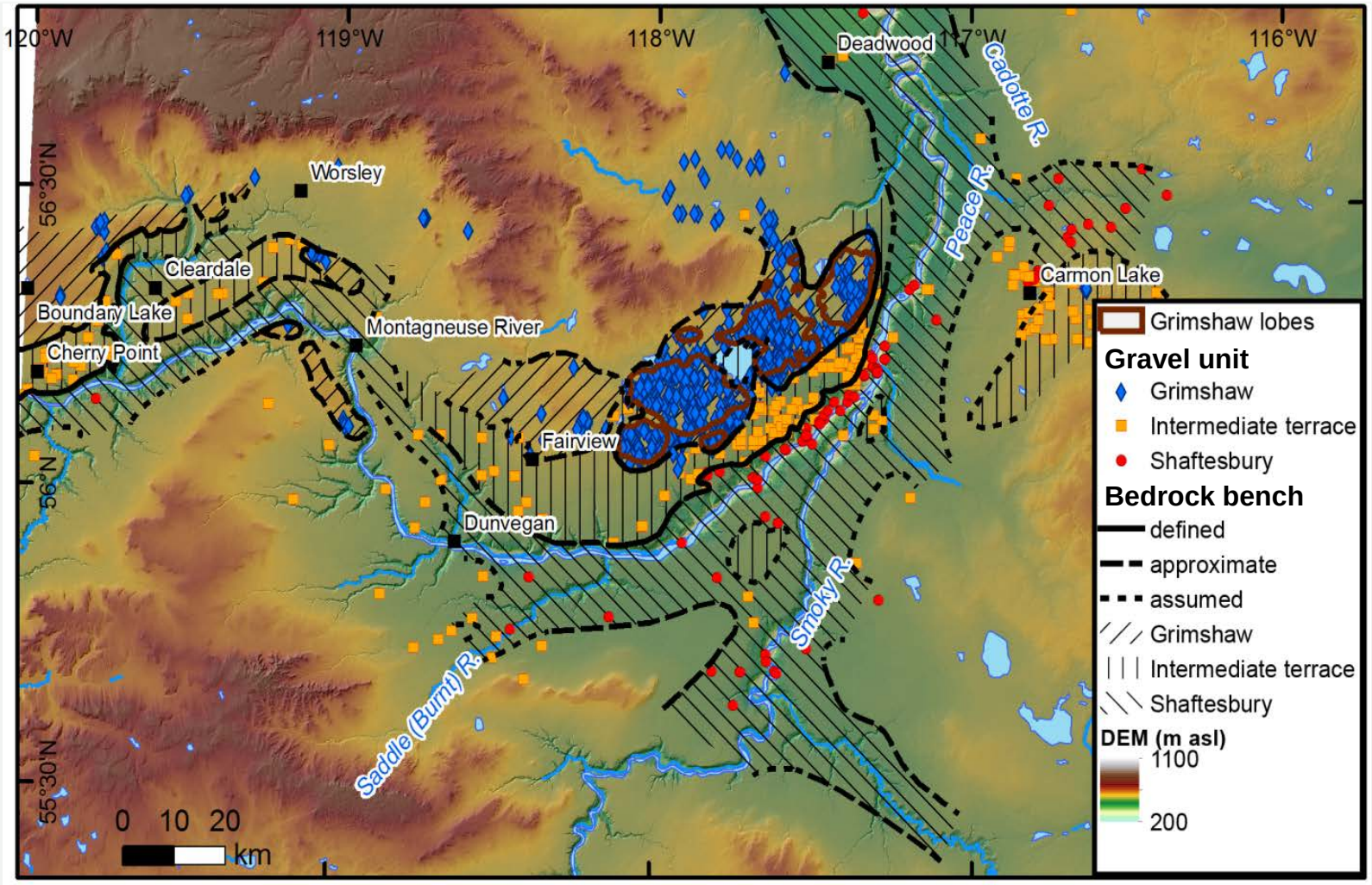
Three main elevation groups of gravel tops indicate three levels of river incision



