

LeRoy Salt Company (1884–1928): A Late- Stage Wild-Brining Operation Using Salt-Contact Brine at the Up-Dip Terminus of Halite Beds in the Silurian Salina Group, Northern Rim of the Appalachian Basin

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WORLD SALT SYMPOSIUM

June 19-21, 2018

Park City UT, USA

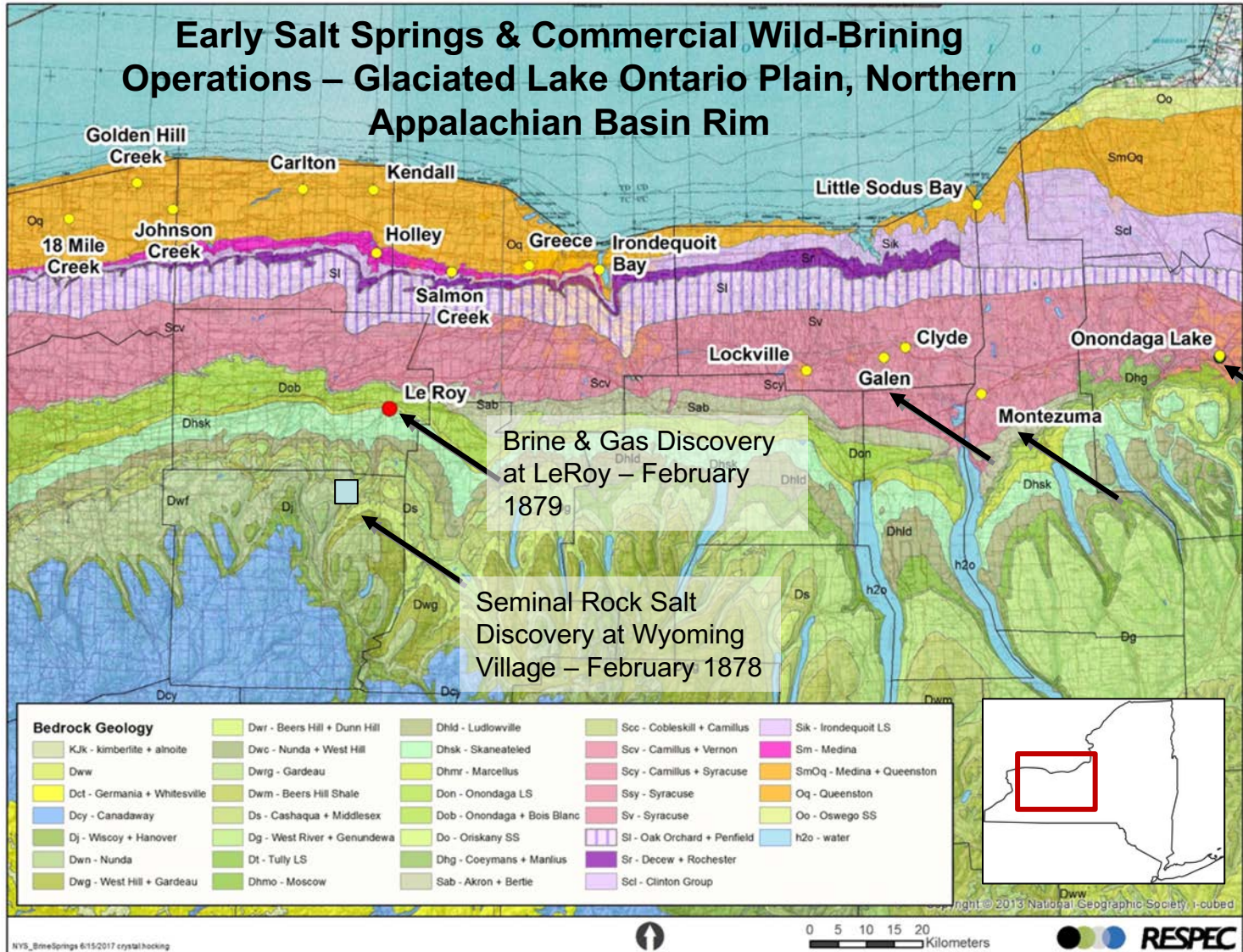


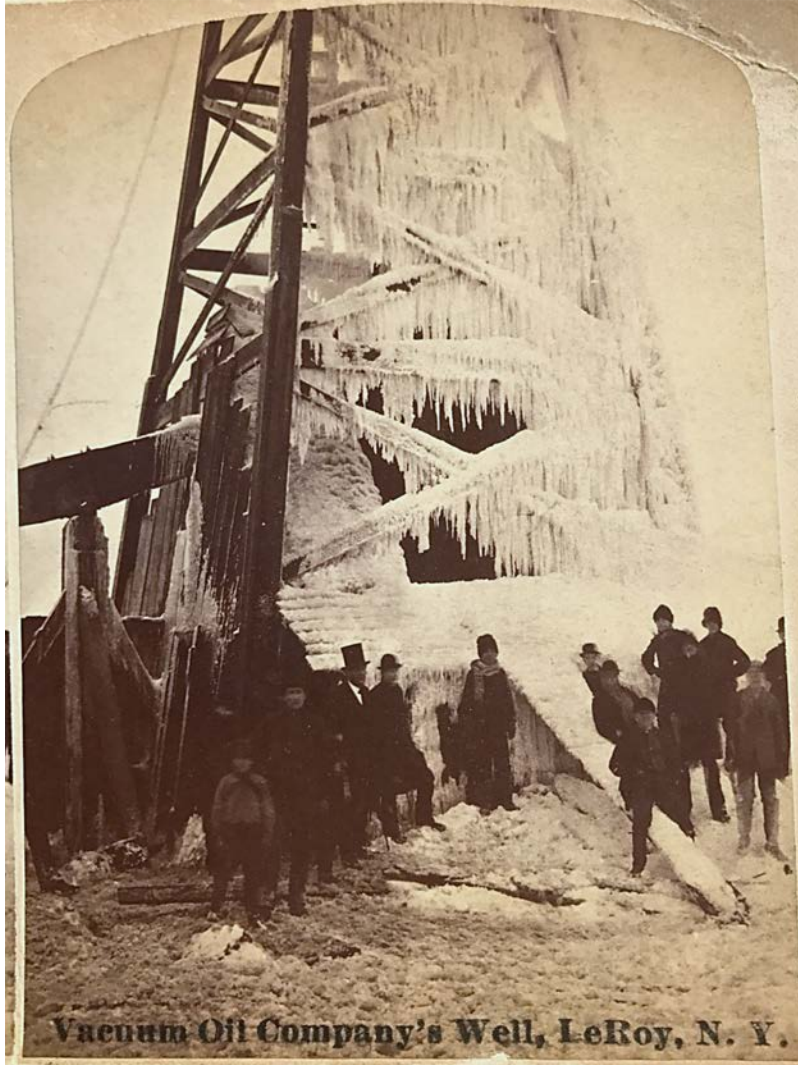
Early Salt Springs & Commercial Wild-Brining Operations – Glaciated Lake Ontario Plain, Northern Appalachian Basin Rim

Oldest Strata (Ordovician)

Silurian Salina Group Outcrop (No Halite Preserved)

Youngest Strata (Upper Devonian)





