Monitoring and Numerical Modeling of Shallow CO_2 Injection, Greene County, Missouri

DE-FE0001790

Charles Rovey

Missouri State University

U.S. Department of Energy

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Developing the Technologies and Building the Infrastructure for CO_2 Storage

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Presentation Outline

I. Benefits

II. Project Overview

III. Technical Status

   A. Background
   B. Results

IV. Accomplishments

V. Summary

Benefit to the Program

- Program goals.
  - Prediction of CO_2 storage capacity.

- Project benefits.
  - Workforce/Student Training:

    Support of 3 student GAs in use of multiphase flow and geochemical models simulating CO_2 injection.

  - Support of Missouri DGLS Sequestration Program.

Project Overview:
Goals and Objectives

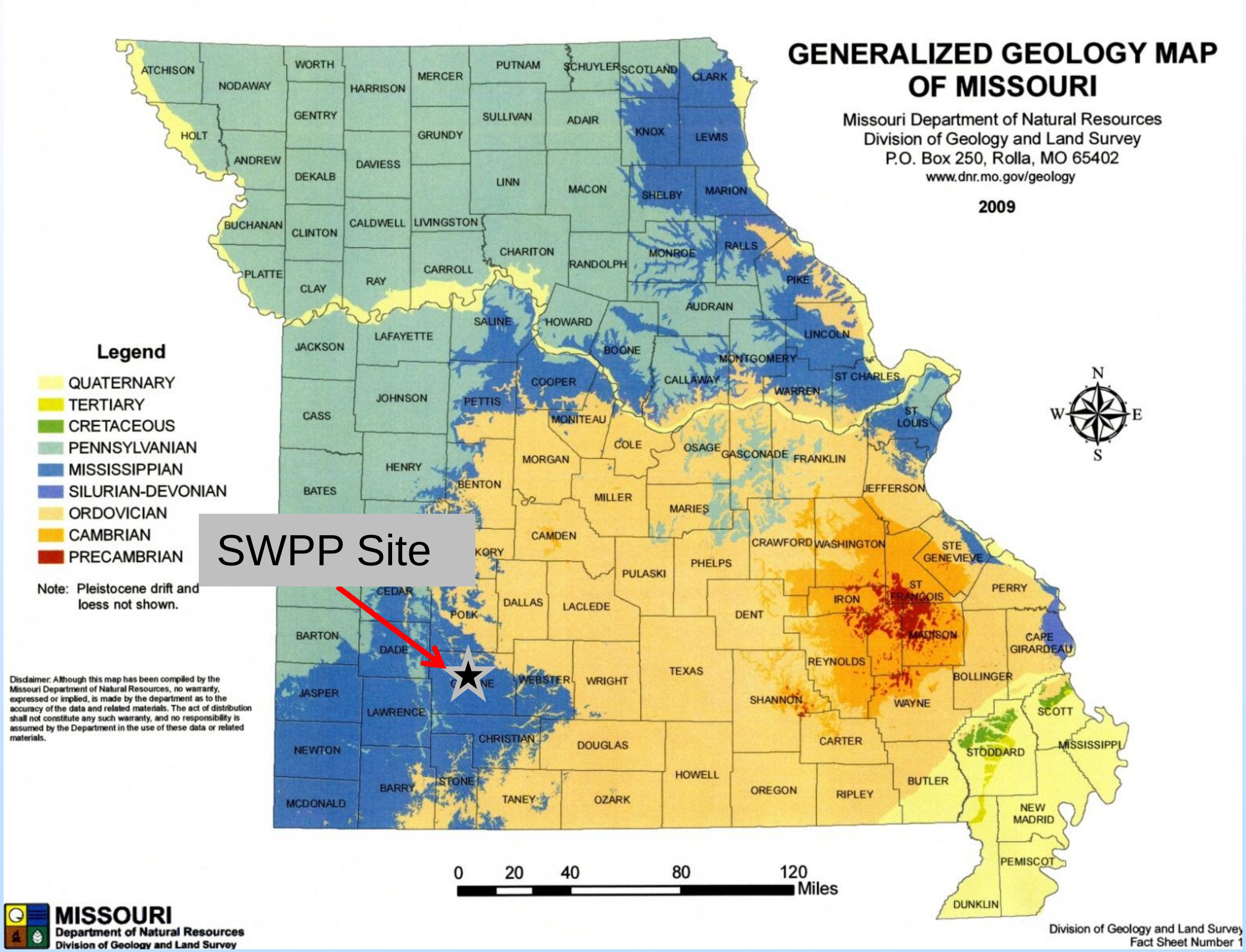
Project Goals and Objectives.

