INFLUENCE OF TILL PROVENANCE ON REGIONAL GROUNDWATER GEOCHEMISTRY

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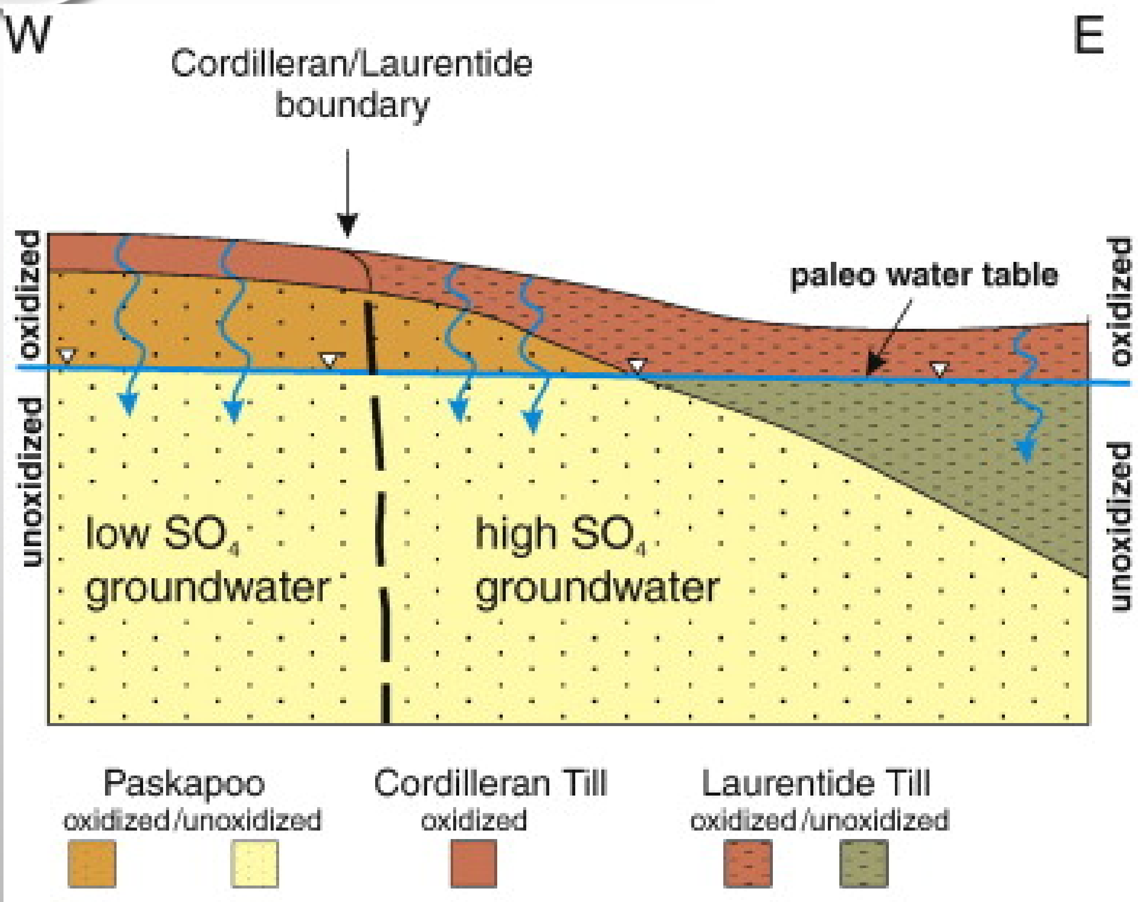
WHY THIS TOPIC?

- I wanted to know more about the formation of gypsum.
- I wanted to know more about the formation of gypsum in the Paskapoo Formation.
- I want to know when or what conditions would make one of the well samples equal equilibrium or saturated.

