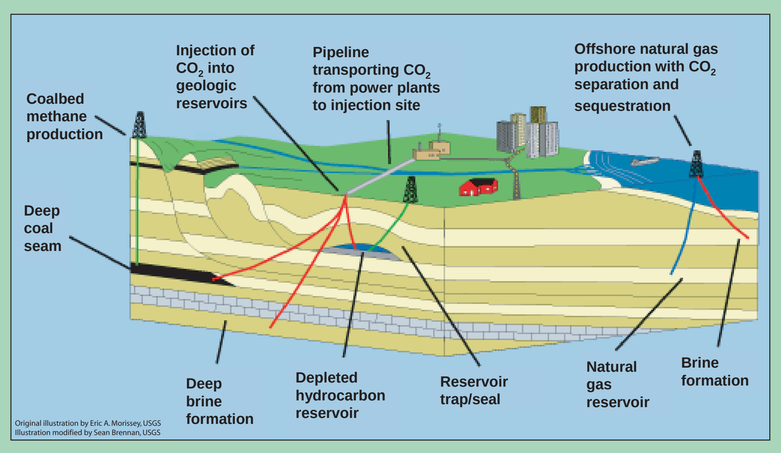
Geological Carbon Sequestration in New York State

Alexa Stolorow, Reservoir Characterization Group, New York State Museum
Richard Nyahay, Reservoir Characterization Group, New York State Museum
Taury Smith, Reservoir Characterization Group, New York State Museum

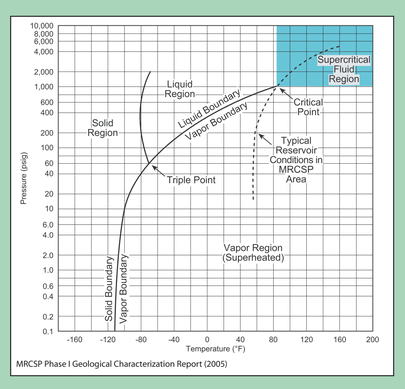
Carbon Capture and Storage (CCS)

Carbon capture and sequestration is the process by which carbon dioxide from stationary sources is captured and stored below ground or offshore under the ocean. New York will be focusing on geologic storage (below ground).

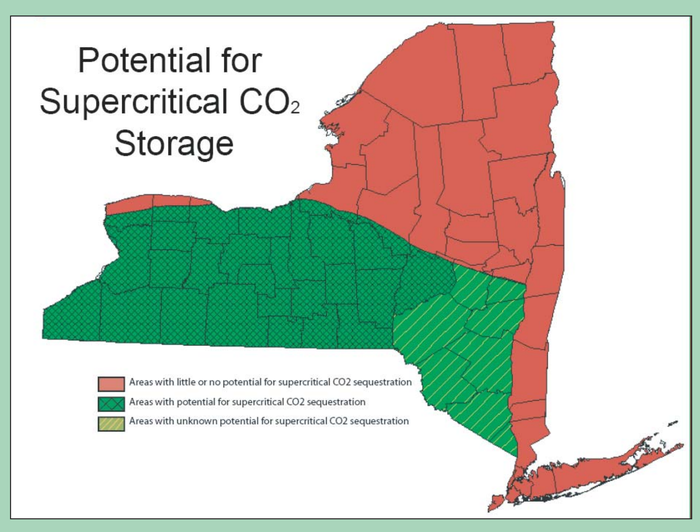


Geological Carbon Sequestration

In order to effectively and efficiently sequester carbon dioxide underground, it must be in a supercritical state, which has the density of a liquid but flows like a gas. In a given space, one can store about 260 times more CO_2 when it's in a supercritical state as compared to a gas or liquid state. Supercritical CO_2 requires temperatures and pressures of at least 31.1°C and 73atm, respectively. Supercritical storage potential in New York State occurs in formations at least 2500' below ground. The potential for supercritical storage in NY is mainly in western and central portions of the state.