1. Training graduate students in use of multi-phase flow models related to CO_2 sequestration.

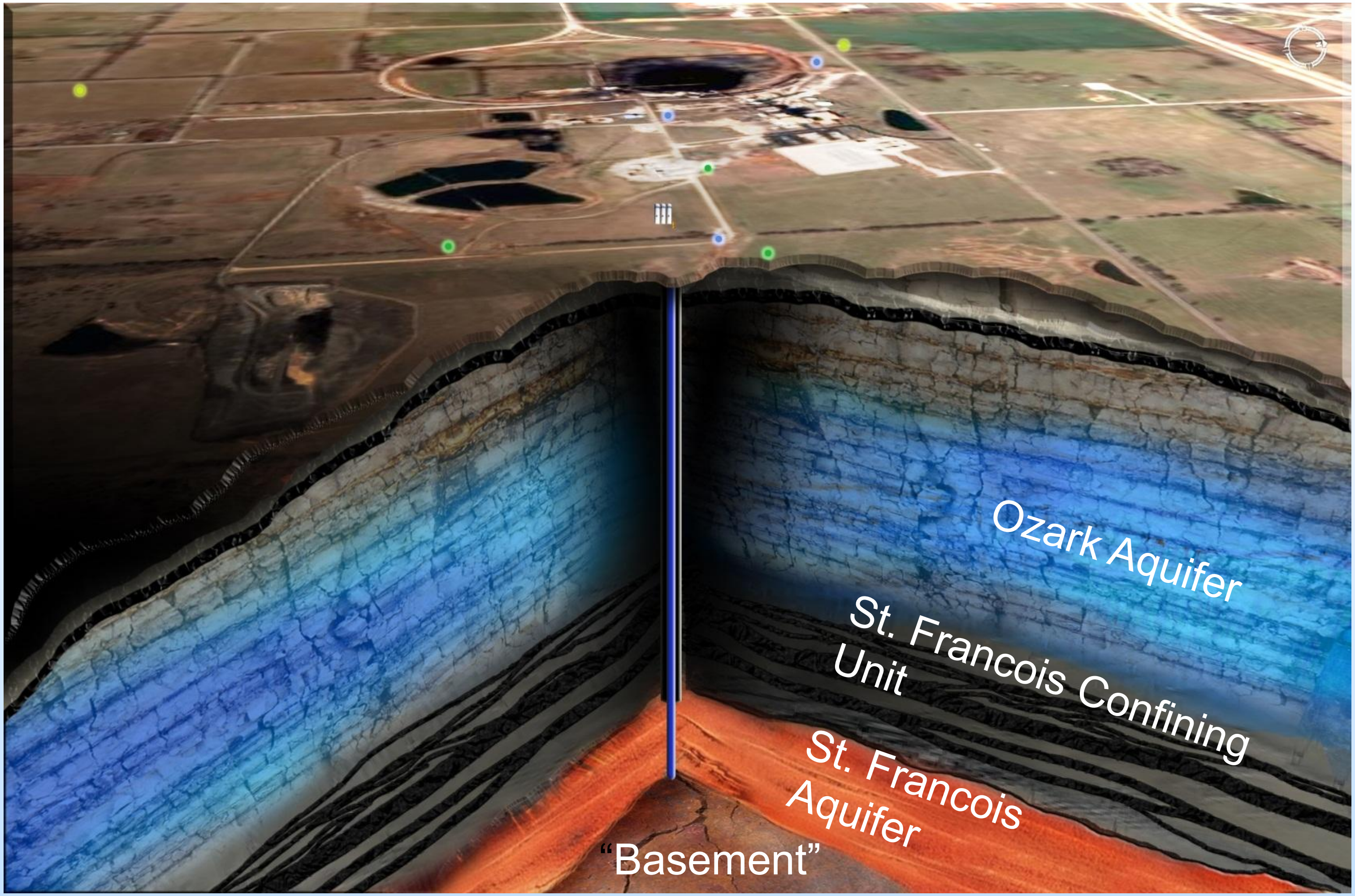
2. Training graduate students in use of geochemical models to assess interaction of CO_2 with pore fluids and potential for precipitation within solid mineral phases.

3. Generating a GIS database of pore-fluid chemistry within and above potential CO_2 injection zones in Missouri.

Technical Status:
Background



Background



- Main target for CO_2 injection throughout Missouri.
- Viability depends on effective caprock and high permeability injection zone.