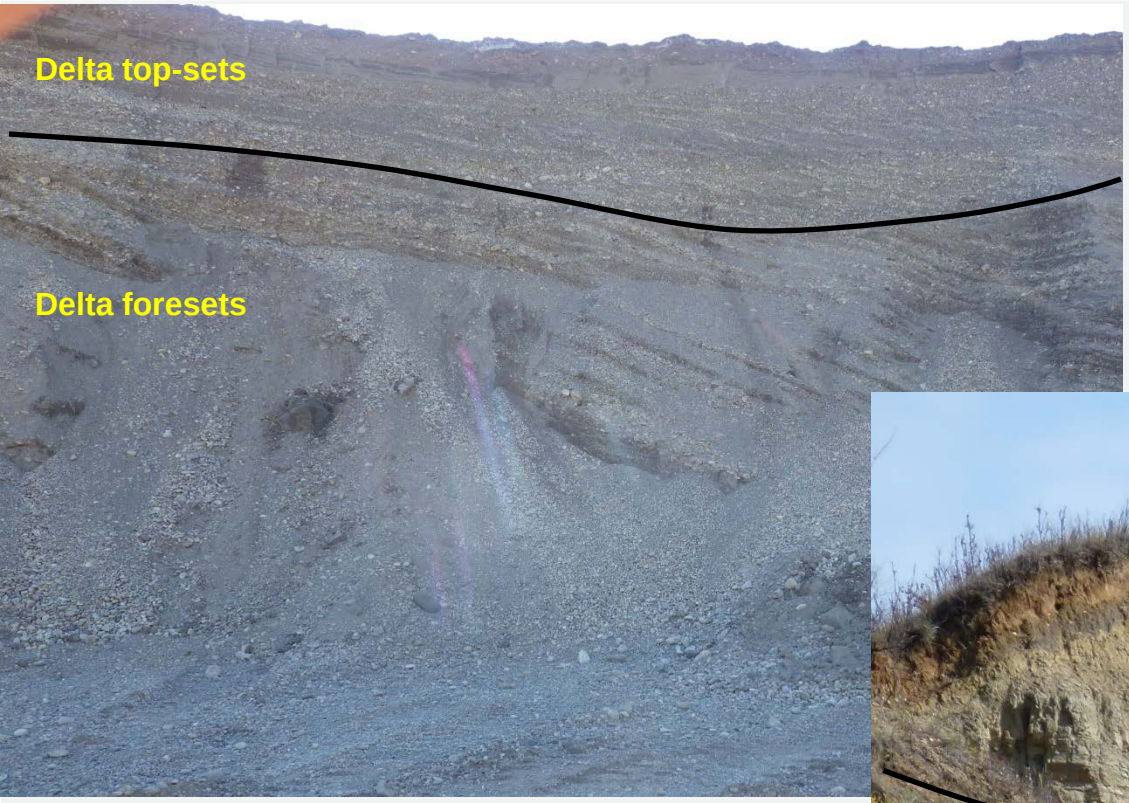
Three gravel units at mean heights of 320 m, 220 m, and 25 m above the modern Peace River



Regional mapping of gravel deposits (and underlying bedrock benches)