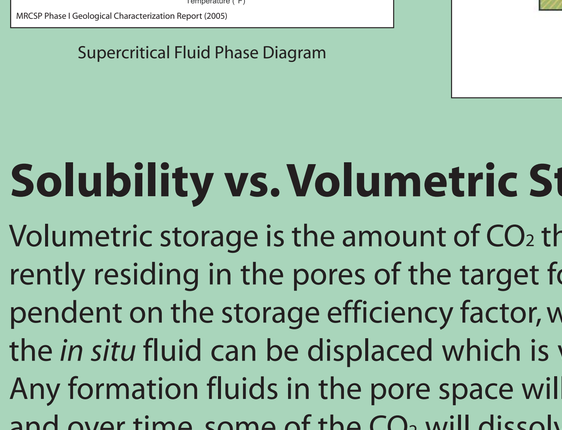


Supercritical Fluid Phase Diagram



Solubility vs. Volumetric Storage

Volumetric storage is the amount of CO_2 that can be stored by displacing the fluid currently residing in the pores of the target formation. Volumetric storage is heavily dependent on the storage efficiency factor, which is the percent of the pore space where the *in situ* fluid can be displaced which is variably estimated at between 0.5 and 30%. Any formation fluids in the pore space will have to be displaced as the CO_2 is injected, and over time, some of the CO_2 will dissolve into these fluids. Solubility of CO_2 greatly decreases as salinity rises. Most of the prospective sequestration formations in New York contain high salinity brine near 300,000 ppm, so there will be very little solubility storage capacity in NY. In Phase I of the MRSCP project, the CO_2 storage capacity for the Mt. Simon Sandstone (Potsdam) was estimated using both volumetric and solubility storage equations. The resulting potential storage capacity decreased by a factor of 2.6 when salinity concentrations in the formation fluids was included in the calculation.



CO_2 solubility decreases as salinity increases

Jarrel and Others, 2002

Table 2.4
BRINE QUALITY DATA FROM
NEW YORK'S GAS AND OIL PRODUCING ZONES

Parameter (mg/L)	Potsdam/ Theresa	Queenston	Medina	Oriskany	Bass Island	Upper Devonian Oil Zones
Sodium (Na)	36,712	73,500	69,893	45,457	60,750	36,367
Calcium (Ca)	31,256	36,603	37,124	33,684	36,400	16,467
Magnesium (Mg)	4,449	2,887	2,766	3,169	3,160	2,733
Strontium (Sr)	-	0	-	-	-	107
Barium (Ba)	790	0	-	-	-	8
Potassium (K)	3,367	-	-	1,307	-	71
Iron (Fe)	17	1,124	676	215	18	189
Manganese (Mn)	0	195	84	-	0	7
Chloride (Cl)	183,701	182,418	181,298	145,442	208,000	92,167
Bromide (Br)	1,417	1,120	1,721	1,687	-	860
Sulfate (SO_4)	18	-	736	57	180	619
Bicarbonate (HCO_3)	89	-	25	203	50	0
Iodine (I)	9	10	18	10	-	200
Lithium (Li)	54	-	-	-	-	-
Trace Metals	-	-	-	-	-	0.74
Hydrocarbons	-	-	-	-	-	107.5
Measured TDS	300,763	298,358	292,121	231,836	323,500	156,267
Calculated TDS	299,137	302,609	292,723	232,743	323,558	149,582
IONIC RATIOS						
Na/Ca	2.4	2.01	1.89	1.42	1.08	2.24
Ca/Mg	9.75	12.76	15.90	6.93	34.17	6.04
Mg/K	1.07	2.64	-	4.00	-	47.03
Cl/Br	142.84	255.07	102.49	104.66	-	104.60
No. of Analyses	9	2	8	4	2	3

DEC, 1988

Salinity concentrations are very high. What type of reactions might occur between the CO_2 and other elements in the brine?

