Feasibility Study of a Potential CCUS Project in Colorado

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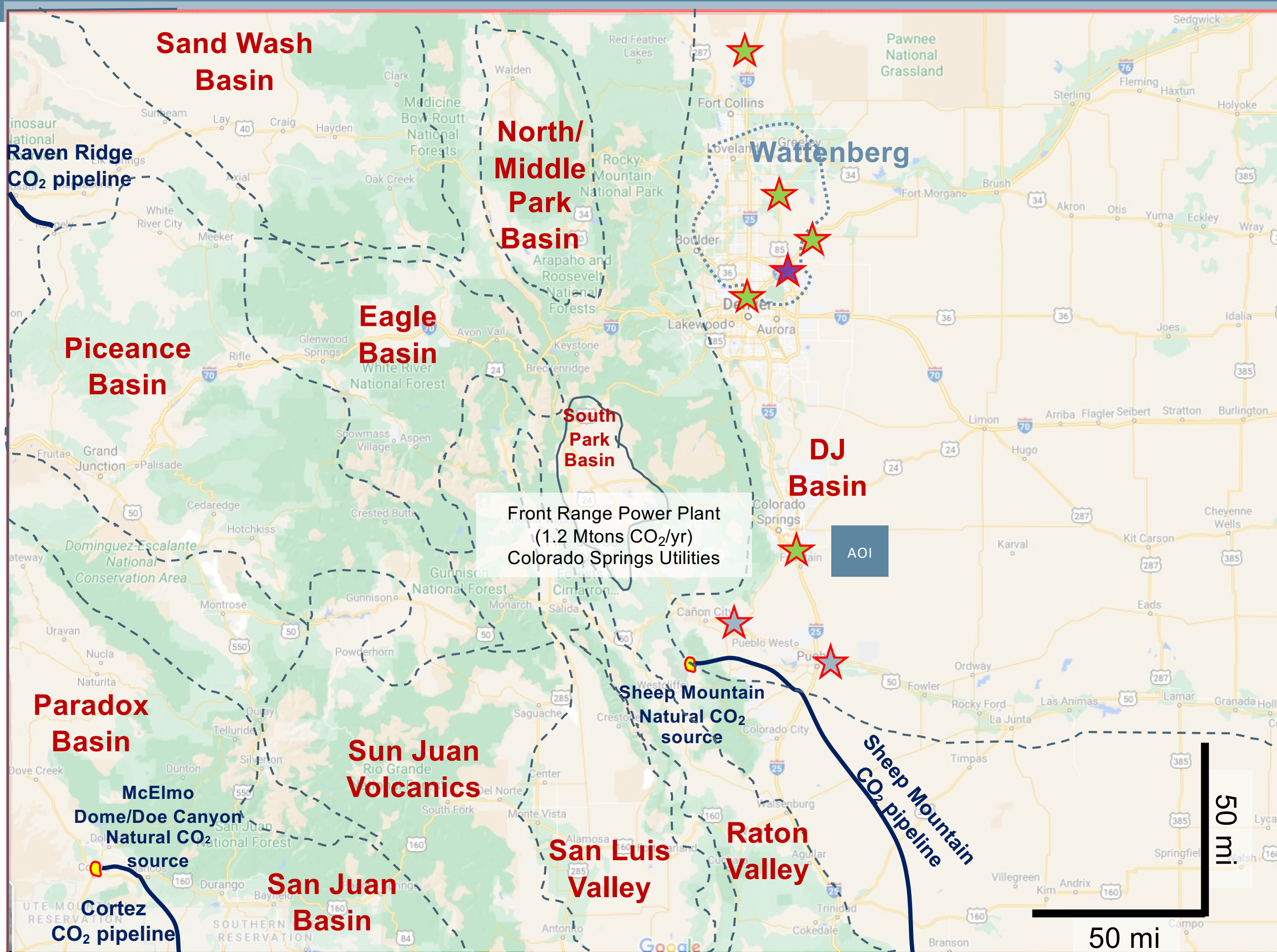
Project Overview

- Project:
  - CO2 Capture from a Gas Power Plant Source
  - Sequestration in the DJ Basin or a Saline Aquifer Near the CO2 Source
- Partners
  - Colorado Springs Utilities (CSU)
    - > Front Range Power Plant
    - > 1.2 MMtons CO_2/year
  - Oxy Low Carbon Ventures
    - > Operators
- Tasks:
  - Implement a carbon capture utilization and sequestration (CCUS) project in Colorado
    - > Estimate the captured CO2 amount
    - > Find the most cost-effective capturing technology currently available
    - > Build a robust and cost-effective infrastructure network to transport the compressed CO2
    - > Understand how much CO2 can be sequestered into typical saline aquifers and in DJ Basin
      - – Conduct subsurface geological, geophysical and reservoir engineering models
      - – Equation calculation
      - – EasiTool

Front Range Power Plant: Sequestration or Transportation?