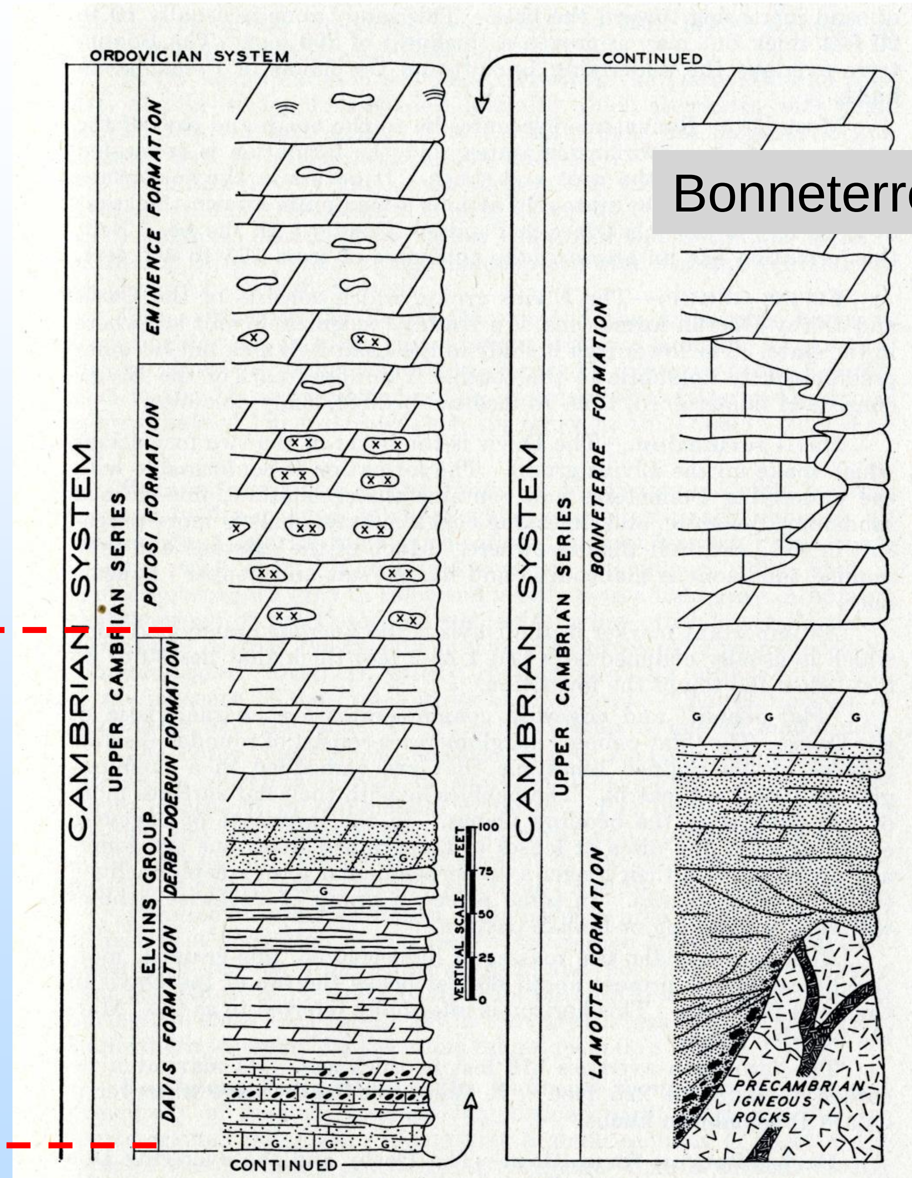
Background-Stratigraphy

Base of Ozark Aquifer

Derby-Doerun Fm.

Caprock

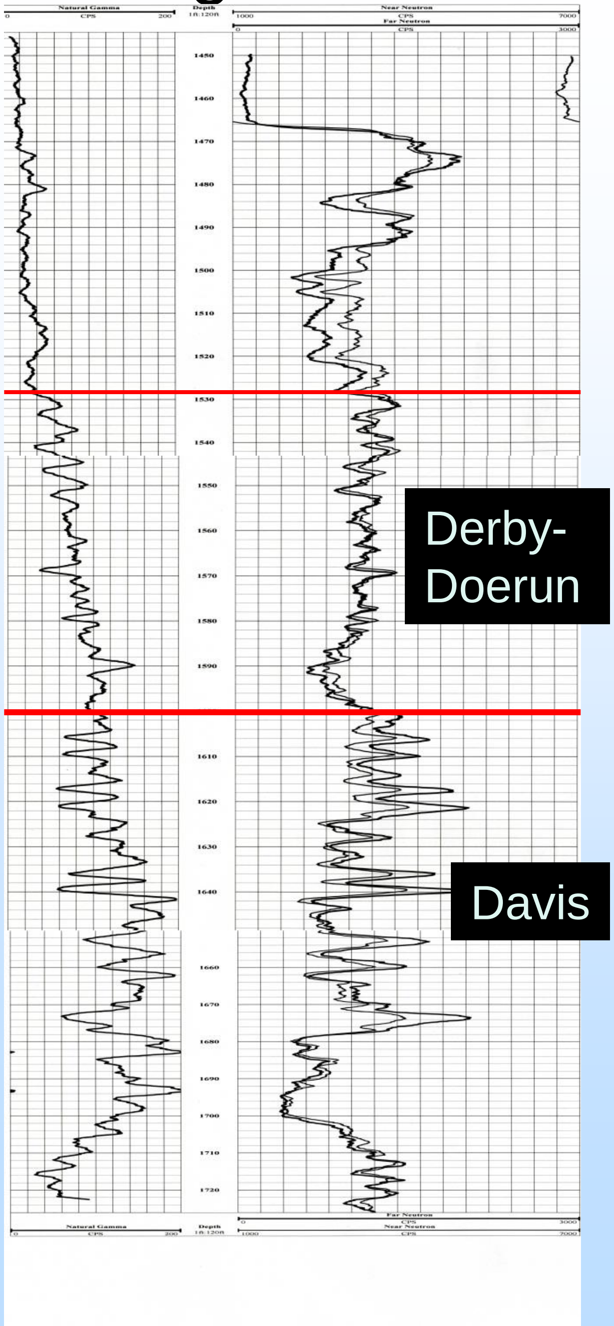
Davis Fm.



Bonneterre Fm

Lamotte

Background: Onsite Coring & Testing



St. Francois confining unit is about 50% shale; carbonates are mostly discrete clasts within shale.

