

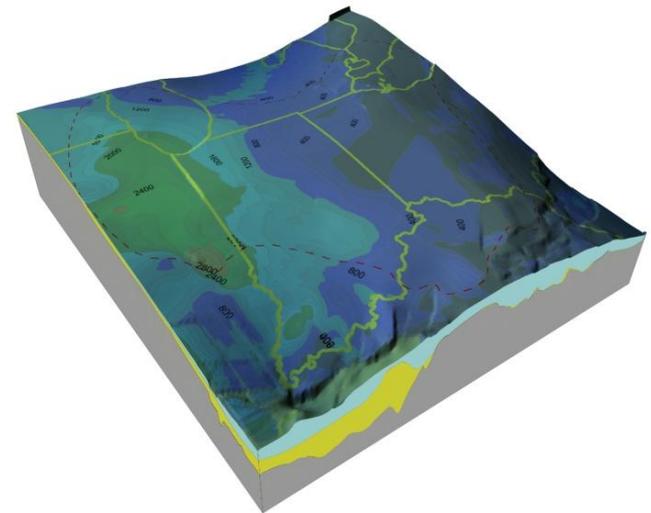
Simulation Framework for Regional Geologic CO₂ Storage Infrastructure Along Arches Province of Midwestern United States

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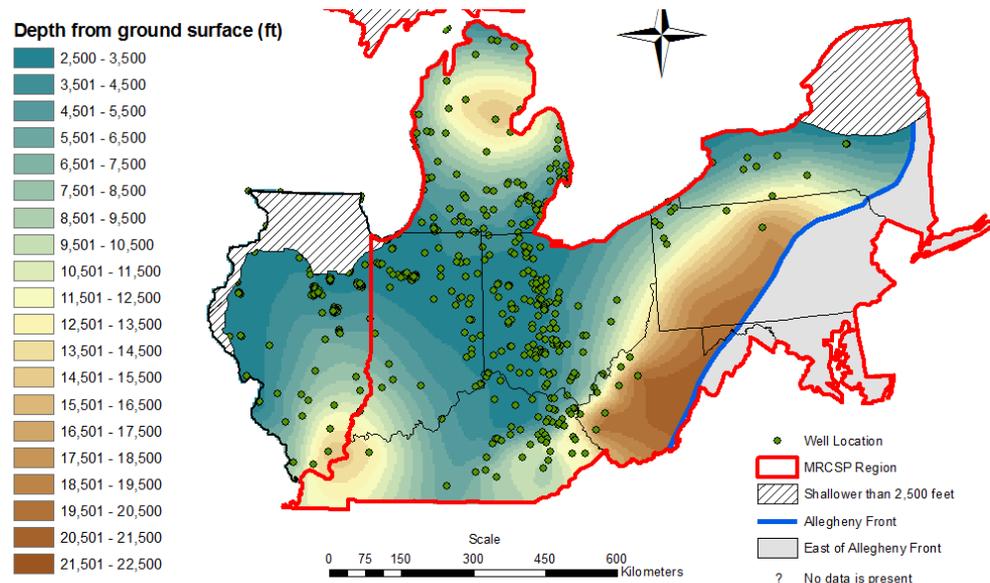


DOE/EPA Collaborative Review- Tracking Geologically
Sequestered CO₂: monitoring, Verification, & Accounting
MVA, Simulation, and Risk Assessment

March 24, 2010 Pittsburgh, PA

Introduction

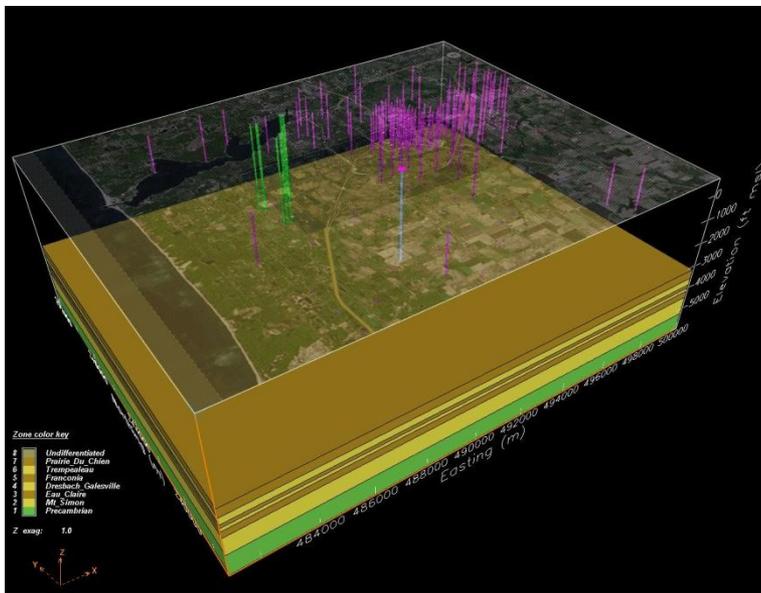
- Widespread deployment of CCS will require an understanding of the regional, basin-scale impacts on groundwater flow, and quality.
- Basin-scale hydrodynamics are controlled by numerous factors, including regional geology, fluid pressure and density, and tectonic history.
- Arches province is important area for CCS due to thick, pervasive nature of Mt. Simon Sandstone and favorable hydrogeologic properties.



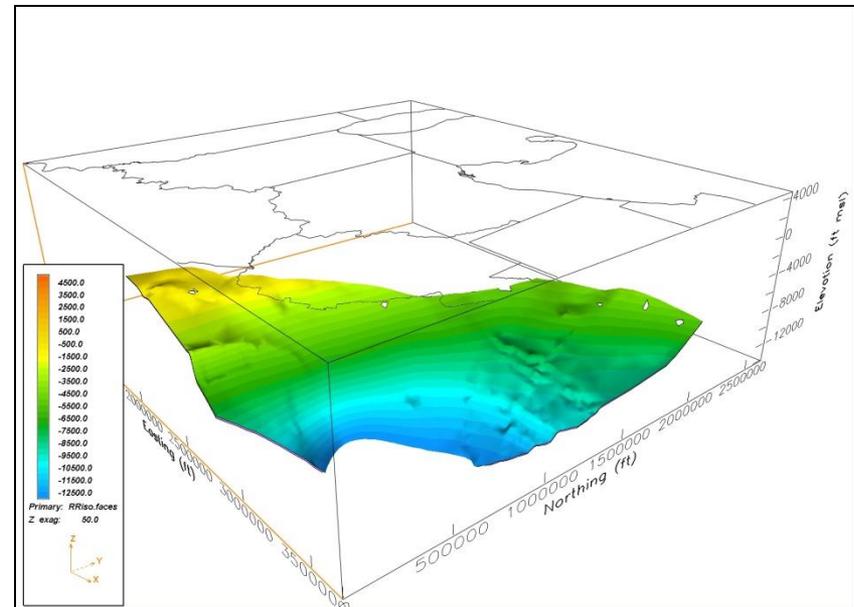
Arches Province Simulation Project

- The work will represent the “next step” in simulation of CO₂ storage — the widespread application along a major, regional geologic structure in an area of the country with a dense concentration of large CO₂ sources.
- As such, it will help answer technical and infrastructure questions related to simulation methods and also contribute to research on monitoring options and risk assessment.