BACKGROUND



- Paskapoo Formation is located in southern Alberta, Canada
- Study area focuses on a region where two continental ice sheets met, the Cordilleran and Laurentide
- Oxidation of pyrite in Laurentide till generates high-sulphate groundwater

LOCAL GEOLOGY

- Paskapoo Formation is an extensive Tertiary fluvial mudstone and sandstone complex.
- The Cordilleran ice sheet covers plains from the eastern slopes of the Canadian Rocky Mountains and deposited sediment made of carbonates and pink-purple quartzite.
- The Laurentide ice sheets are from the Hudson Bay region, hat moves over high grade metamorphic and igneous rocks from the Canadian Shield, but also shales form the regions of the Western Canada Sedimentary Basin.

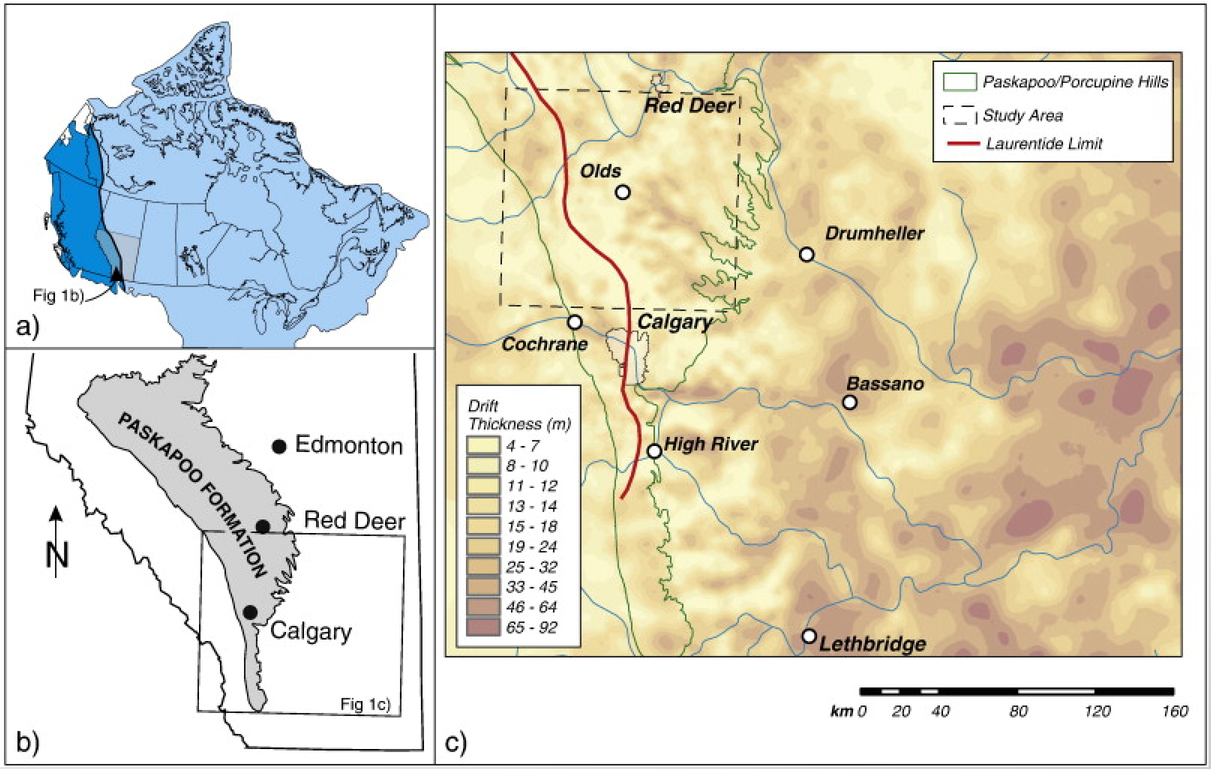


Fig. 1. Regional map showing location of a) extent of maximum continental glaciation and the boundary between the Cordillera (dark blue) and Laurentide (light blue) ice sheets that runs through our study area, b) spatial distribution of the Paskapoo Formation in southern Alberta, and c) variation of drift thickness across southern Alberta, along with the western boundary of Laurentide glacial deposits derived from Prest et al. (1968).