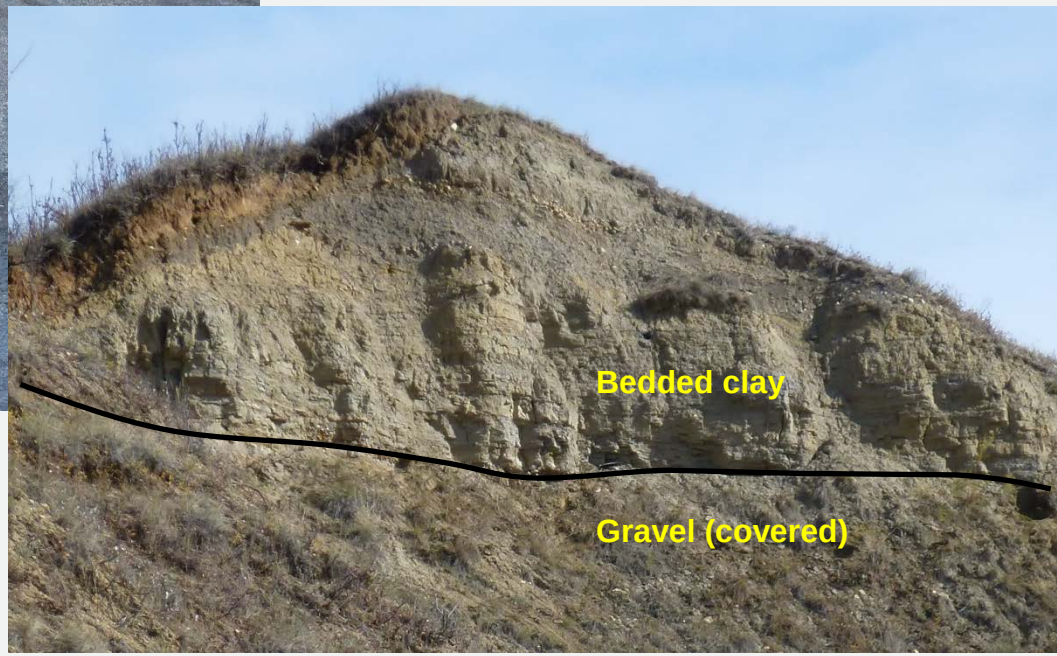


Evidence of glacial damming of the paleo-Peace River



Deltaic foresets in Grimshaw gravel near Weberville

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

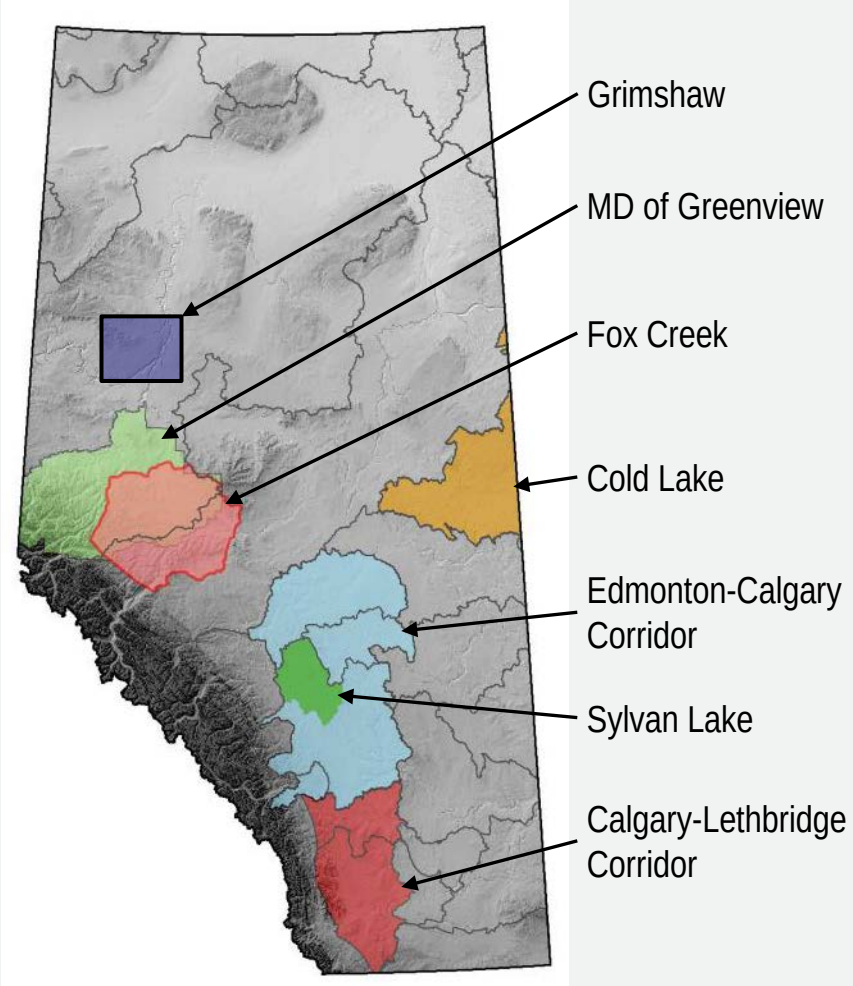


Regional Geological Interpretation

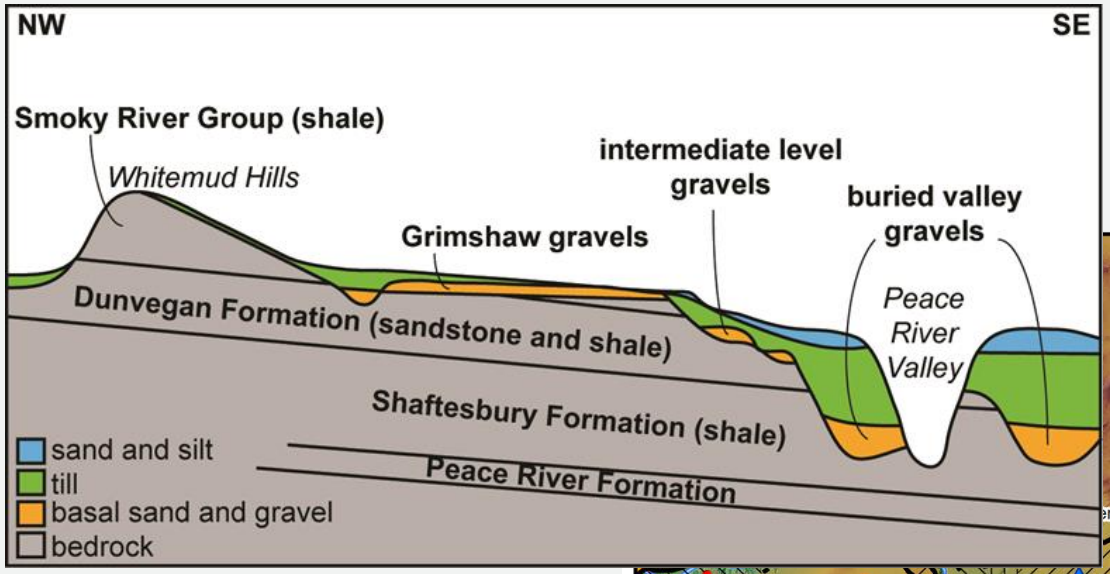
- Three benches at successively lower elevations throughout the Peace River Lowland in Alberta and BC indicate stepwise incision of Peace River Valley
- Radiocarbon dating of fossils recovered from the lowest bench (the buried Shaftesbury Valley) returns mid-Wisconsinan ages (~20,000 to 30,000 C^{14} 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

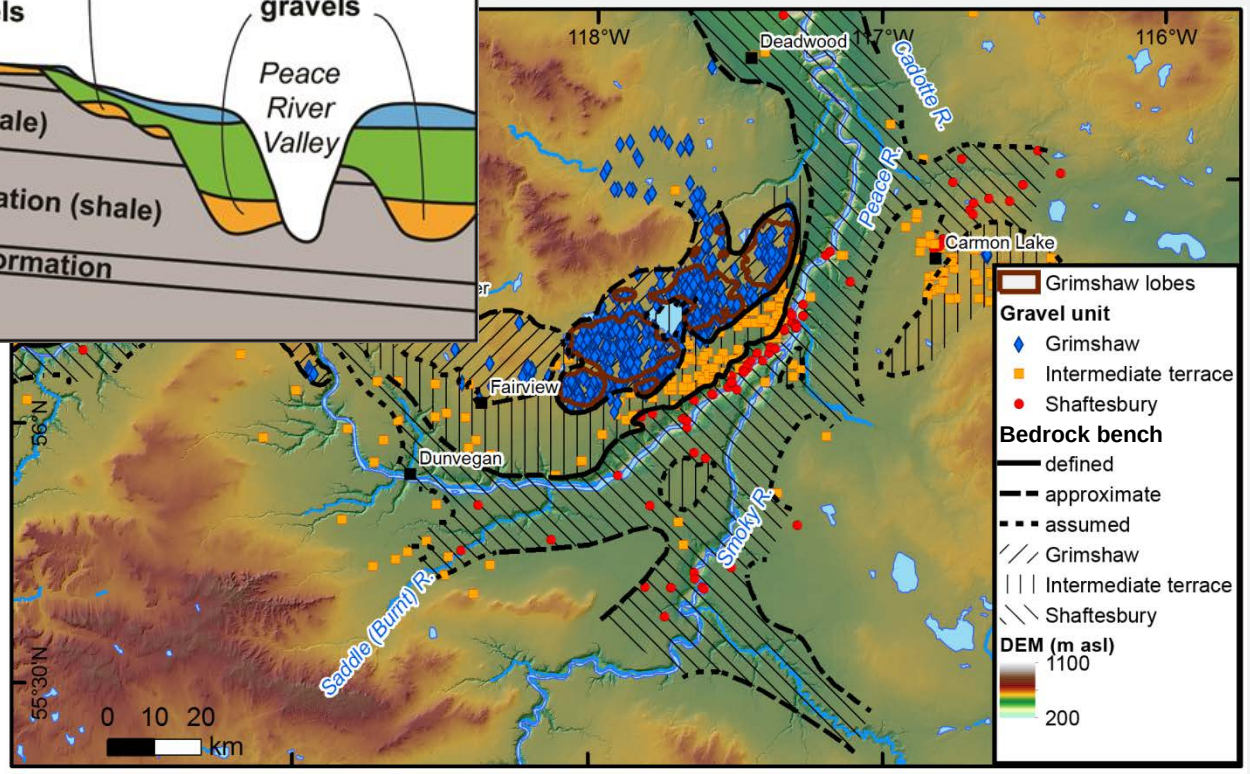
Provincial Groundwater Inventory Program