Ex. Site Model

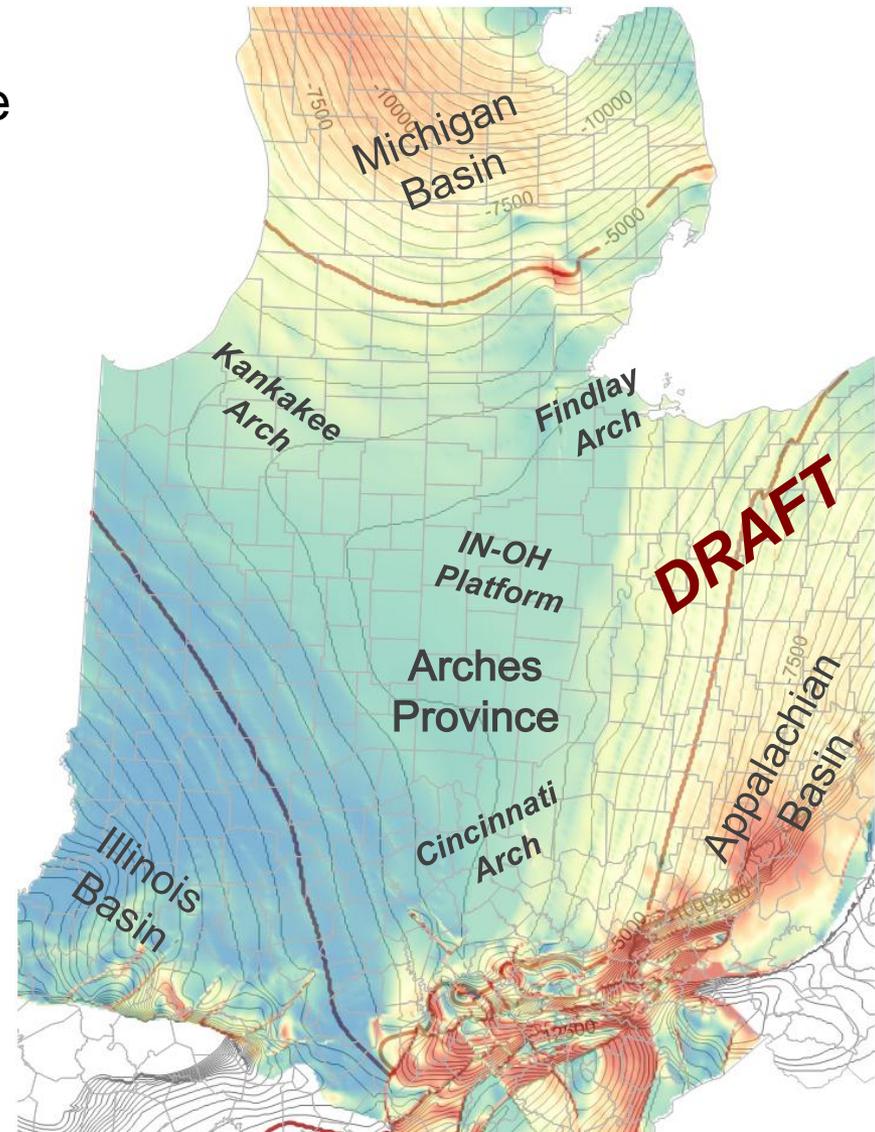


Ex. Regional Model

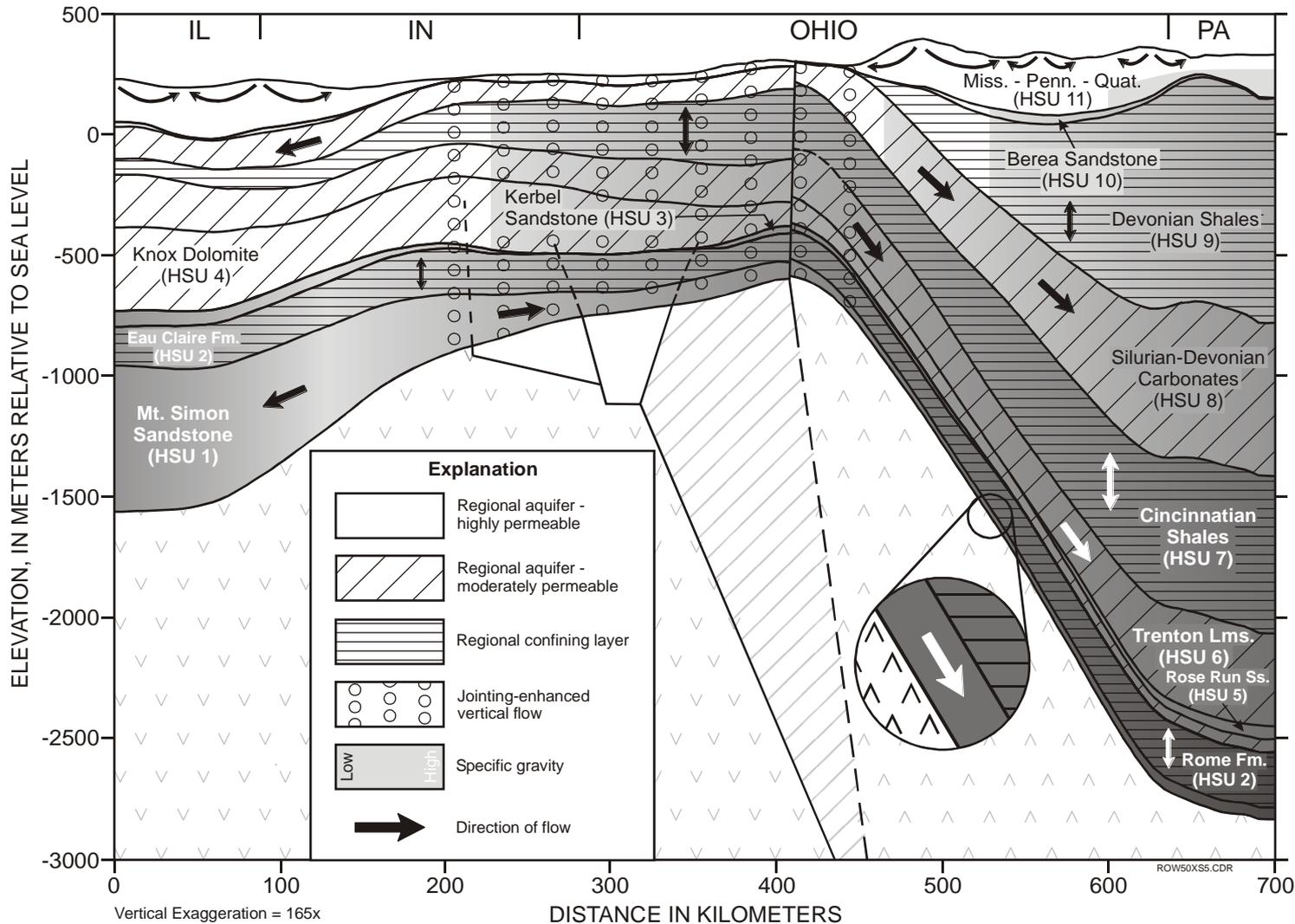


Arches Province Simulation Project

- Arches Province is present between the Appalachian, Illinois, and Michigan sedimentary Basins.
- The province includes portions of Indiana, Illinois, Kentucky, Michigan, and Ohio.
- There is a history of wastewater injection operations in Mt. Simon in the region dating back to 1970s.



Conceptual Flow Model Example for Midwest (Gupta and Bair, 1997)



Arches Province Simulation Project

- *Simulation Framework for Regional Geologic CO₂ Storage Infrastructure along Arches Province of Midwestern United States* project selected by DOE/NETL under FOA23.
- Three year project through September 2012.
- Project team includes Battelle, Indiana Geological Survey, Kentucky Geological Survey, Ohio Geological Survey, and Western Michigan University. Cost share provided by Ohio Air Quality Development Authority-Ohio Coal Development Office.
- Significant collaborations with MRCSP, MGSC, and other projects.