METHOD OF HOW DATA WAS COLLECTED

- **Pumps run for 10 to 15 minutes, until stable readings of pH, temperature, redox potential, and dissolved O_2 were measured by electrodes within an in-line flow cell.**

- **Samples collected that were collected were preserved in the field.**

SAMPLE COLLECTED

SOLUTION 1

TEMP	6.6
PH	7.51
PE	4
REDOX	PE
UNITS	MG/L
DENSITY	1
ALKALINITY	660.9
MG	17
CA	66
NA	710
K	3.7
S(6)	1015.2
CL	5.3
WATER	1 # KG

PHASE	SI**	LOG IAP	LOG K(279 K, 1 ATM)	
ANHYDRITE	-1.48	-5.57	-4.09	CASO4
ARAGONITE	0.02	-8.22	-8.24	CACO3
CALCITE	0.18	-8.22	-8.40	CACO3
CO2(G)	-1.76	-2.98	-1.22	CO2
DOLOMITE	-0.17	-16.80	-16.64	CAMG(CO3)2
GYPSUM	-0.97	-5.57	-4.61	CASO4:2H2O
H2(G)	-23.04	-26.09	-3.04	H2
H2O(G)	-2.01	-0.00	2.01	H2O
HALITE	-7.06	-5.51	1.55	NACL
O2(G)	-43.81	-46.54	-2.73	O2
SYLVITE	-8.83	-8.02	0.80	KCL