The "Brine Fountain" – February 1879

Earliest Exploration and Production

Vacuum Oil Test Well No. 1

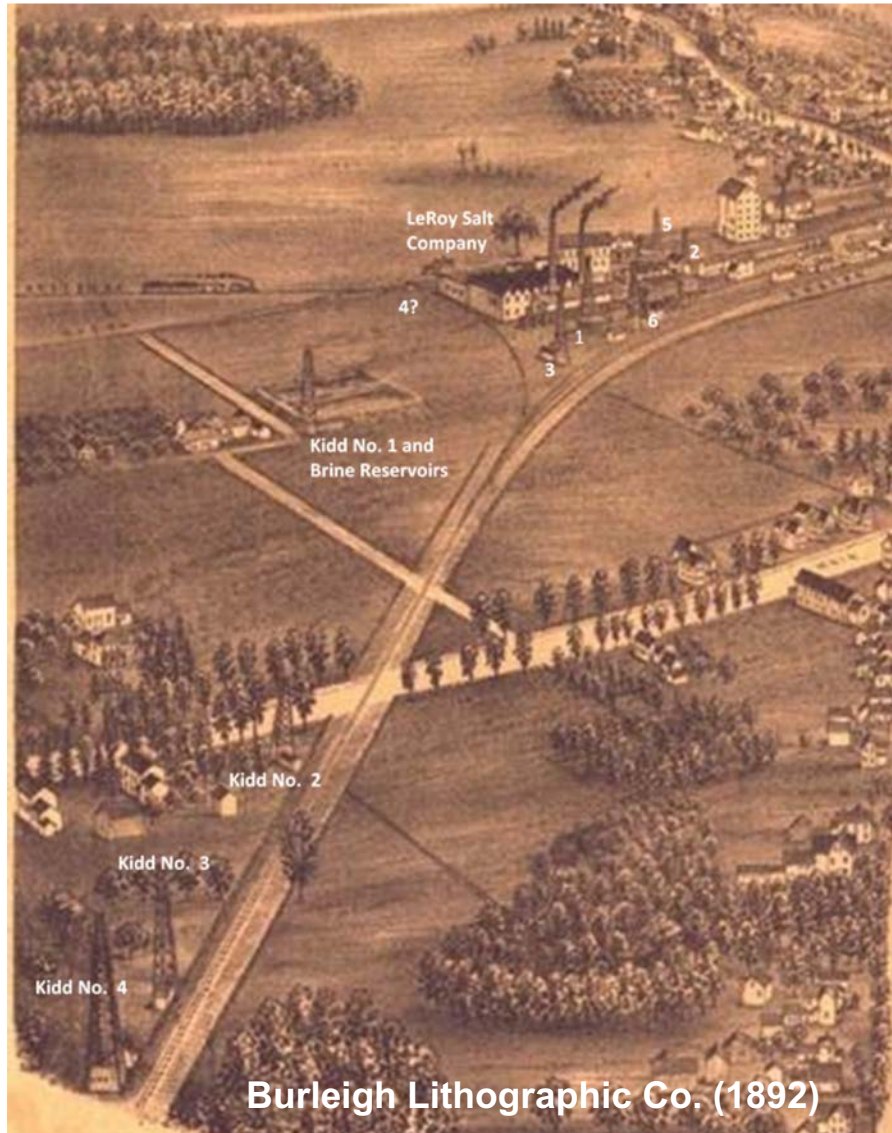
- Spudded December 1878
- Gas and Brine at 137 Meters (450 Feet)
- Rig Caught Fire
- Brine Eruption Extinguished the Fire
- Brine Froze on the Derrick
- Well Prematurely Abandoned; Litigation Ensued

Vacuum Oil Test Well No. 2

- Spudded November 1881
- Halite and Brine at 187 Meters (615 Feet)
- Halite Bed 6.4-7.5 Meters (20-25 Feet) Thick
- Brine at 70-90% Saturation, Averaging 75%

After Acquisition by Standard Oil, Vacuum Oil Divests

In 1883, American Chemical Company Builds and Operates a Plant of Experimental Design. It Fails.