U.S. DOE/NETL



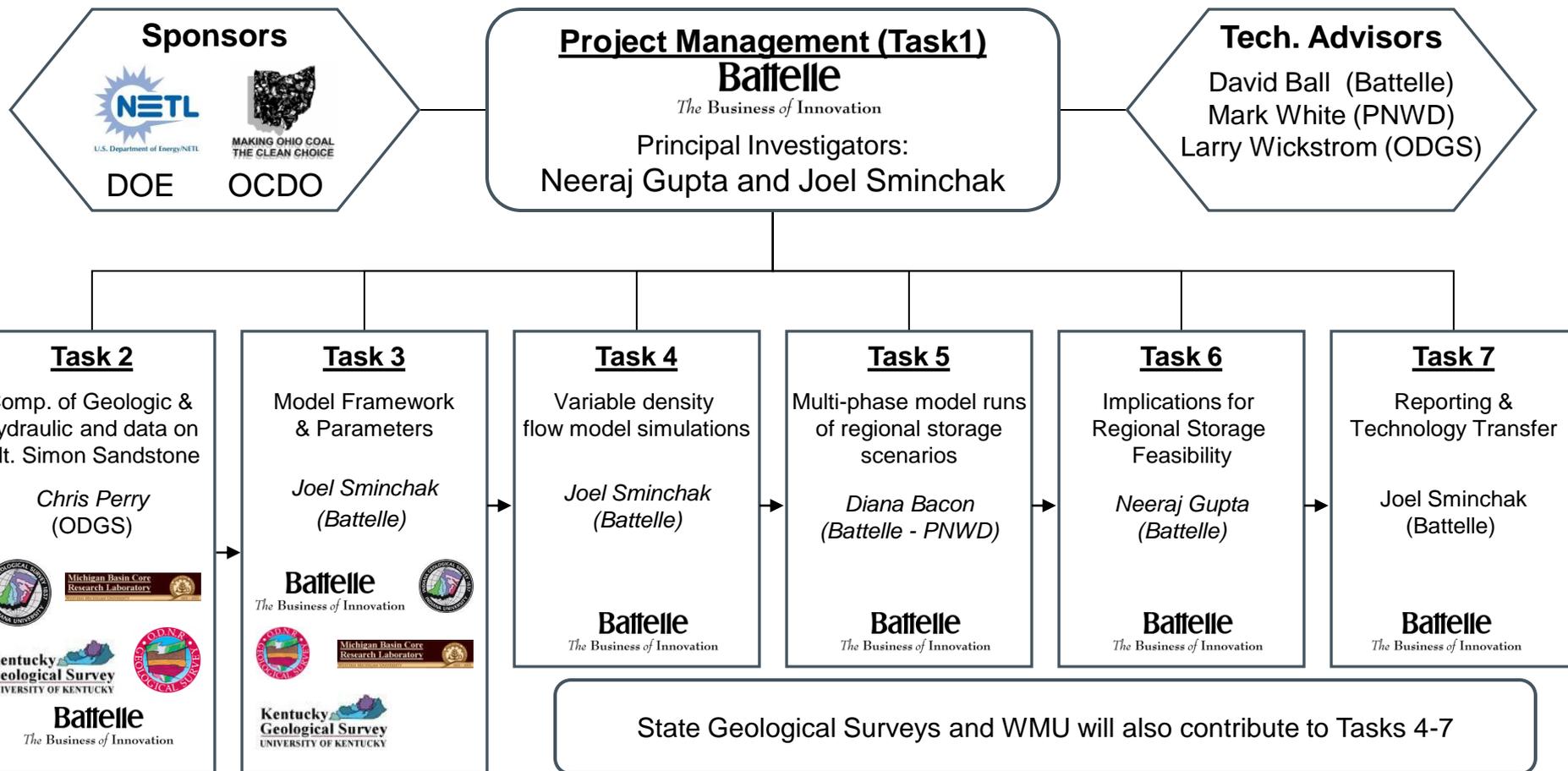
Battelle
The Business of Innovation



Kentucky Geological Survey
UNIVERSITY OF KENTUCKY



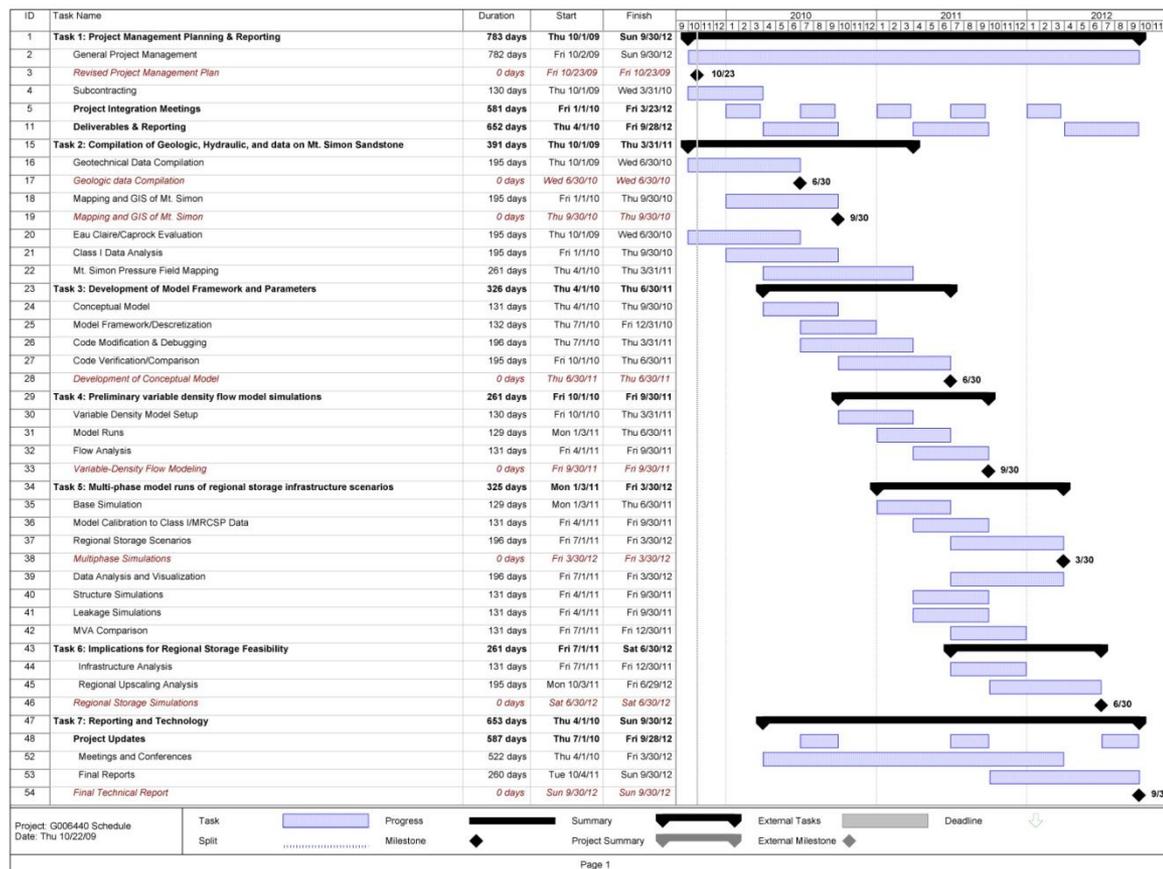
Project Organization



- Project will seek collaborations with MRCSP, MGSC, and other