- 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^2



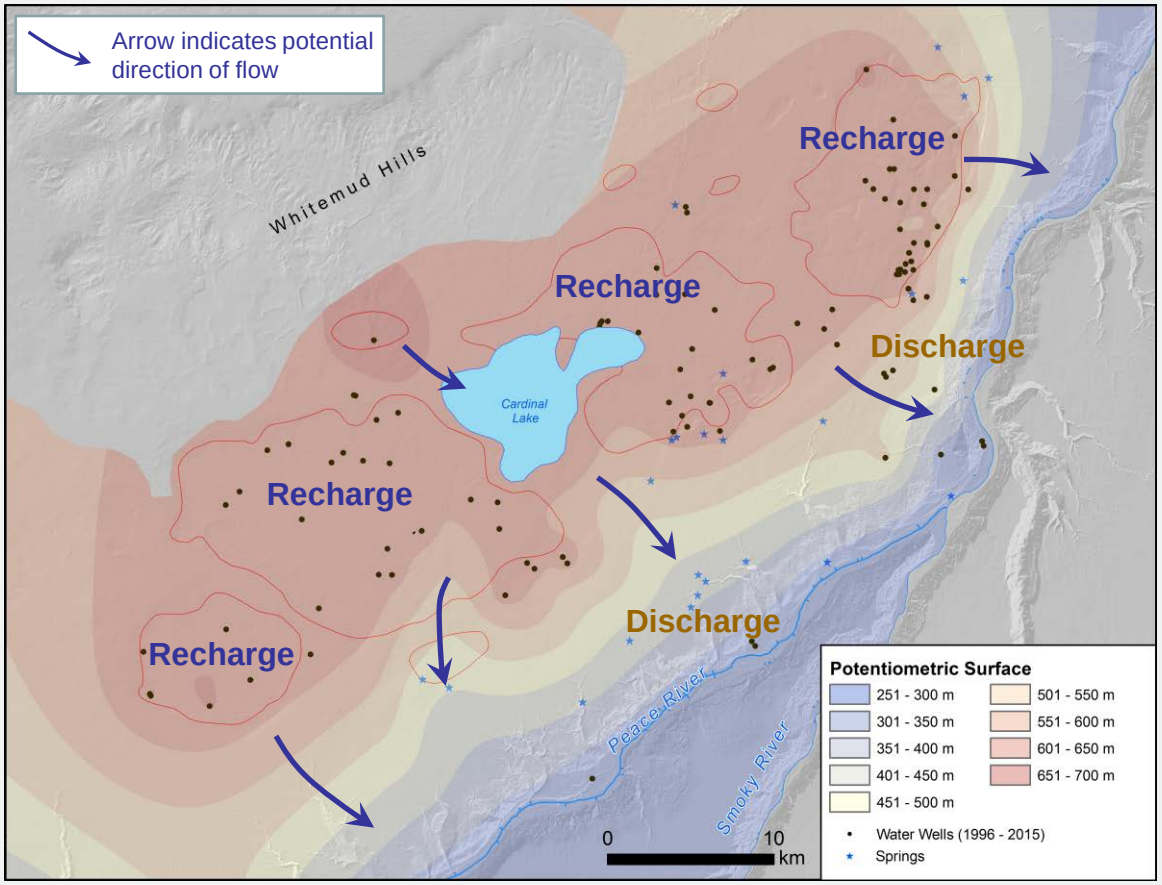
Terraced system rather than *single aquifer*