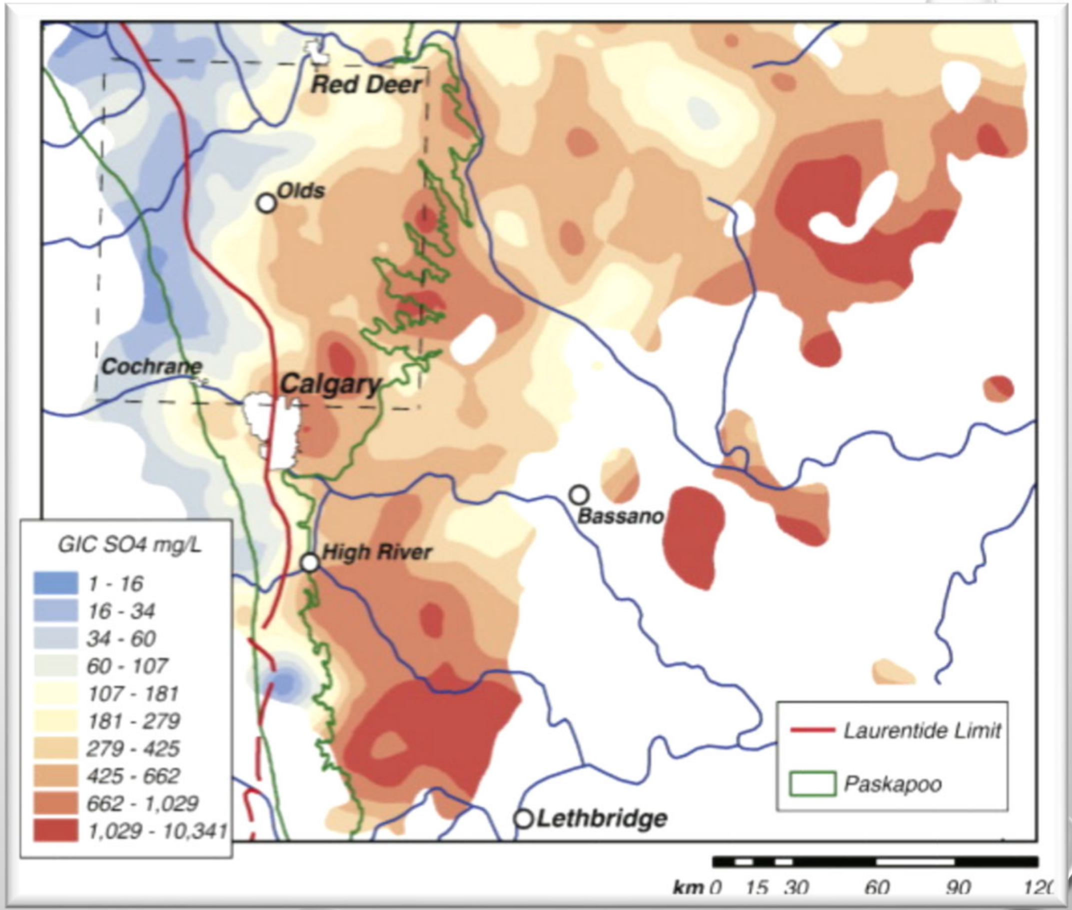
PREVIOUS WORK

- **Activities of major ions and solubility indexes were calculated by using PHREEQC.**
- **Solubility indexes show that increasing concentrations approach, but do not meet, the gypsum saturation.**
- **Lack of precipitation of gypsum precipitation in the study area, unlike the high-sulfate groundwater regions that are east of the study area.**

MY WORK

What would make the Gypsum precipitate, like areas east of the study area?

By changing the amounts of Calcium, so that gypsum so that the SI for Gypsum is at equilibrium or to be saturated.



RESULTS FOR AT EQUILIBRIUM

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SOLUTION 1

TEMP      6.6

PH       7.51

PE       4

REDOX     PE

UNITS     MG/L

DENSITY   1

ALKALINITY 660.9

CA        1100

CL        5.3

K         3.7

MG         17

NA        710

S(6)      1015.2

WATER    1 # KG
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PHASE              SI** LOG IAP   LOG K(279 K,   1 ATM)


ANHYDRITE      -0.51     -4.60   -4.09  CASO4

ARAGONITE       1.18     -7.06   -8.24  CACO3

CALCITE         1.34     -7.06   -8.40  CACO3

CO2(G)         -1.81     -3.03   -1.22  CO2

DOLOMITE        0.93    -15.70  -16.64  CAMG(CO3)2

GYPSUM          0.00     -4.60   -4.61  CASO4:2H2O

H2(G)         -23.04    -26.09   -3.04  H2

H2O(G)         -2.01     -0.00    2.01  H2O

HALITE         -7.09     -5.54    1.55  NACL

O2(G)         -43.81    -46.54   -2.73  O2

SYLVITE        -8.86     -8.06    0.80  KCL
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RESULTS FOR SATURATED

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SOLUTION 1

   TEMP      6.6

   PH        7.51

   PE        4

   REDOX     PE

   UNITS     MG/L

   DENSITY   1

   ALKALINITY 660.9

   CA        2000

   CL        5.3

   K         3.7

   MG        17

   NA        710

   S(6)      1015.2

   WATER     1 # KG
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PHASE            SI** LOG IAP   LOG K(279 K,   1 ATM)


ANHYDRITE       -0.40    -4.49   -4.09  CASO4

ARAGONITE        1.38    -6.86   -8.24  CACO3

CALCITE          1.54    -6.86   -8.40  CACO3

CO2(G)          -1.85    -3.07   -1.22  CO2

DOLOMITE         1.07   -15.56  -16.64  CAMG(CO3)2

GYPSUM           0.11    -4.49   -4.61  CASO4:2H2O

H2(G)          -23.04   -26.09   -3.04  H2

H2O(G)          -2.01    -0.00    2.01  H2O

HALITE          -7.12    -5.57    1.55  NACL

O2(G)          -43.81   -46.54   -2.73  O2

SYLVITE         -8.89    -8.09    0.80  KCL
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CONCLUSIONS

- 1,034 mg/L of Ca needs to be added to the original solution for the gypsum to equal equilibrium.
- This means that the solution would need 1,035 mg/L of Ca to be added to the original solution to have Gypsum to precipitate.
- The reasoning of the lack of Gypsum precipitating in the study area, is that there isn’t enough Calcium to support the precipitation of gypsum as in the areas east of the study area.

SOURCES

- GRASBY, STEPHEN E., ET AL. "INFLUENCE OF TILL PROVENANCE ON REGIONAL GROUNDWATER GEOCHEMISTRY." *PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B: BIOLOGICAL SCIENCES*, THE ROYAL SOCIETY, 15 MAY 2010, DOI.ORG/10.1016/J.CHEMGEO.2010.02.024.

QUESTIONS