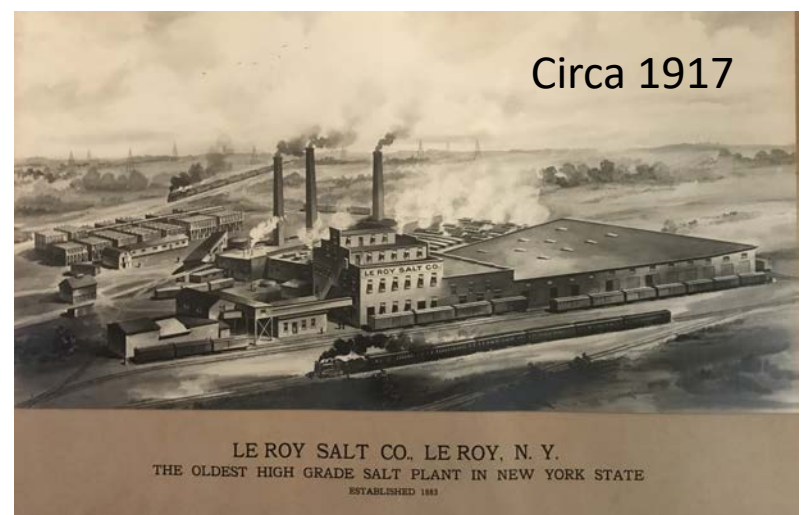
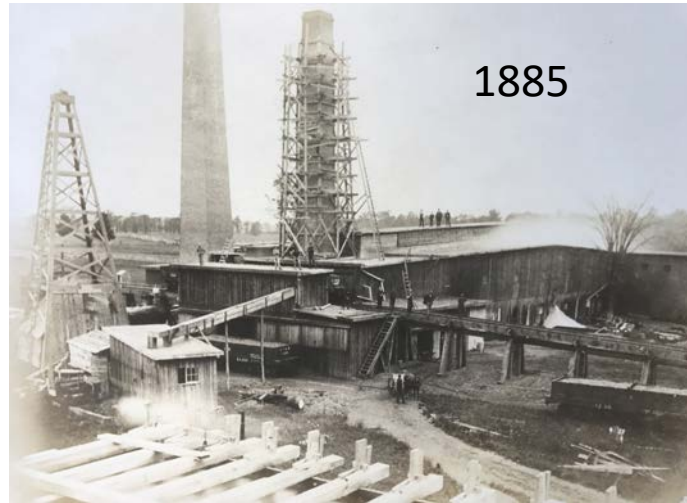


LeRoy Salt Company (Formed 1884)

- 1884: Initial plant - grainer process - two wells
- 1886: Well No. 3 added, Well No. 4 started, plant capacity at 500 barrels per day (BPD). Potential competitor George Kidd drilled wells on adjacent lands, constructed large brine reservoirs.
- 1888: artesian brine struck at 174 meters (571 feet) and 5.2 meter (17 feet) thick halite bed penetrated at 183 meters (600 feet) in Well No. 5.
- 1889: LeRoy Salt Company acquires the Kidd wells. Eight wells supply the plant, and capacity increased to 600 BPD.
- 1890: Plant fire and reconstruction
- 1893: Major plant upgrades
- 1893: Contract let to drill three more wells
- 1897: 11 wells in field, plant capacity at 1,000 BPD.
- 1899: Plant sold to National Salt Company
- 1901: Plant sold to Buffalo meat packers – name change to Empire Salt
- 1905: Name changed back to LeRoy Salt Co.
- 1915: Plant fire and reconstruction
- 1928: Plant sold to Watkins Salt Co. and shuttered

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LE ROY SALT CO., LE ROY, N. Y.
THE OLDEST HIGH GRADE SALT PLANT IN NEW YORK STATE
ESTABLISHED 1883