Top 8 CO_2 emission facilities in CO:

- 5 Natural gas power plant (#1 - 5)
- 1 Refinery (#6)
- 2 Cement plant (#7-8)

Potential storage sites in CO:

- Sedimentary Basin

Pipelines and CO_2 sources:

- Natural CO_2 sources
- CO_2 pipelines

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Estimate Storage capacity – previous CGS (Colorado Geological Survey) study

- Previous work in 2006
  - Is Fountain a potential storage target?
- Equation

$$G_{CO_2} = A_t h_g \phi_{tot} \rho E_{saline}$$

Where:

$A_t h_g \phi_{tot}$ calculates the reservoir volume of CO_2

A_t is the total area

h_g is the formation gross thickness

ϕ_{tot} is the total porosity

ρ is CO_2 density

E_{saline} is the storage efficiency factor

Goodman et al., 2011

Table 14. Reservoir Properties for Deep Saline Aquifers in Colorado

Pilot Study Region	Formation	Minimum Depth to Top of Formation (ft)	Average Formation Thickness (ft)	Porosity (%)	Permeability (millidarcies)	Salinity (ppm)	Reservoir Temperature (°F)	Reservoir Pressure (psig)	Reservoir Area (sq mi)	Potential Seal Formation
Cañon City	Morrison	2,884	320	15.7	31	56,500	144	2,691	1,300	Graneros
	Lyons	2,922	240	4.4	0.9	6,293	123	2,644	1,600	Lynkis
	Fountain	3,068	3,460	16	2	22,000	102	3,984	1,600	Sundance

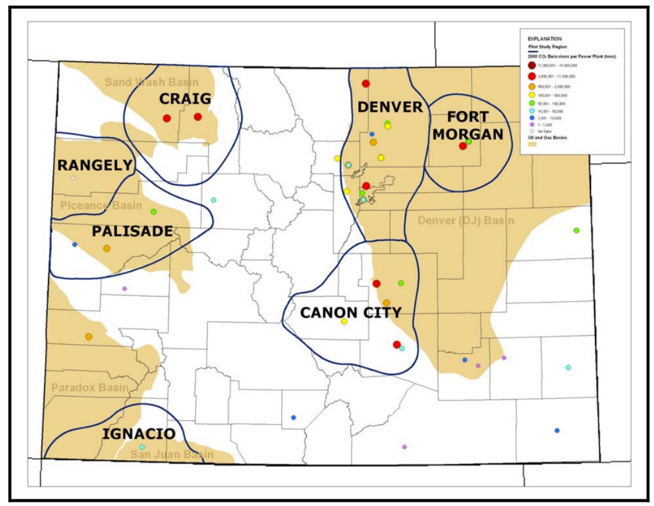
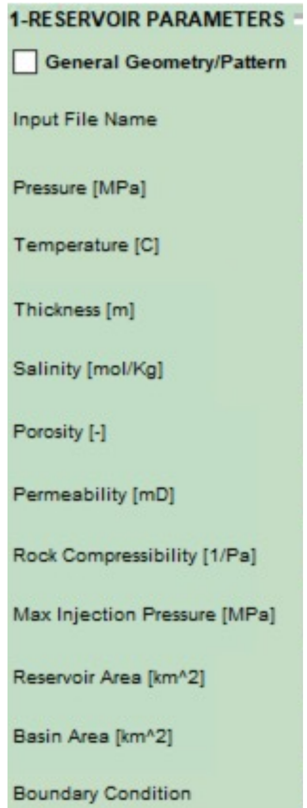


Figure 5.2: Locations of Pilot Study Regions, the consolidated sedimentary basins underlying each region, and power plants in Colorado (from Lintz, 2004; USEPA, 2004).