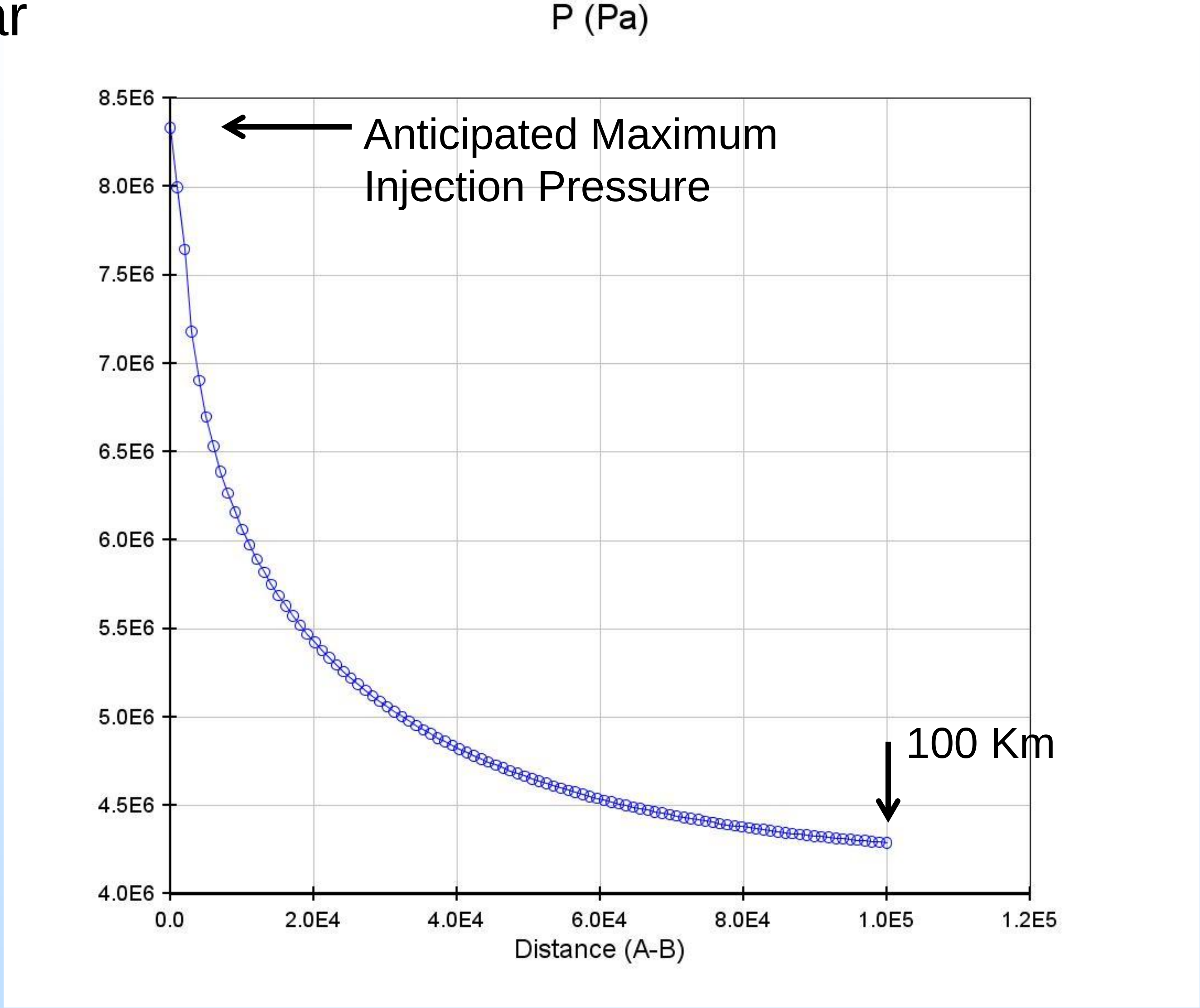
Upper Davis: ~2E-6 mD

Background: Onsite Coring & Testing

Injection Interval:
~100 mD

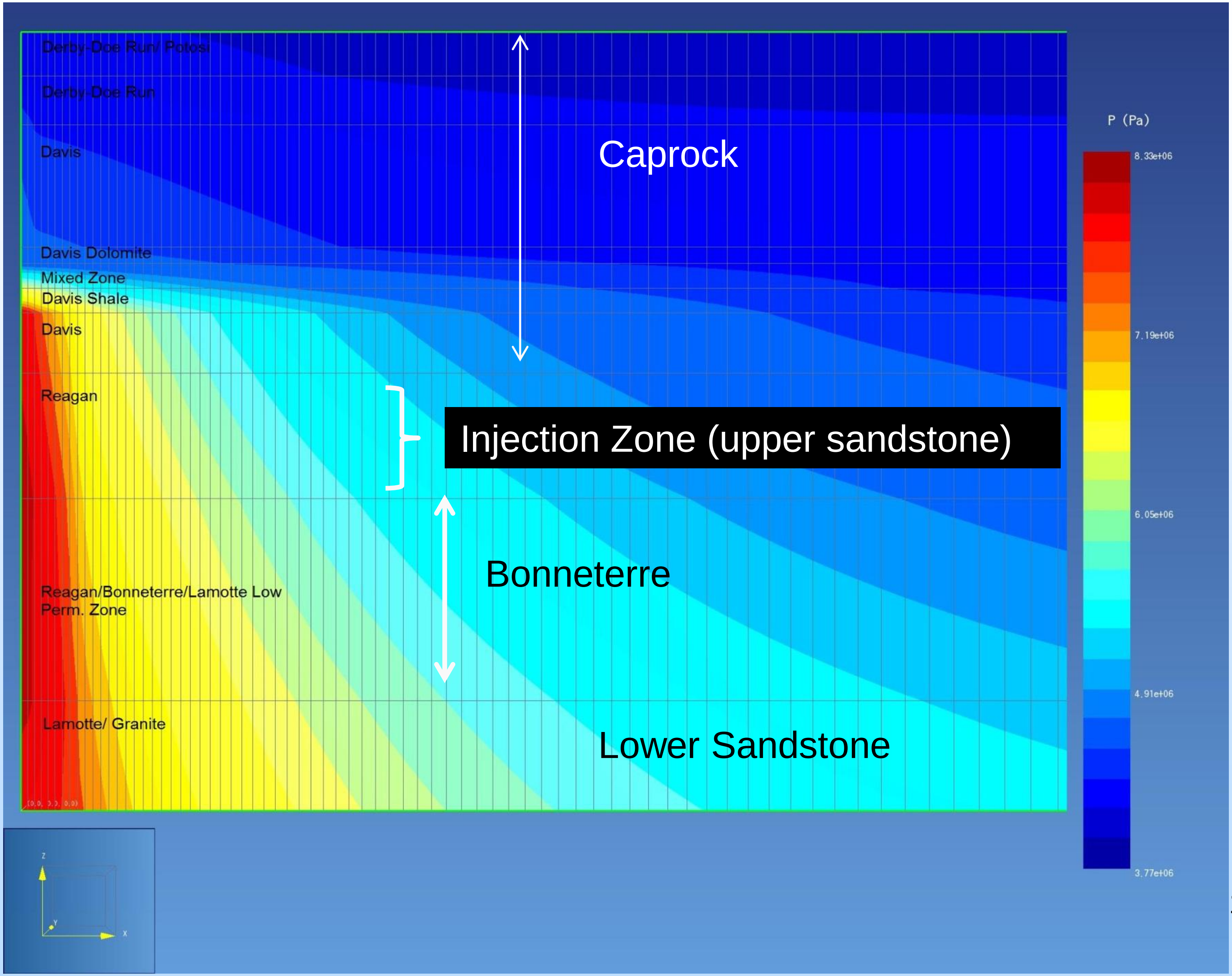
"Upper Lamotte"