Comparison of LeRoy Salt Brine Chemistry with Manufactured Brines

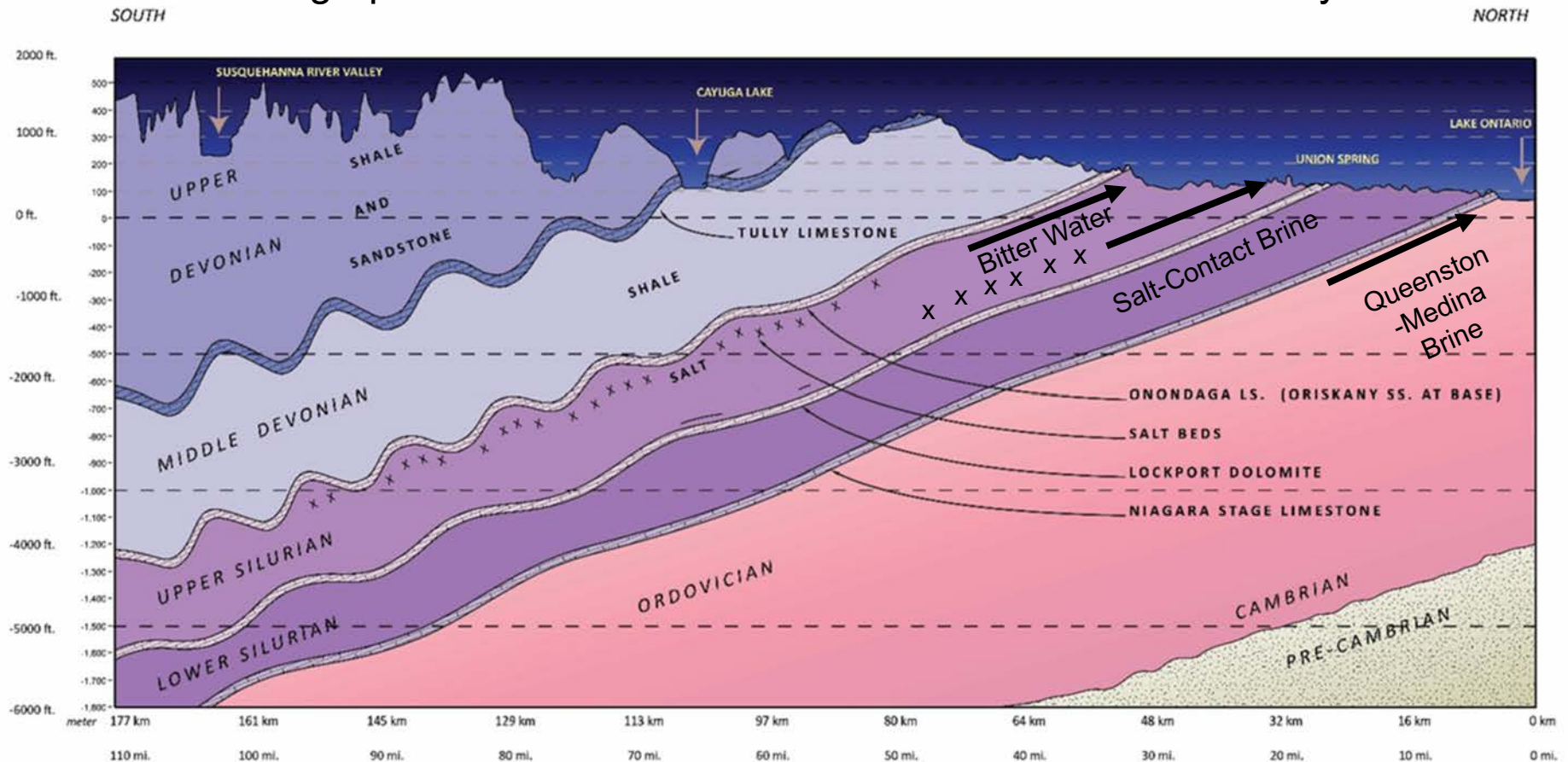
Salt Well	Pearl Creek	Warsaw	LeRoy	Piffard	Tully
Specific Gravity	1.1924	1.2045	1.192	1.1891	1.1861
CaSO ₄ (%)	1.70	1.68	1.26	1.52	2.41
CaCl ₂ (%)	0.27	0.52	2.15	0.77	0.05
MgCl ₂ (%)	0.55	0.20	0.42	0.76	0.05
NaCl (%)	97.48	97.60	96.17	96.95	97.49
Based on data from Bishop [1886] and Brummelkamp [1889].					

Elevated CaCl₂ appears to be the only difference between the natural brine in contact with halite and the manufactured brines.



“Not All Brines Are Created Equal”