projects as viable given project schedule and budget.

Task 1: Project Management and Planning

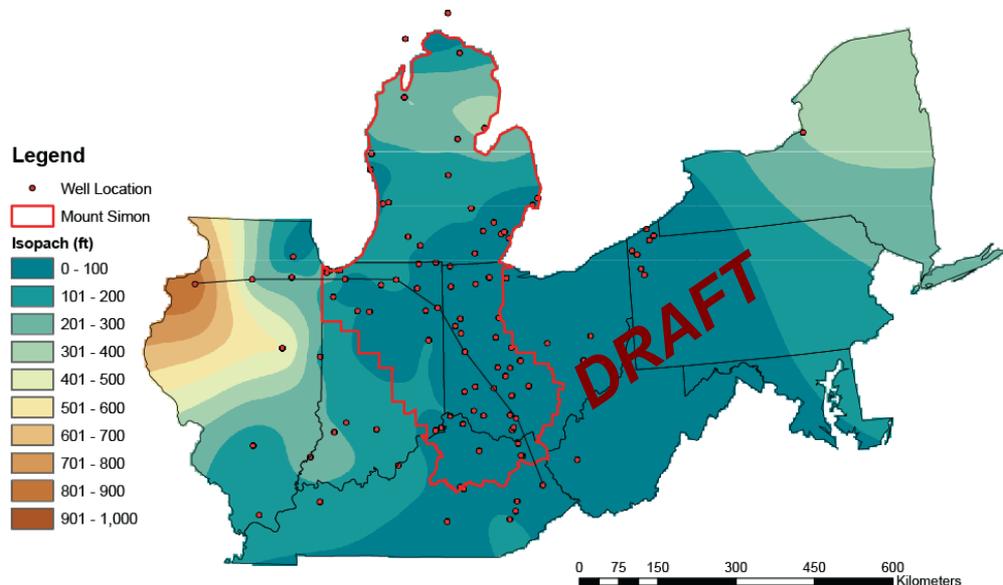
- Project Management Plan
- Reporting and status meetings



Task 2: Compilation of Geologic, Hydraulic, and Injection data on Mt. Simon Sandstone