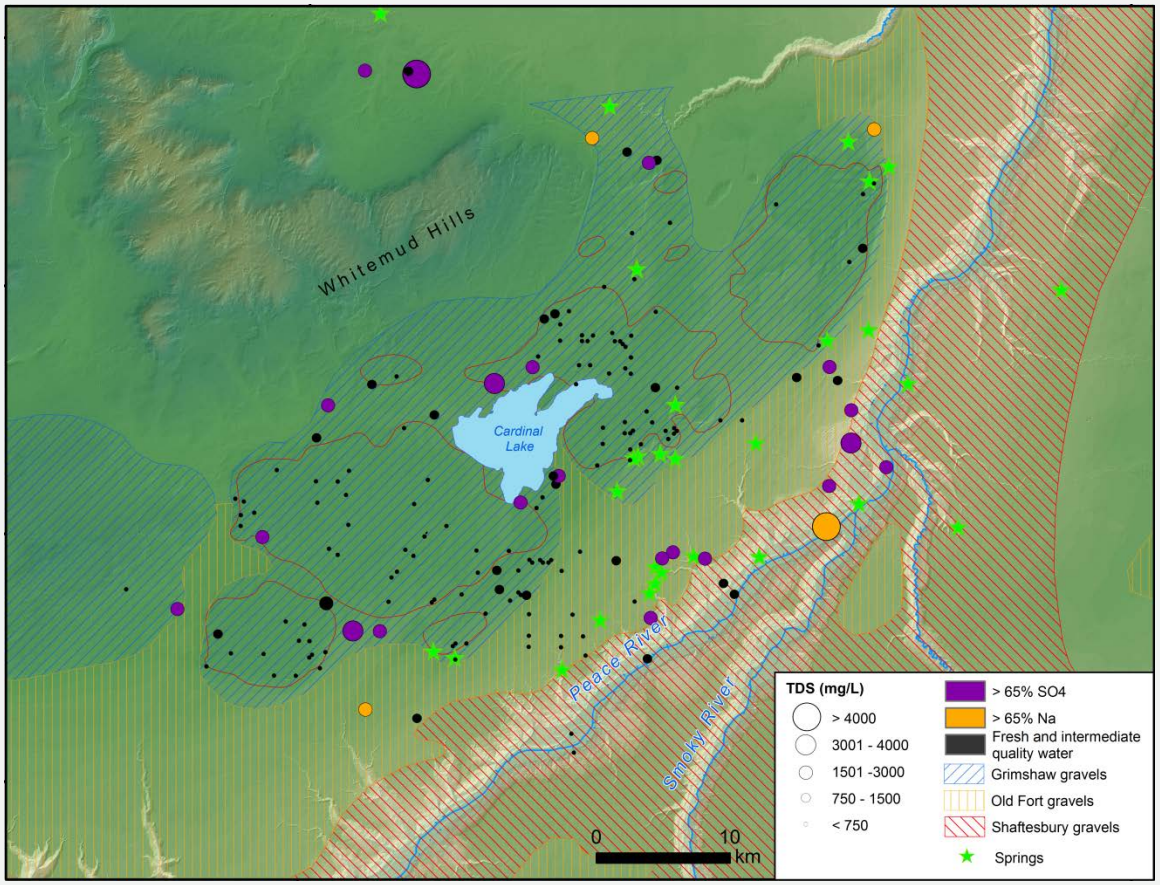
- Helps explain spatially varying water availability and quality

Groundwater Flow Direction



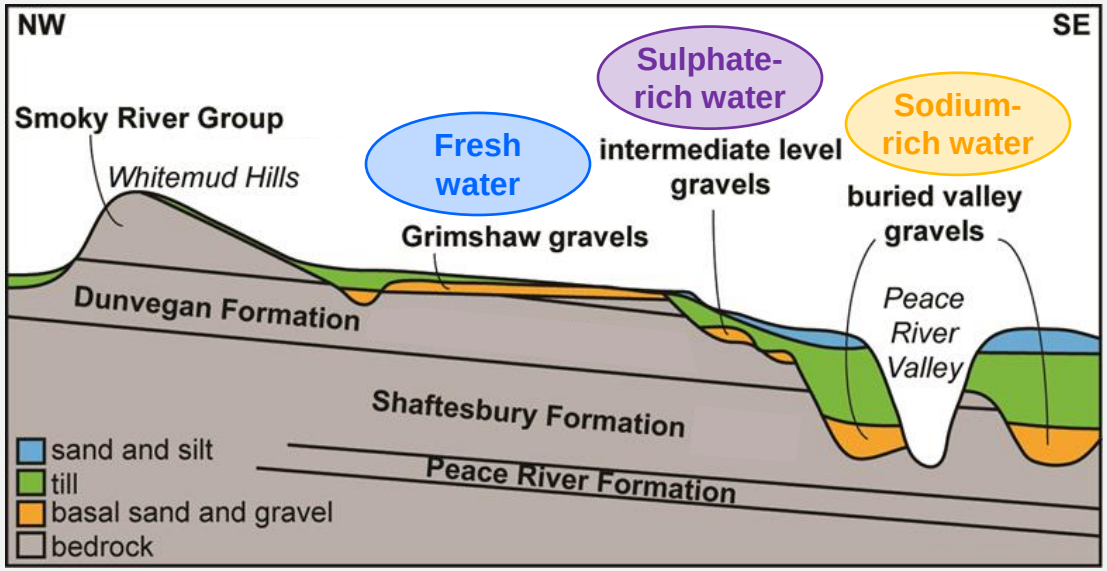
- Estimated from water well records
  - Alberta Water Well Information Database
  - Groundwater level at time of completion
  - 1996 to 2015 period
- Hydrogeological conditions
  - Lower gradient across Grimshaw gravels
  - Higher gradient across Old Fort and Shaftesbury gravels