Stratigraphic Control on Brine Occurrences and Geochemistry



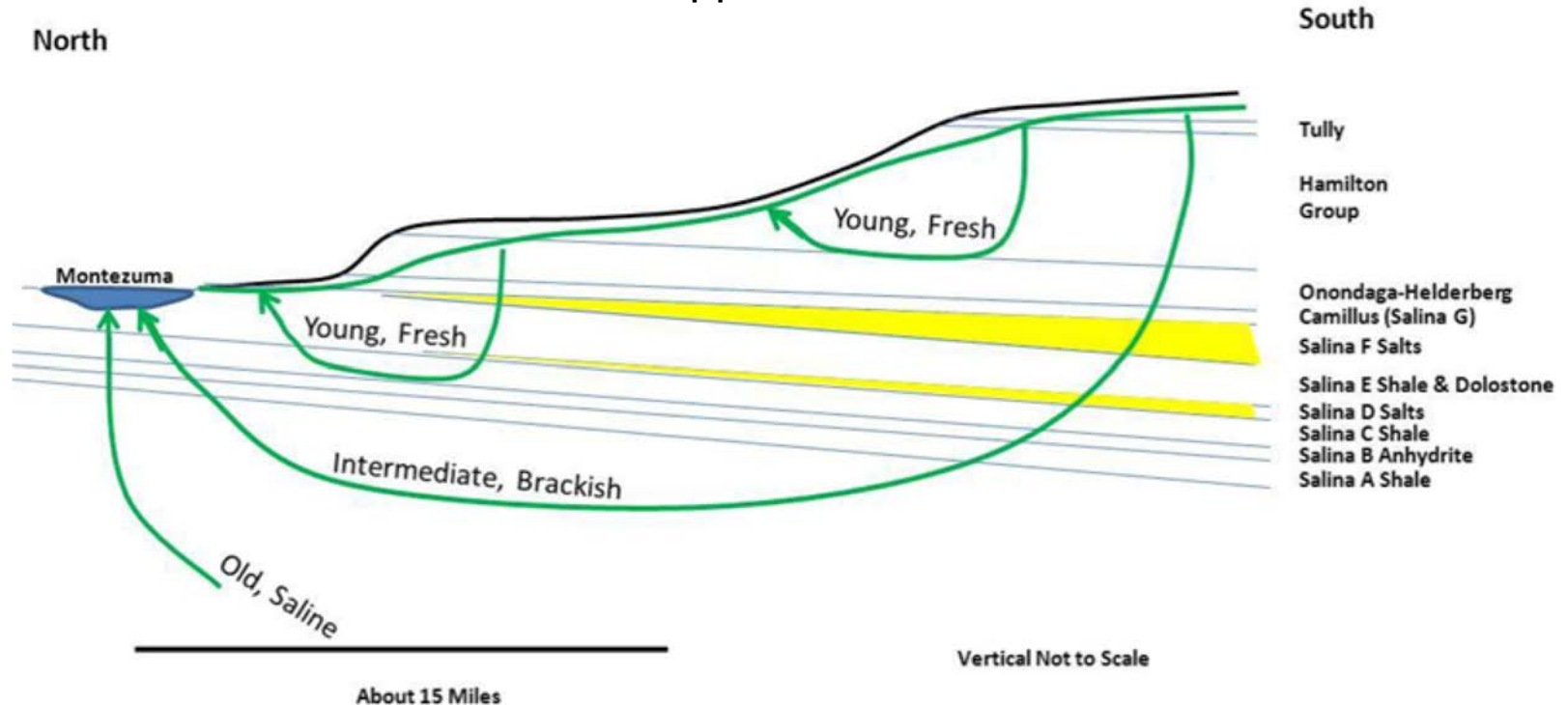
- Stratigraphically Lowest: Queenston-Medina (Ordovician-Silurian)
 - Siliciclastic source rocks - ferruginous
 - Unconventional gas reservoir (permeable to gas; less so to water)
 - Na>Ca>Mg>K
 - Cl/Br ~ 100
 - Isotopically heavier than modern meteoric water
 - Likely concentrated seawater later diluted by meteoric water (Tertiary?)

- Intermediate Position: Salina Group Halite Contact Brine (LeRoy)
 - Mixed carbonate-siliciclastic-evaporitic source rocks
 - Na>>Ca>Mg>K
 - Cl/Br ~ 3000+
 - Isotopic signature undocumented
 - Halite dissolution brine

- Stratigraphically Highest: Salina-Bertie Group Bitter Water
- Intermediate Position: Salina Group Halite Contact Brine
 - Mixed carbonate-siliciclastic-evaporitic source rocks
 - Na>>Ca>Mg>K
 - Isotopic signature undocumented
 - Likely in chemical equilibrium with Upper Salina-Bertie Group dolomites