Estimating storage capacity using in EasiTool

- Reservoir parameters of Lyons Formation near CSU CO_2 sources:
  - Thickness
  - Porosity
  - CO_2 Density
  - Reservoir Pressure
  - Reservoir Temperature
  - Permeability



Estimate total cost

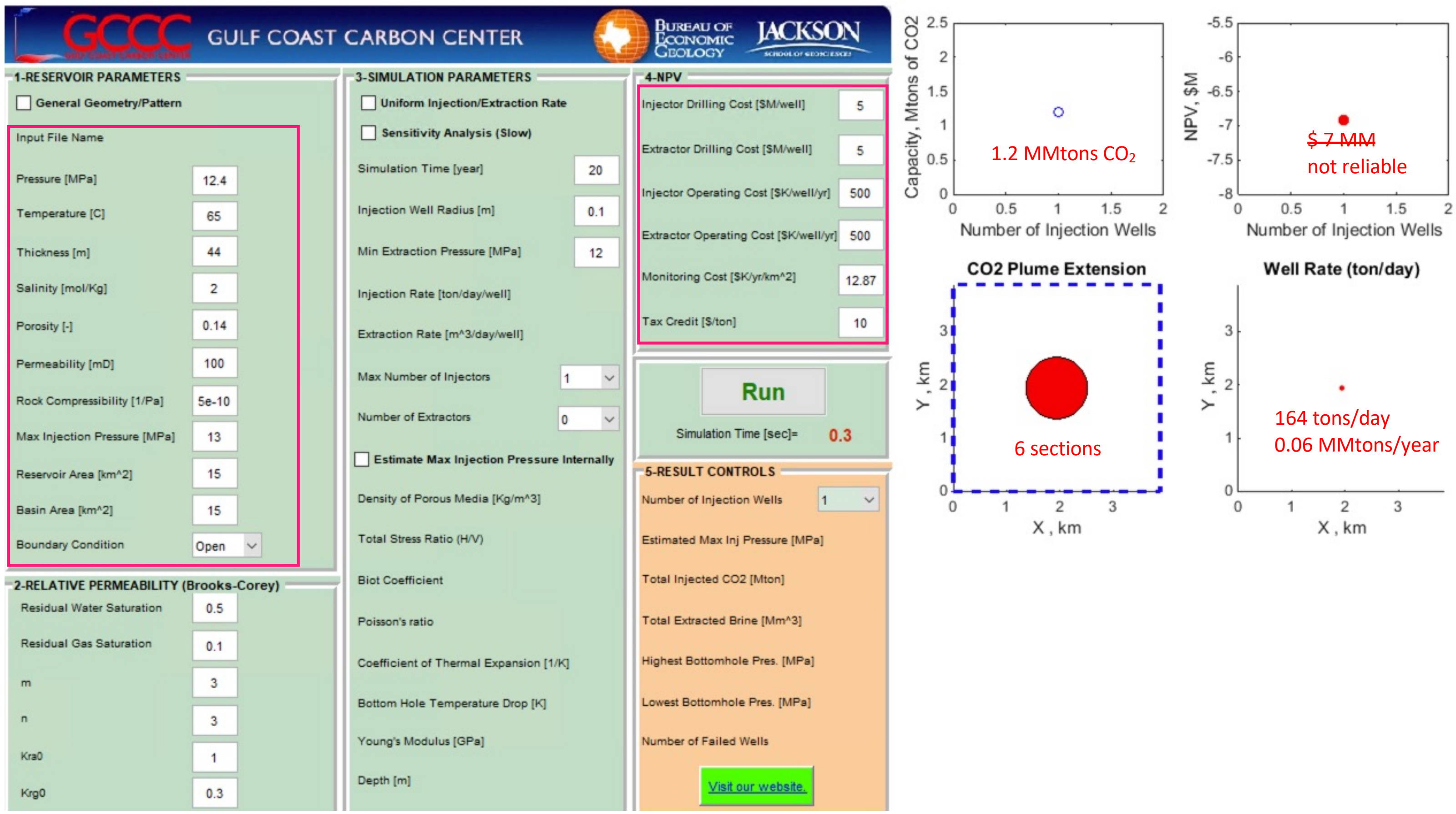
- Cost estimation in EasiTool - Too simple
  - Only consider the cost of Drilling, Operation, monitoring
  - There are more related cost that is not considered.
    - Acreage, monitor, mineral interest owner, etc.