Groundwater Chemistry



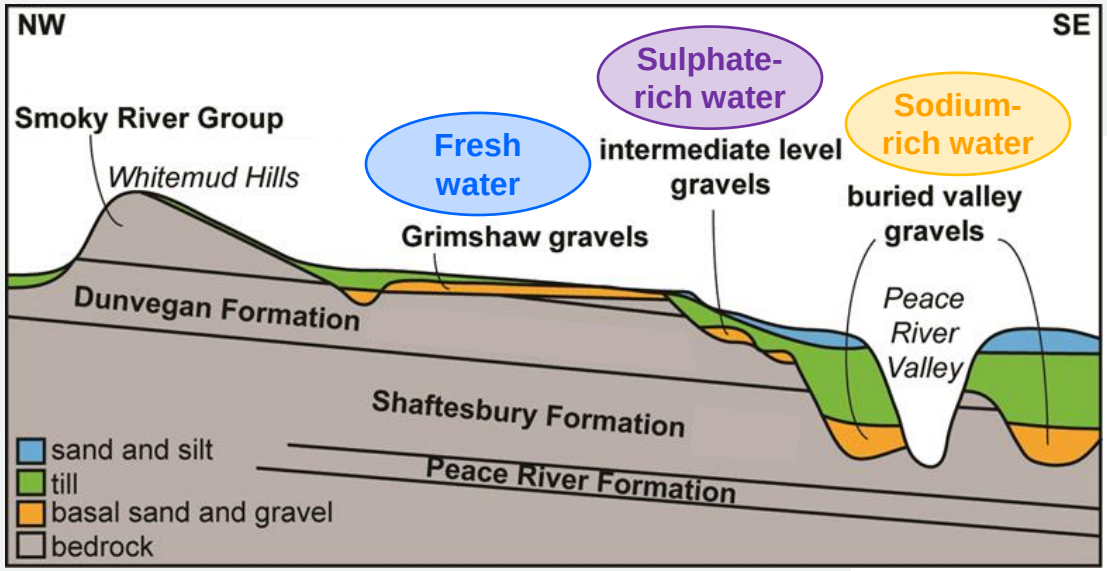
- Alberta Water Well Information Database
- Grimshaw gravels
  - Good water quality
  - 630 mg/L average total-dissolved-solids
- Old Fort and Shaftesbury gravels
  - Lower water quality
  - 1365 mg/L average total-dissolved-solids
  - Higher concentrations of sulphate and sodium