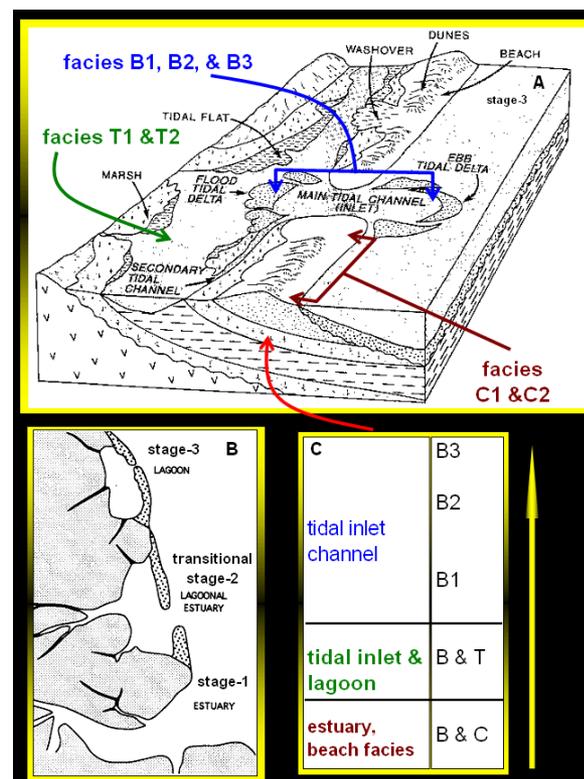
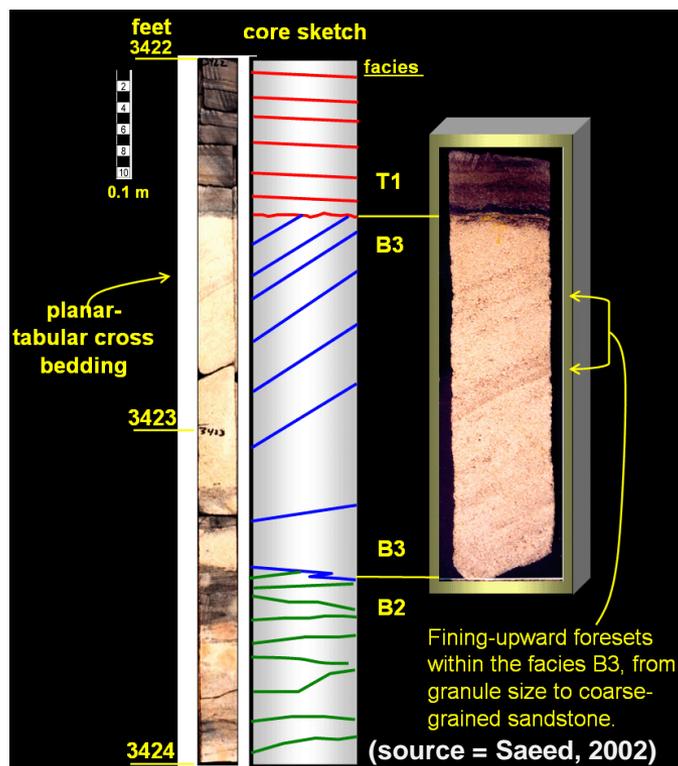
- Subtask 2.1. Geotechnical Data Compilation
- Subtask 2.2. Mapping and GIS of Mt. Simon
- Subtask 2.3. Eau Claire/Caprock Evaluation
- Subtask 2.4. Class I Data Analysis

Mount Simon Subdivision: Isopach III (Lower Unit)



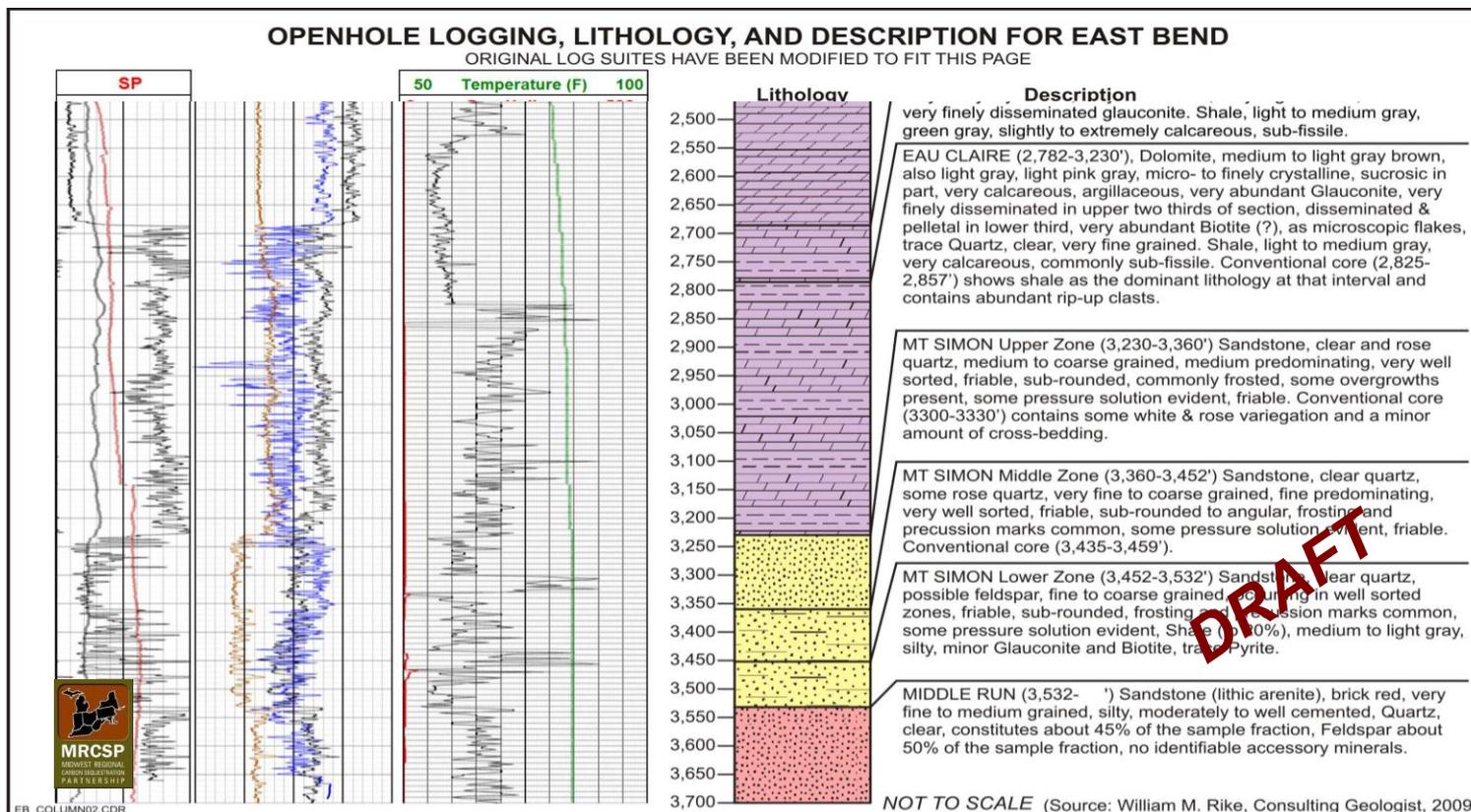
Task 2: Compilation of Geologic, Hydraulic, and Injection data on Mt. Simon Sandstone

- Facies distribution studies suggest several units with the Mt. Simon Sandstone formation which are important to CO₂ storage potential.