Wells
Acreage ($500/acre)
Pore Space Owner ($0.60/Mt may be up to $1.00/Mt)
Mineral Interest Owners($0.60/Mt may be up to $1.00/Mt)
Pipeline to deliver CO2 to sequestration hub
ROW
3D Seismic Shoots every 5 years (15 years injection 50 years post injection)
Abandonment
Monitoring (Operatiing shack), Inspections, surface pressure/temp measurements
Supercritical CO2 -1900 psi injection pressure (could be $0)

4-NPV
Injector Drilling Cost [$M/well]
Extractor Drilling Cost [$M/well]
Injector Operating Cost [$K/well/yr]
Extractor Operating Cost [$K/well/yr]
Monitoring Cost [$K/yr/km^2]
Tax Credit [$/ton]

- Calculate cost separately
  - Stored CO2: 1.2 MM tons
  - 4 wells: 1 injector + 2 monitor + 1 USDW
  - All cost included
- Compare sequestration cost with pipeline cost

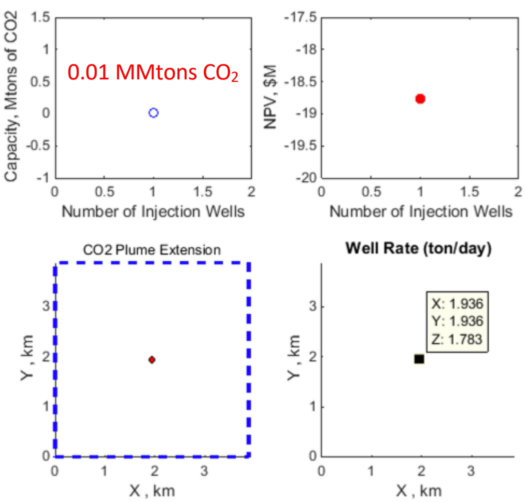
Using EasiTool, when Capacity Equals 1.2 MMtons



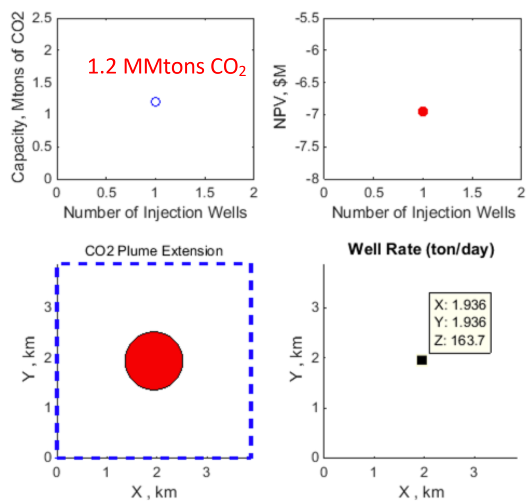
Sensitivity Analysis on Different Reservoir Perm

- Permeability of Lyons:
  - Well 1: 50 – 800 md
  - Well 2: 0.5 – 5 md

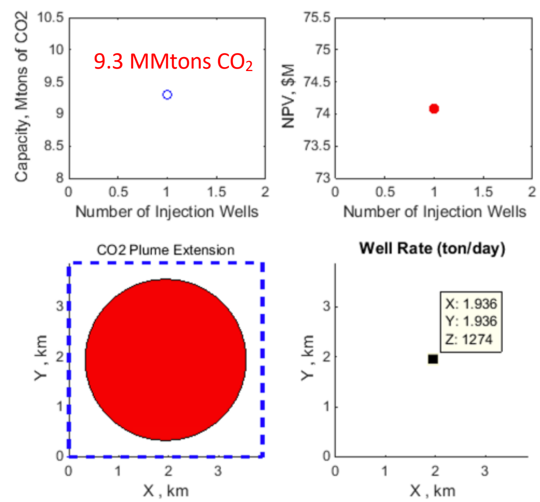
Perm = 1 mD



Perm = 100 mD



Perm = 800 mD



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Future work

- Calculate the carbon storage capacity more accurately
  - What is a reasonable range for E_{saline}?
- Compare the sequestration cost with the pipeline cost
- Evaluate multiple formations/potential storage sites
- Build the subsurface models to estimate the stored CO_2 capacity and CO_2 plumes

Acknowledgement

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