Results: Injection Simulations: 30 years at 740,000 metric tons/year

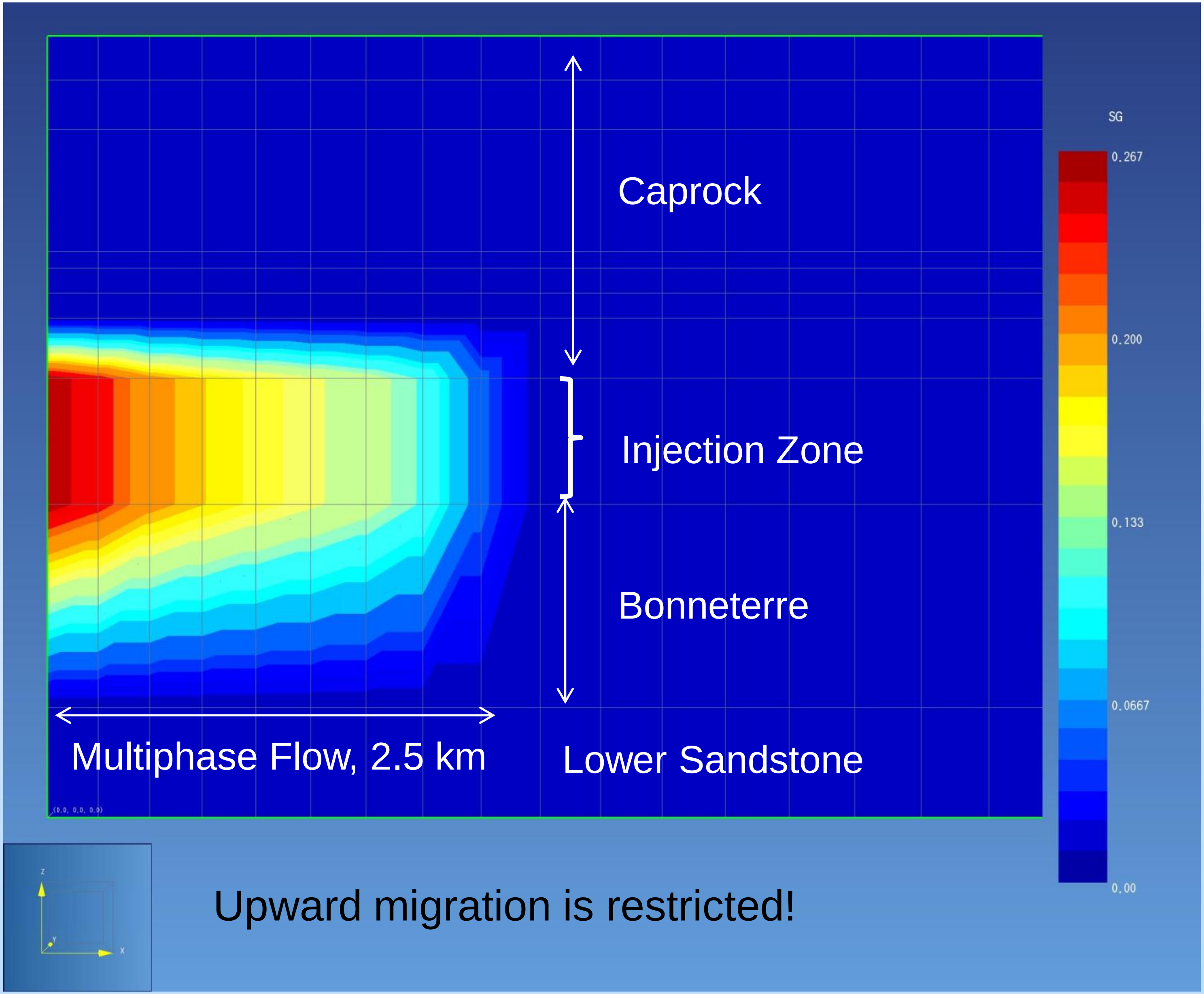


Pressure Within Injection Zone

Results: Injection Simulations: 30 years at 780,000 tons/year