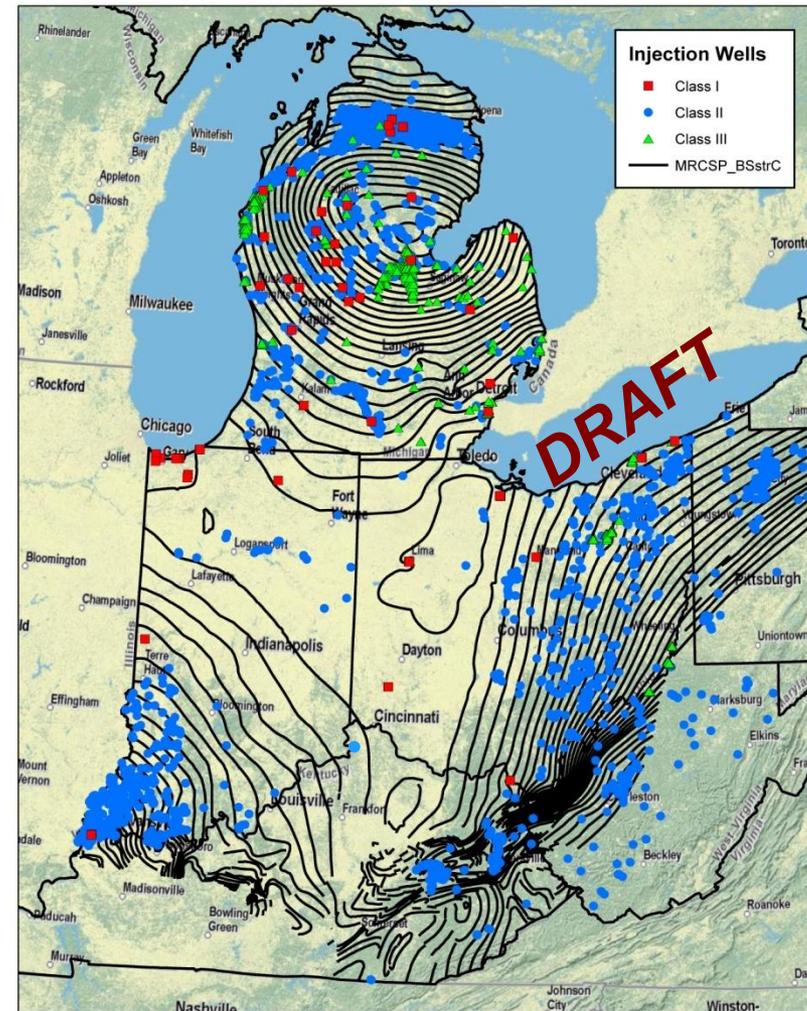
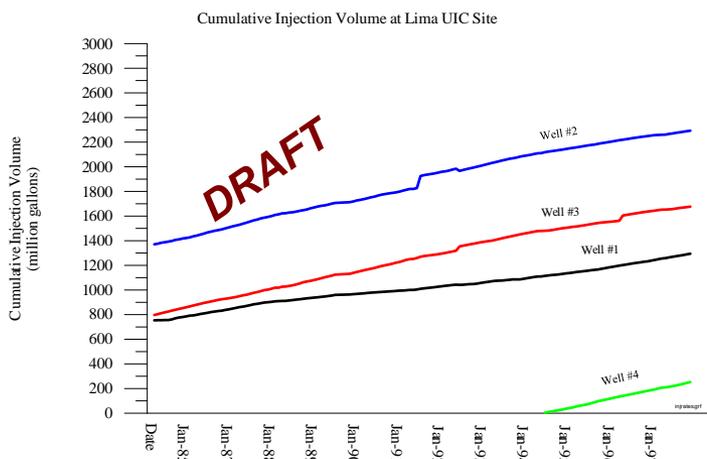
Task 2: Compilation of Geologic, Hydraulic, and Injection data on Mt. Simon Sandstone

- Facies distribution present in recent MRCSP test well at Cincinnati Arch East Bend test site.



Task 2: Compilation of Geologic, Hydraulic, and Injection data on Mt. Simon Sandstone

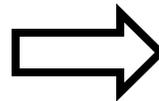
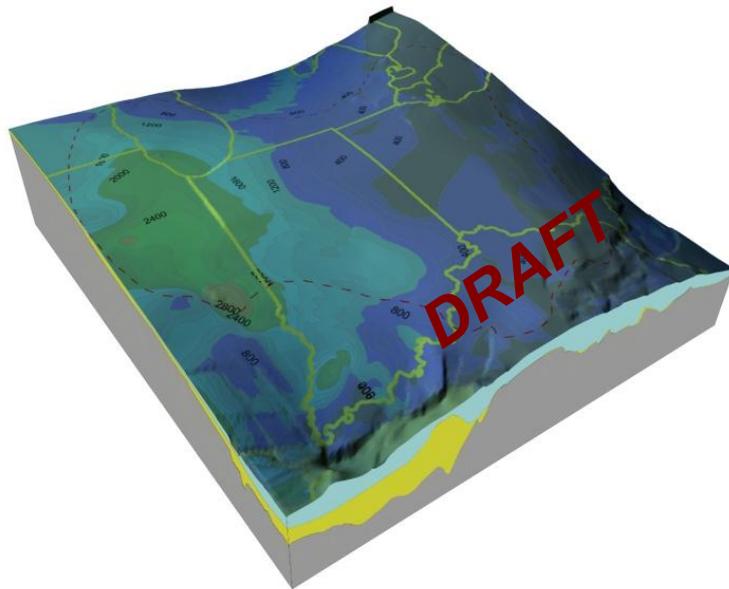
- Injection data from region is being compiled (operational injection rates, pressures, falloff test data).
- Some injection sites have been operating since 1970s.
- Data will be used for model calibration to injection data and reservoir pressures.



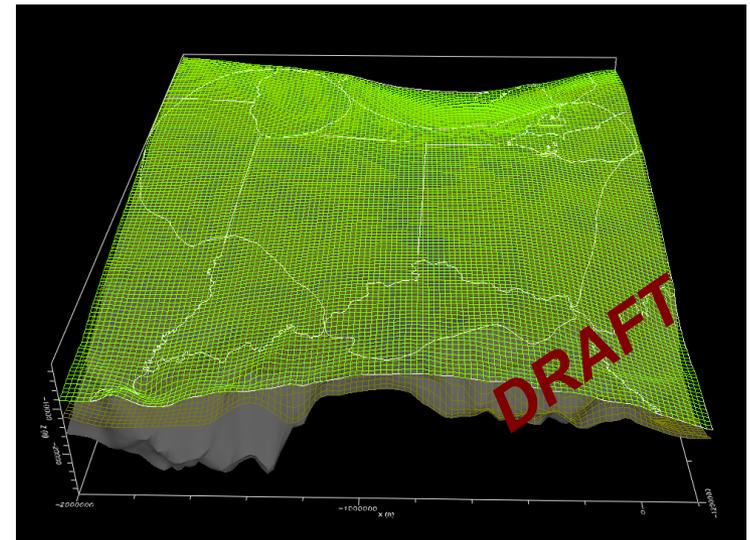
Task 3: Development of Model Framework and Parameters