Geological Work with the MRCSP

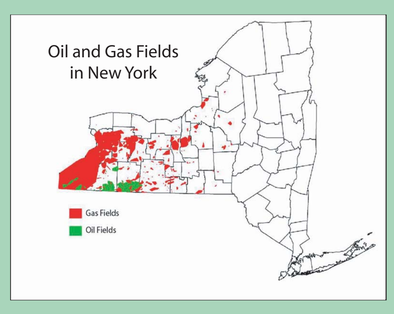
The Midwest Regional Carbon Sequestration Partnership (MRCSP) began in 2003 and is one of seven USDOE regional partnerships exploring CCS. New York recently joined the partnership and the NYS Museum Reservoir Characterization Group is now in the process of integrating its geological data with that of the other member states. The first step for New York in the MRCSP CCS research plan is to perform a detailed characterization of geological formations in NYS to identify storage opportunities.

Sequestration Targets in New York

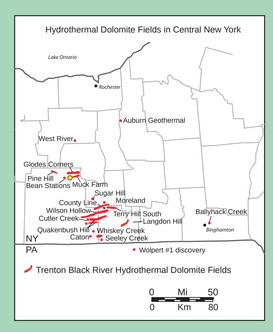
The main opportunities for geological sequestration are depleted gas reservoirs and saline aquifers.

Depleted Oil and Gas Reservoirs

New York has produced natural gas for more than a century, and there are many depleted reservoirs. Most of the reservoirs are currently used for natural gas storage which is a lucrative business. Most fields used for storage would not be available for carbon sequestration. The biggest gas reservoirs in the State are in the Black River Formation. Assuming these reservoirs produce 500 BCF and that all of the pore space was filled with CO2 they could store the amount captured from one large powerplant for 40 years.

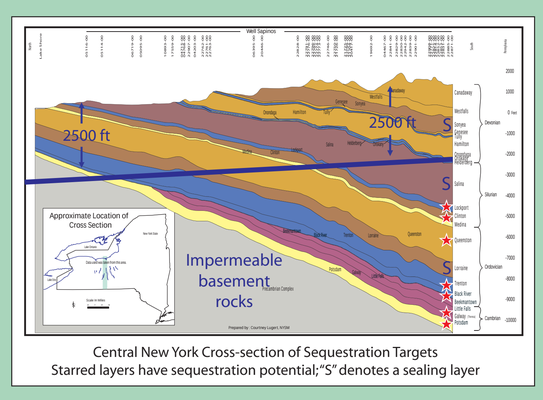


Black River Core

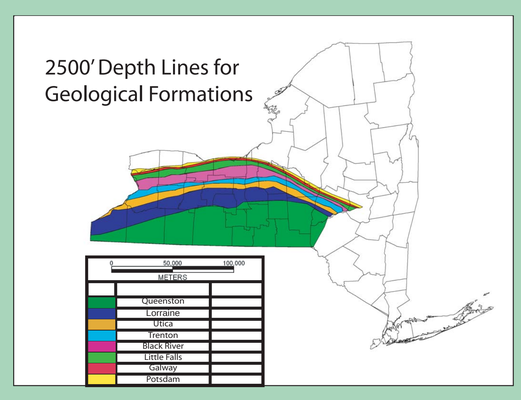


Onshore Saline Aquifers

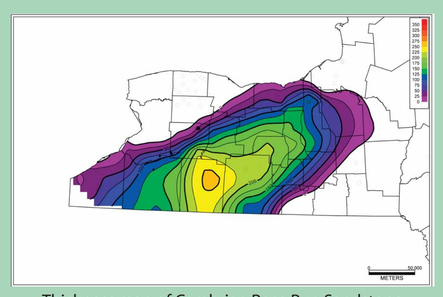
Saline aquifers are formations deep in the subsurface that are filled with very salty water. The formations need to have porosity and permeability and be at least 2500 feet deep. All formations will be evaluated. At present, the best options are thought to be in the Cambrian Potsdam (which has few wells drilled to it) and the Cambrian Rose Run Sandstone.