Results: Injection Simulations: CO_2 Migration after 30 years



Upward migration is restricted!

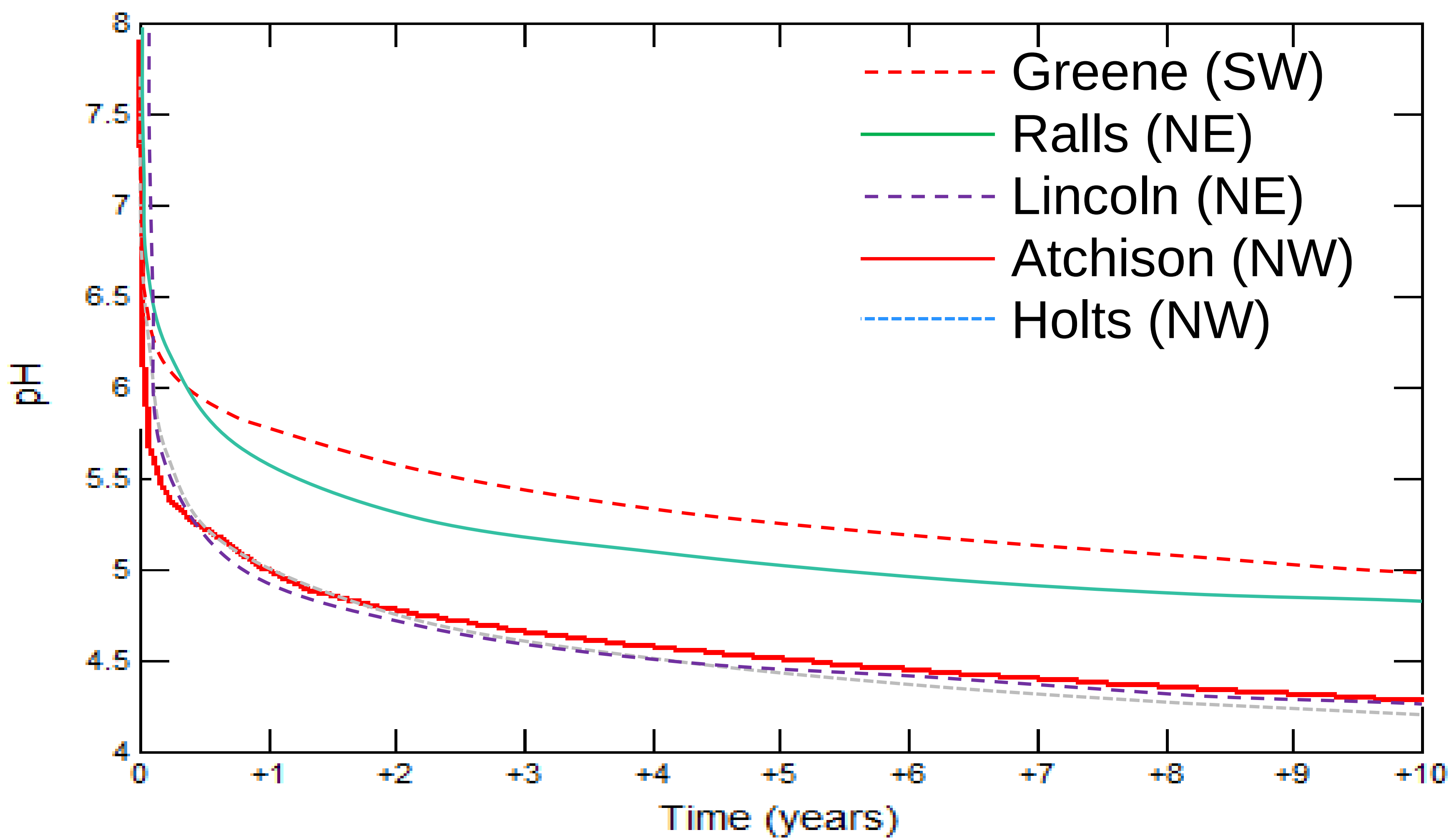
Results: Geochemical Modeling: Need Major minerals.