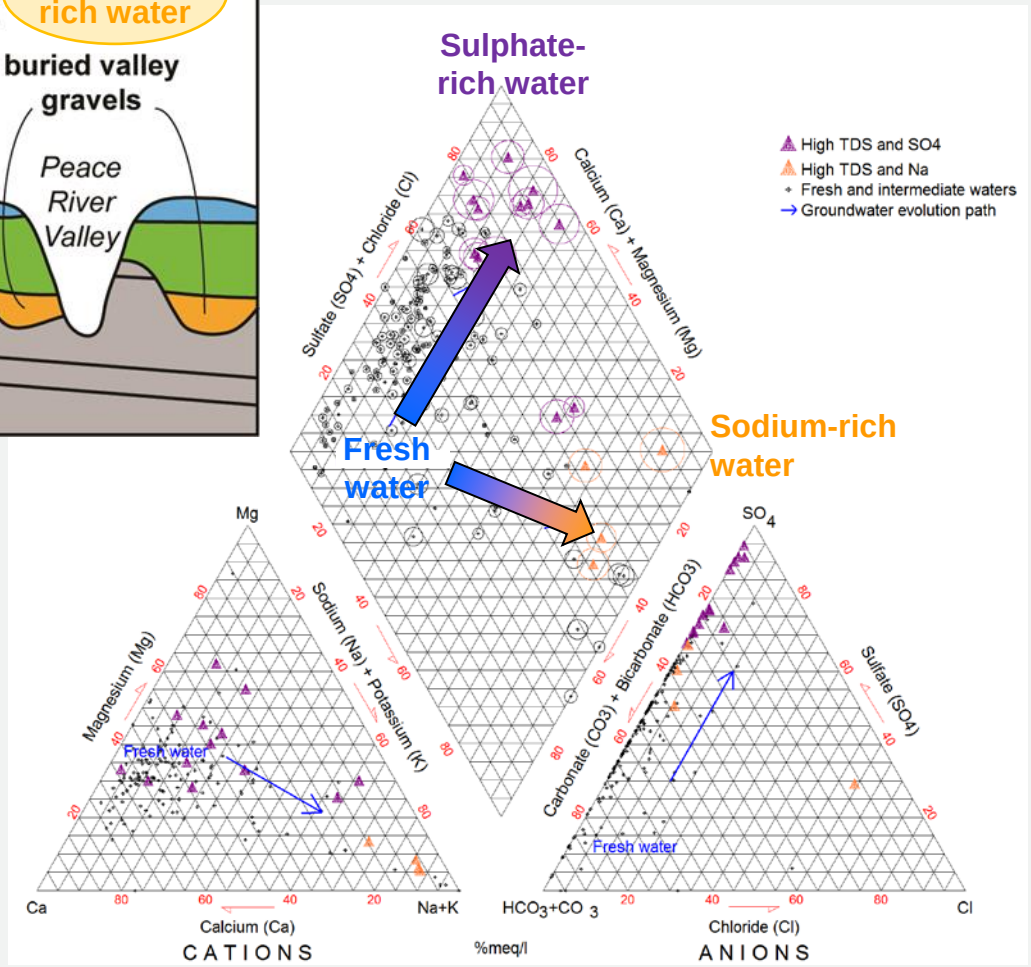
Groundwater Chemistry



- 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

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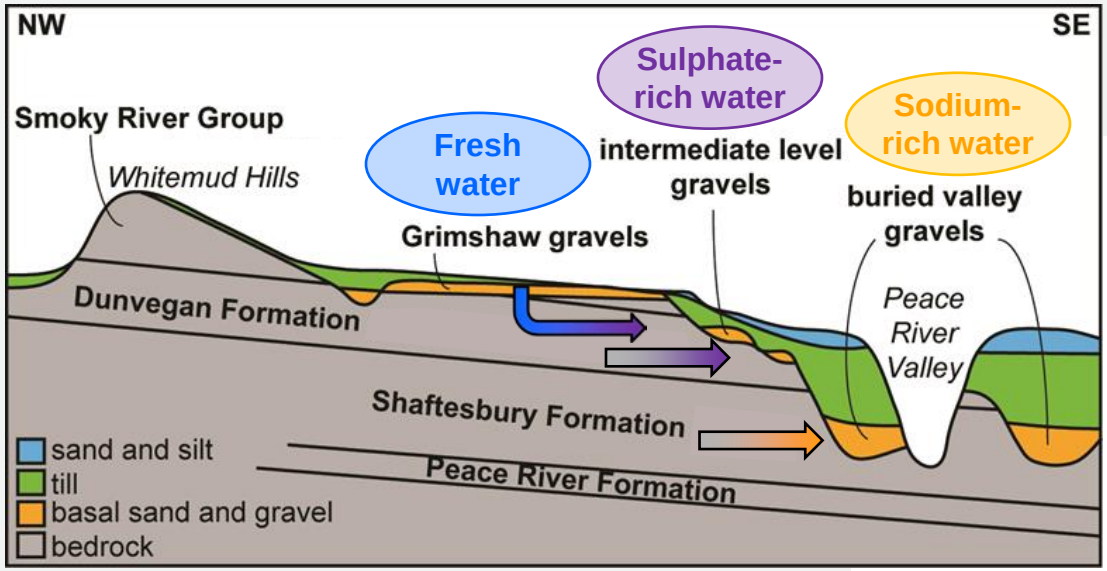
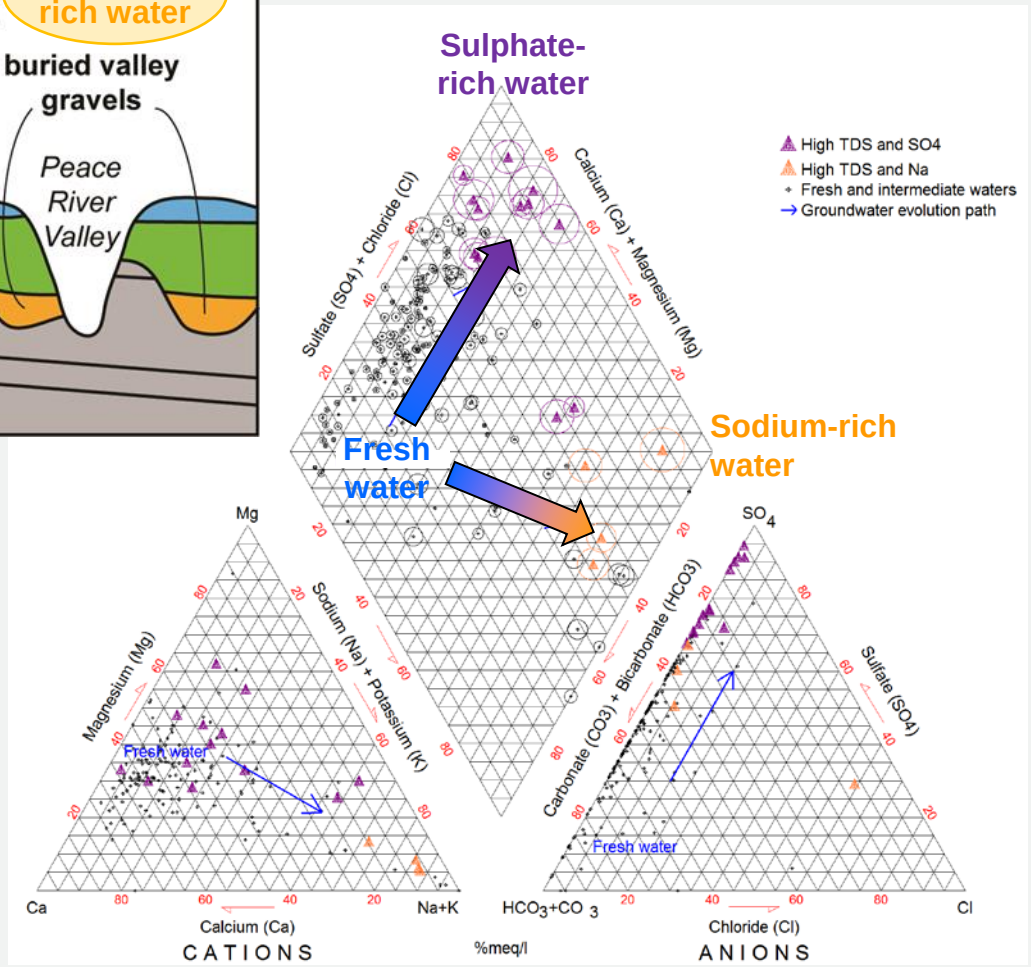
Groundwater Circulation