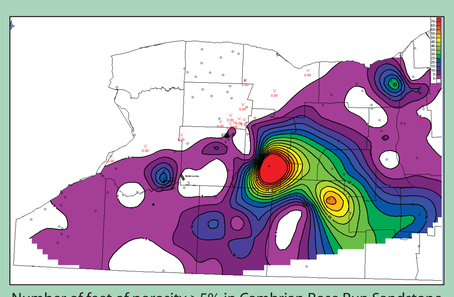
Central New York Cross-section of Sequestration Targets
Starred layers have sequestration potential; "S" denotes a sealing layer



Rose Run Core



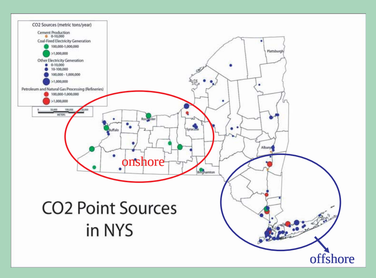
Thickness map of Cambrian Rose Run Sandstone

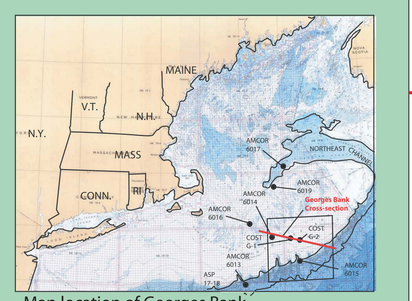


Number of feet of porosity >5% in Cambrian Rose Run Sandstone

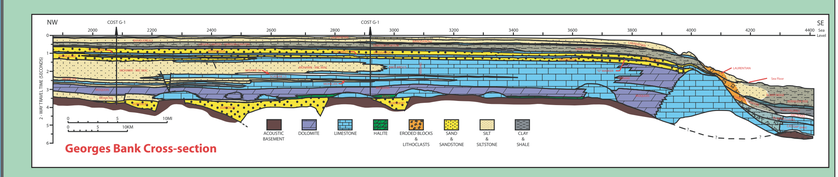
Offshore Saline Aquifers

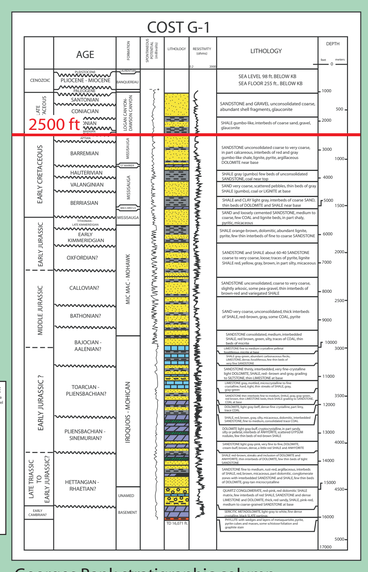
The greatest potential for geological carbon sequestration in saline aquifers is offshore. There more than 25 different layers with up to 30% porosity (compared to a maximum of 10-15% onshore). These Formations would require pipelines and platforms in offshore areas which are expensive, but many of the regulatory and safety issues would be avoided with offshore sequestration.





Map location of Georges Bank





Georges Bank stratigraphic column

Other Options in New York

In addition to depleted gas reservoirs, enhanced gas recovery (EGR) is also being explored. In gas shales, methane is adsorbed onto the surfaces of clay particles. When CO_2 is injected into a carbonaceous gas shale formation, it can displace and desorb the methane, thus sequestering the CO_2 and mobilizing the natural gas. At this point EGR is more of a theory than a reality, however since there are large volumes of shale in NY it would be beneficial to be able to apply this method of sequestration. NYSERDA has funded two shale gas projects that are currently be researched at the New York State Museum.