Mineral sequestration: need (non carbonate) source of divalent cations

Minerals	Chemical composition	% (vol)
Quartz	SiO_2	77.19
K-feldspar	$KAlSi_3O_8$ =(1/2K_2O, 1/2Al_2O_3, 3SiO_2)	0.18
Albite	$NaAlSi_3O_8$	0.04
Kaolinite	$Al_2Si_2O_5(OH)_4$	0.11
Illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$	0.24
Montmorillonite	$(Na,Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2 \cdot nH_2O$	0.13
Glauconite	$(K,Na)(Fe,Al,Mg)_2(Si,Al)_4O_{10}(OH)_2$	0.02
Chlorite	$(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$	0.02
Calcite	$CaCO_3$	0
Dolomite	$CaMg(CO_3)_2$	0
Hematite	Fe_2O_3	0.08
Goethite	$FeO(OH)$	0.05

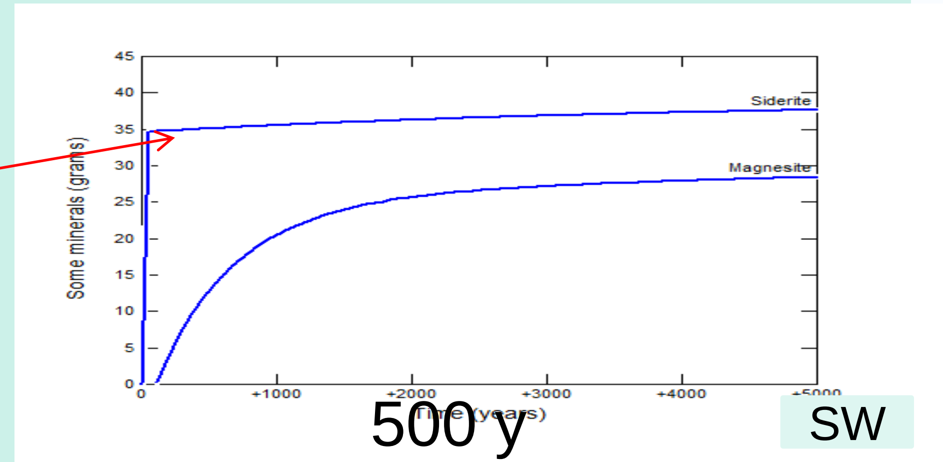
Nondorf, 2010: MS Thesis

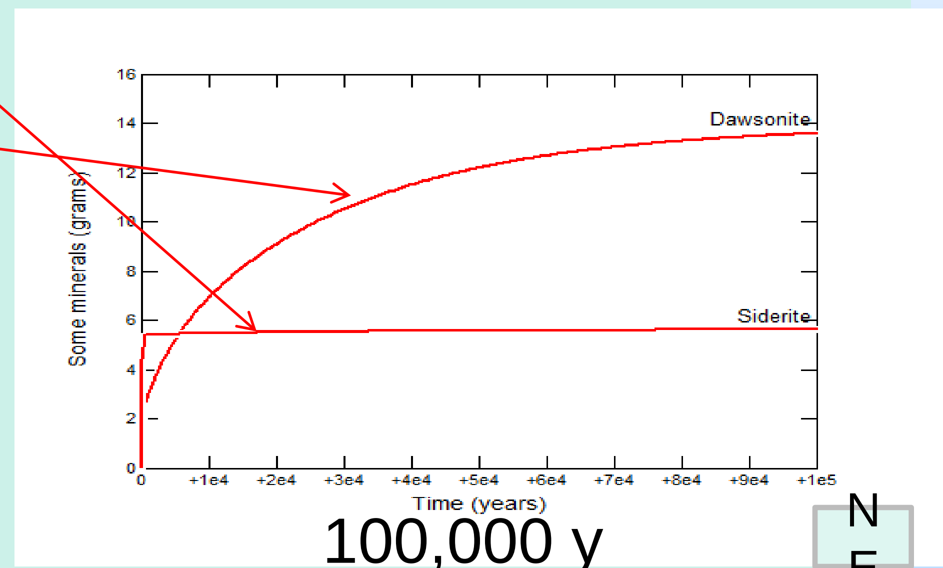
Results: Geochemical Modeling: pH Changes Due to CO_2 Injection



Results: Mineral trapping

- Major minerals precipitating:
- Siderite ($FeCO_3$)
- Magnesite ($MgCO_3$)- SW Mo
- Dawsonite ($NaAlCO_3(OH)_2$)





Results: Long-Term Mineral Trapping

CO2 stored in Minerals (in g/kg of free

Mineral	Greene (SW)	Atchison (NW)	Holts (NW)	Ralls (NE)	Lincoln (NE)
Magnesite	7	0	0	0	0
Siderite	12	2.9	3.1	2.5	3.2
Dawsonite	0	2.0	2.6	3.0	2.3
Total	19	4.9	5.7	5.5	5.5

Accomplishments to Date

1. Completed simulations of injection phase for the St. Francois aquifer system in Missouri.

2. Compiled a GIS database of pore-fluid chemistries within and above potential injection zones in Missouri.

3. Completed geochemical reaction modeling CO2 reactions and mineral trapping at four sites in Missouri.

Summary

Key Findings:

1. Sustained Injection rates of nearly 800,000 tons/year of CO_2 are possible within Missouri’s St. Francois aquifer.

2. Mineral trapping should be extensive and rapid due to abundant glauconite.

Lessons Learned:

1. Be Flexible: Original work plans never go according to schedule.

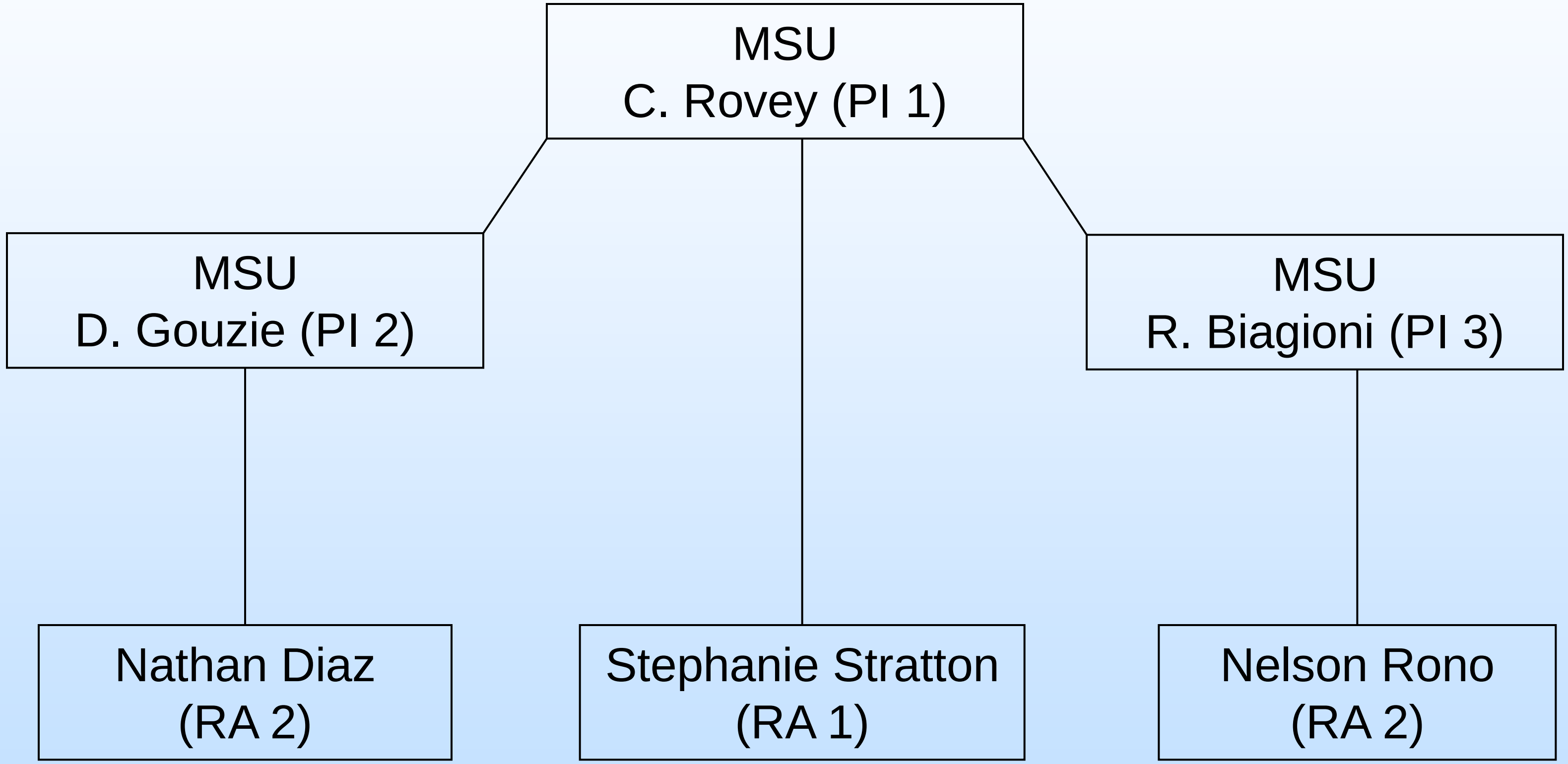
Future Plans:

Extend flow modeling to simulate residual trapping, anisotropy; extend sensitivity analysis.

Appendix

Organization Chart

- Project team, organization, and participants.



Gantt Chart

Year	2010		2011				2012			
Quarter	3	4	1	2	3	4	1	2	3	4
Task: Student Training in Numerical Modeling					←	—	—	—	—	→
Subtask: Internship at DGLS									↔	100
Subtask: Analysis of Onsite Hydraulic Data						←	→	100		
Subtask: Simulation of CO_2 Injection						←	—	—	→	100
Subtask: Long-Term Simulation										↔ 0
Task: GIS Data Base of Pore-Fluid Chemistries in Missouri	←	—	—	—	—	—	—	→		
Subtask: Internship at DGLS					↔	100				
Subtask: Select and Sort Wells by Stratigraphic Unit		←	—	—	→	100				
Subtask: Entry Into GIS Database					←	—	→	100		
Subtask: Chemical Facies Maps							←	→	100	
Task: Student Training in Geochemical Modeling	←	—	—	—	—	—	—	→		
Subtask: Internship at DGLS					↔	100				
Subtask: Obtain Pore-Fluid Chemistries		←	—	—	→	100				
Subtask: Simulate CO2 Injection at 4 Potential Missouri sites					←	→	100			

Bibliography

No peer-reviewed publications to report yet.