- Subtask 3.1. Conceptual Model
- Subtask 3.2. Model Framework/Discretization
- Subtask 3.3. Code Modification & Debugging
- Subtask 3.4. Code Verification/Comparison

Geological Model

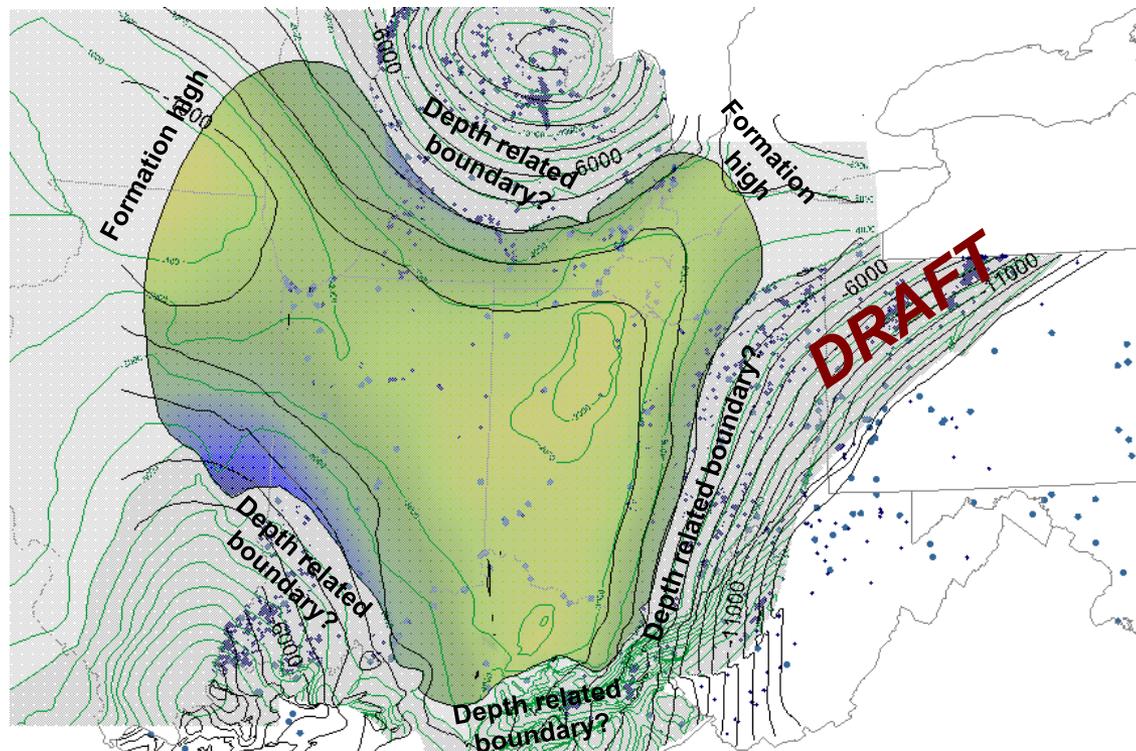


Numerical Model



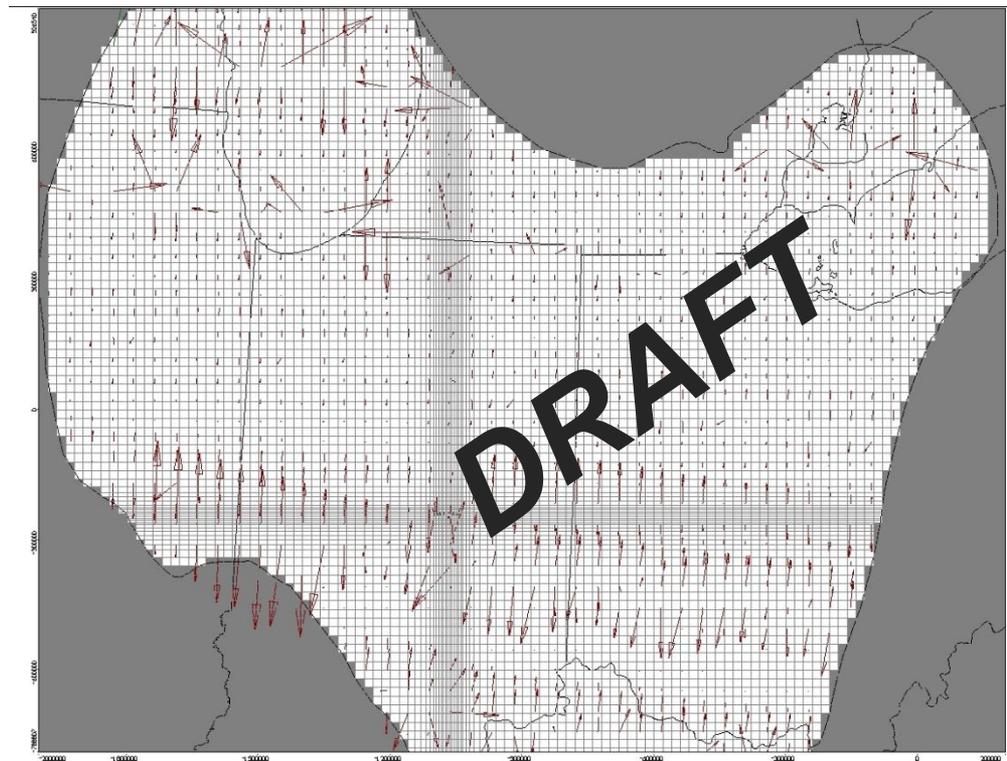
Task 3: Development of Model Framework and Parameters

- Model boundary conditions being examined to ensure accurate model solution.
- Facies changes and depth related porosity cutoffs may provide natural boundaries to the model domain.