- Old Fort and Shaftesbury gravels water quality controlled by bedrock

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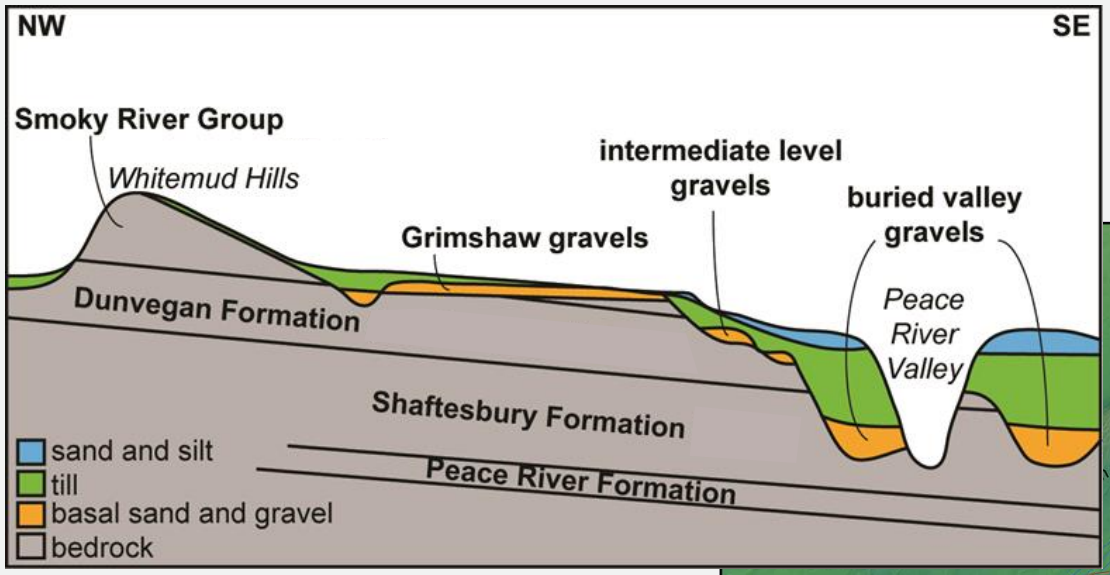
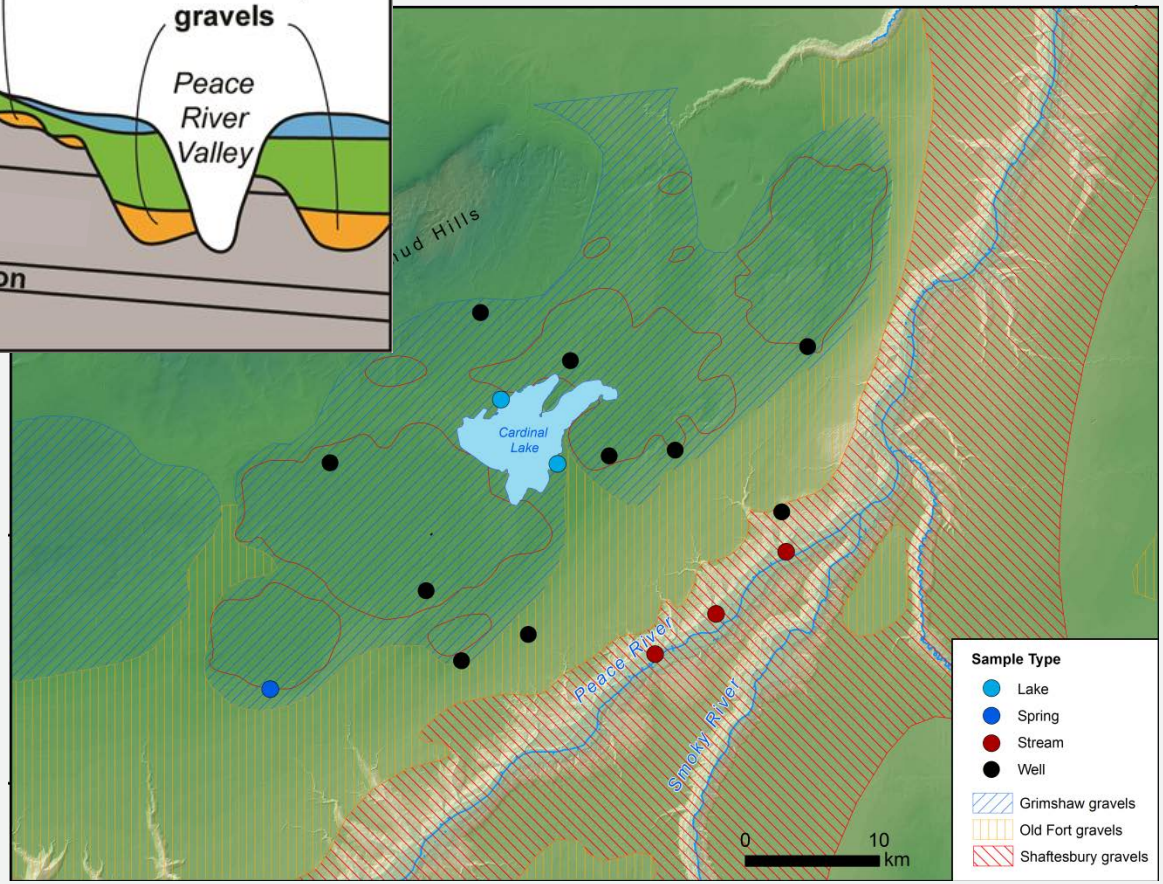
Groundwater Residence Time



- Environmental tracers
  - Stable isotopes (^{2}H, ^{18}O)
  - Tritium (^{3}H), Radiocarbon (^{14}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