Conceptual Tothian Flow System Northern Rim Appalachian Basin



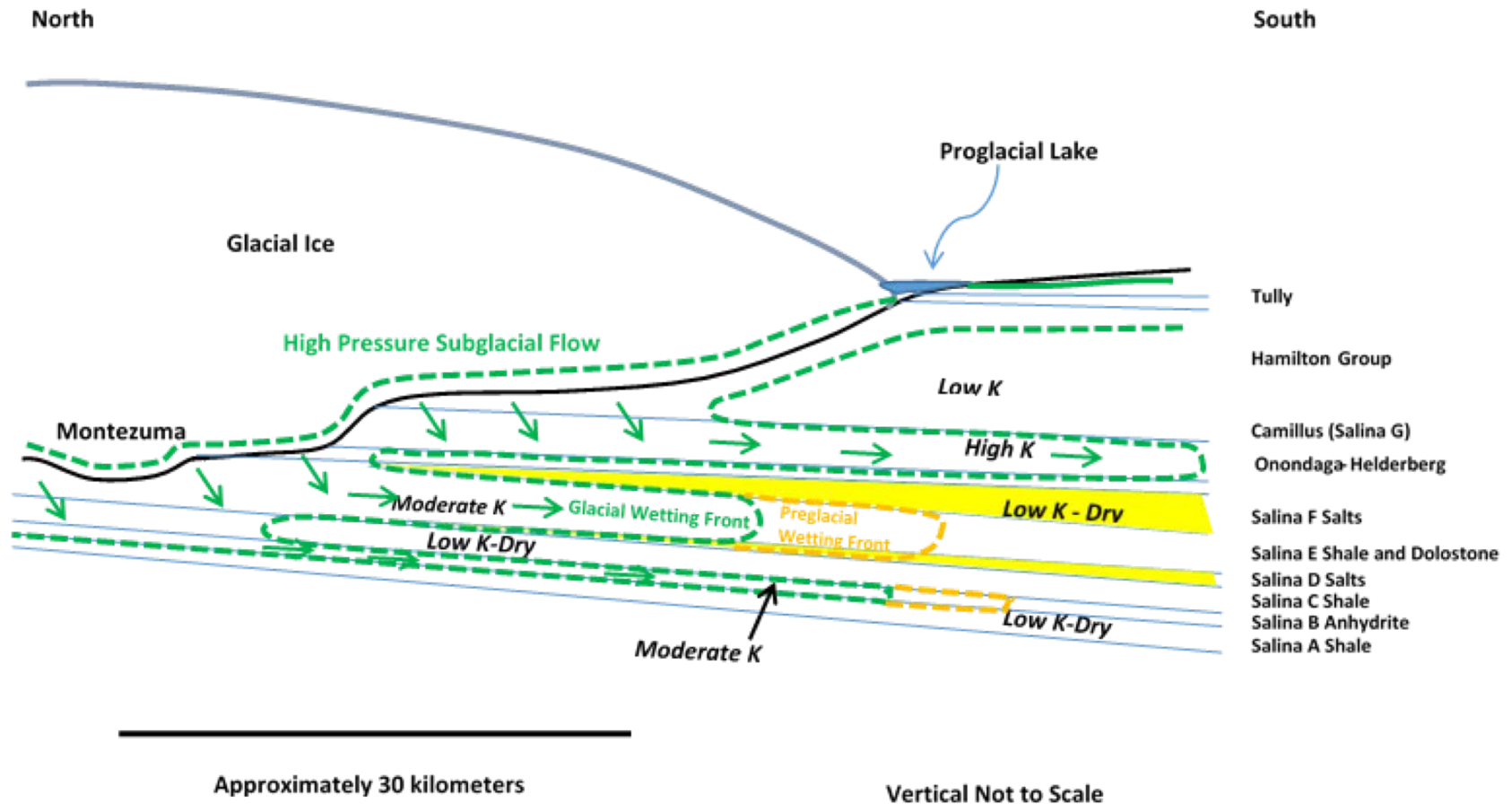
Problems:

- 1) Stratified Geochemistry
- 2) Salina Group Aquifuge (Wet only near up-dip terminus)
- 3) Brine Detected Between Salt Beds in Oil & Gas Wells
- 4) North-Facing Escarpment Topography Is Geologically Young

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Modified from
Goodman et al. [2011]

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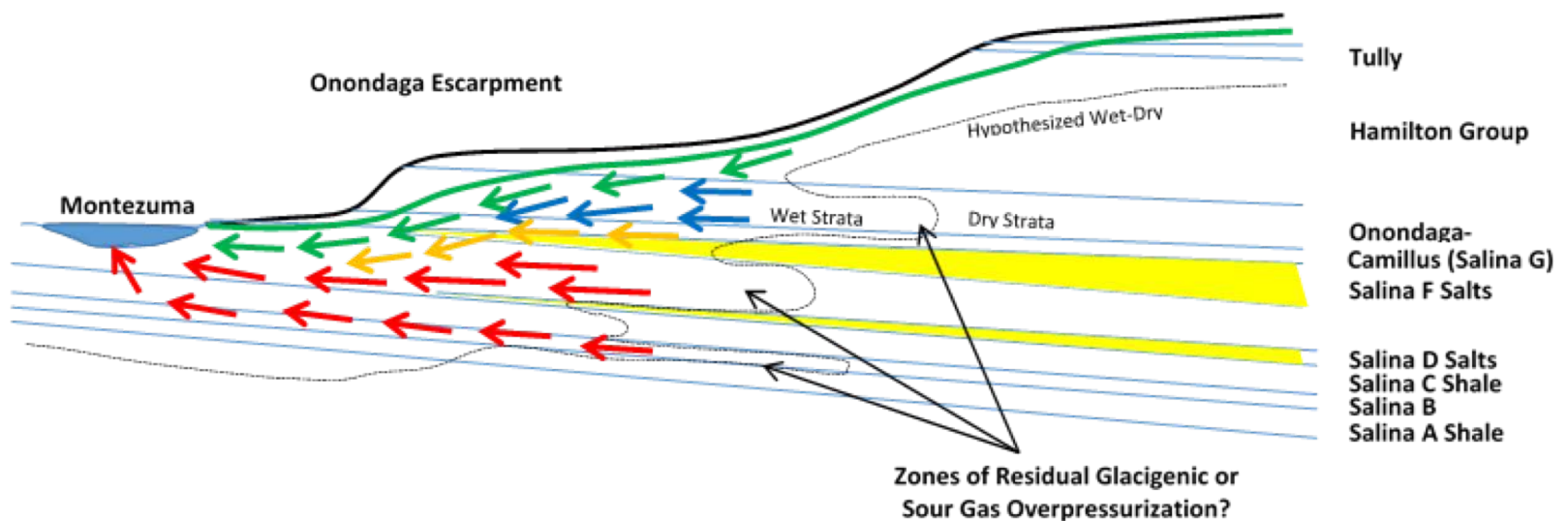
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- ← Modern Meteoric Recharge (Calcium Bicarbonate)
- ← Older Meteoric Recharge (Calcium Sulfate)
- ← Ancient (Glacial or Earlier) Recharge (Sodium and Calcium Chloride)
- ← Ancient (Glacial or Earlier) Recharge (Sodium Chloride)

North

South



Approximately 30 kilometers

Vertical Not to Scale

Modified from
Goodman et al. [2011]



Summary

- LeRoy Salt Company operated a wild-brining operation from 1884 to 1928 exploiting salt contact brine.
- Brine from other formations above and below the Salina salt horizon exploited at LeRoy exhibit different geochemical characteristics that were less conducive to salt manufacture
- The salt-contact brine at LeRoy bears many similarities to manufactured brine with possible exception of higher calcium.
- Stratification of brine geochemistry and field observations argue against cross-formational flow of saline fluids and is consistent with formation-parallel flow possibly recharged transiently from a glacial source to the north.
- The modern Lake Ontario Plain is dotted with brine springs, suggesting that what once may have been a recharge area during the Pleistocene is now the principal discharge area for saline fluids.
- The term “pocket aquifer” is proposed for this hypothesized glacially-driven flow system with no apparent down-dip discharge zone.