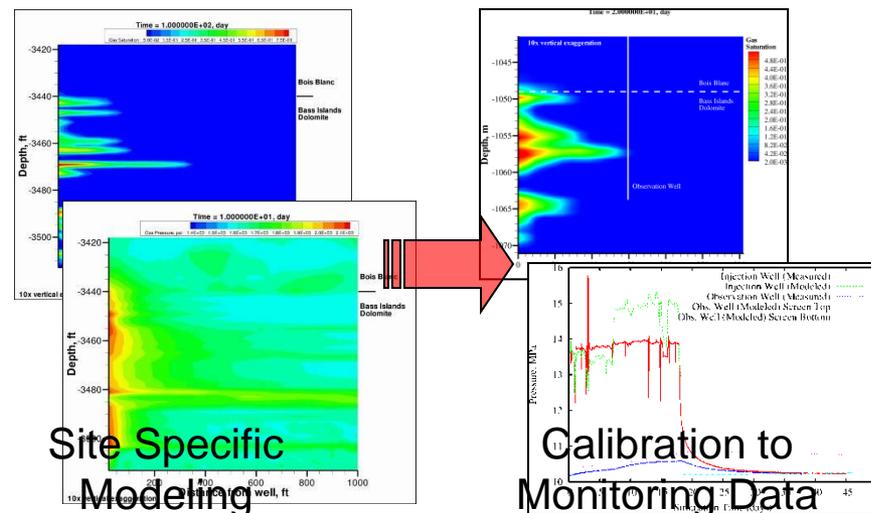
Task 4: Baseline Variable Density Flow Simulations

- Subtask 4.1. Variable Density Model Setup
- Subtask 4.2. Model Runs
- Subtask 4.3 Flow Analysis



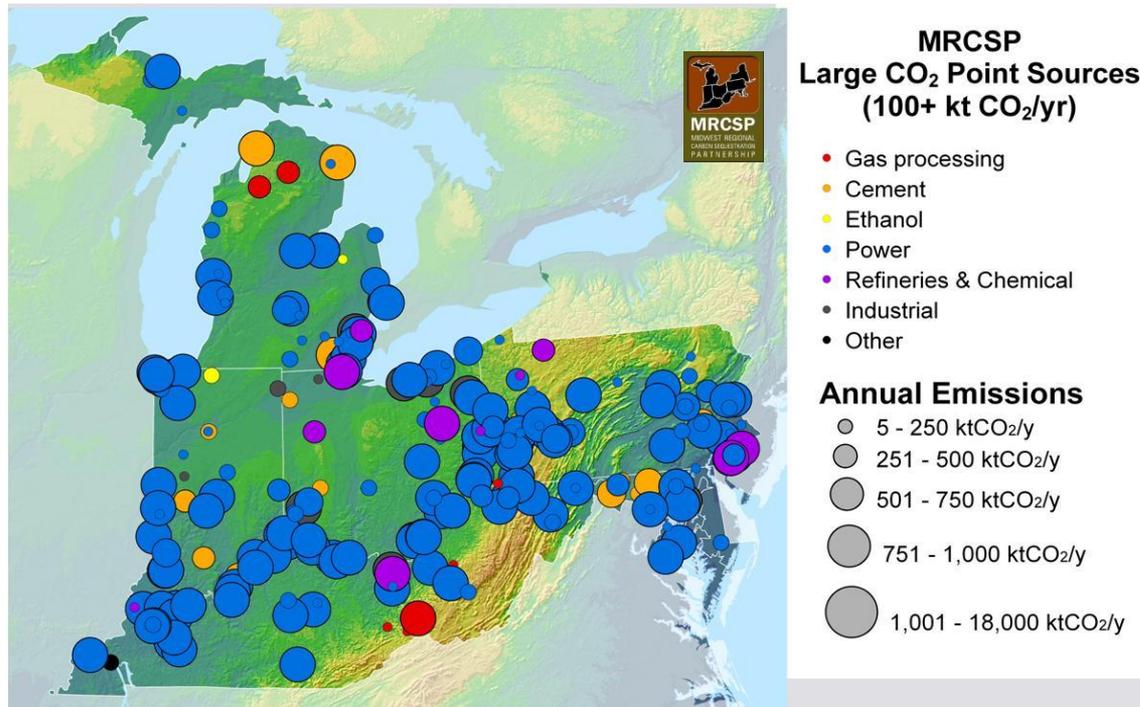
Task 5: Simulations of Regional CO2 Storage Infrastructure Scenarios

- Subtask 5.1. Base Simulation
- Subtask 5.2. Model Calibration to Class I/MRCSP Data
- Subtask 5.3. Regional Storage Scenarios
- Subtask 5.4. Data Analysis and Visualization
- Subtask 5.5. Structure Simulations
- Subtask 5.6. Leakage Simulations
- Subtask 5.7. MVA Comparison



Task 6: Infrastructure Analysis

- Subtask 6.1. Infrastructure Analysis
 - Delineate favorable and unfavorable locations for CO₂ storage in Arches Province given regional framework.
- Subtask 6.2. Regional Upscaling Analysis
 - Assess regional storage and retention potential, range of capacity estimates for large scale CO₂ storage in the Arches Province.



Task 7: Reporting and Tech Transfer

- Subtask 7.1. Project Updates
- Subtask 7.2. Meetings
- Subtask 7.3. Final Reports

Deliverable	Description	Deliverable Date
Project Management Plan	Updated Project Management Plan as per FOA guidelines	Q1 2010
Geologic data Compilation	Hydrogeologic maps showing depth, thickness, hydraulic parameters, and other data from study region	Q4 2010
Development of Conceptual Model	A completed conceptual hydrogeologic framework incorporated into the simulation codes will be presented in a letter report or slide presentation	Q3 2011
Variable-Density Flow Modeling Topical Report	A report on baseline variable density flow model will be submitted	Q4 2011
Multiphase Simulations Technical Progress Report	A report summarizing key findings of the regional and local scale CO ₂ injection models	Q3 2012
Final Technical Report	Final technical report with detailed outcome of all tasks including implications for regional infrastructure deployment and a simulation framework that can be used to address emerging regulatory, monitoring, site selection, and risk assessment issues.	Q4 2012

Project Schedule

Milestone	Planned Completion Date	Milestone Verification Method
Revised Project Management Plan	10/23/2009	Submittal of Revised Project Management Plan to DOE/NETL
Geologic data Compilation	06/30/2010	Submit database of geotechnical data to DOE/NETL
Mapping and GIS of Mt. Simon	09/30/2010	Submit hydrogeologic maps showing depth, thickness, hydraulic parameters, and other data from study region
Development of Conceptual Model	06/30/2011	A completed conceptual hydrogeologic framework incorporated into the simulation codes will be presented in a letter report or slide presentation
Variable-Density Flow Modeling	09/30/2011	A topical report on baseline variable density flow model will be submitted
Multiphase Simulations	03/30/2012	A technical progress report summarizing key findings of the regional and local scale CO ₂ injection models
Regional Storage Simulations	06/30/2012	Confirm regional storage scenarios with DOE/NETL
Final Technical Report	09/30/2012	Final technical report with detailed outcome of all tasks including implications for regional infrastructure deployment and a simulation framework that can be used to address emerging regulatory, monitoring, site selection, and risk assessment issues.

Next Steps

- Compile Class I data (in progress)
- Geology team meeting (March 30, 2010)
- Map facies distribution in the Mt. Simon
- Identify additional rock core at state core libraries for testing
- Develop geo-cellular model.