

SEQUESTRATION TRAINING AND
RESEARCH
2011 YEARLY REVIEW MEETING

PROJECT DE-FE0002441

*MODELING AND EVALUATION OF
GEOPHYSICAL METHODS FOR
MONITORING AND TRACKING CO₂
MIGRATION IN THE SUBSURFACE*

The Ohio State University

Presenter: Dr. Jeff Daniels, School of Earth Sciences

February 23, 2011

Project Participants

- ▣ PI: Dr. Jeff Daniels
- ▣ Student: Michael Murphy
- ▣ Student: Kyle Shalek

Introduction

- ▣ An open source 3D software package for geophysical tracking of CO₂ migration at injection sites
- ▣ EM and Seismic methods in wellbore or surface arrays
- ▣ Geologically characterize a site
- ▣ Make informed decisions for designing geophysical survey parameters

Project Objectives

▣ Primary

- ▣ 3D seismic and EM modeling, imaging, and interpretation software
- ▣ Heterogeneous geological plume models developed and tested for injection site
- ▣ Generate numerical models for imaging and interpretation

▣ Secondary

- ▣ Test using Ohio Information
- ▣ Work with AEP/Battelle data from Mountaineer Project

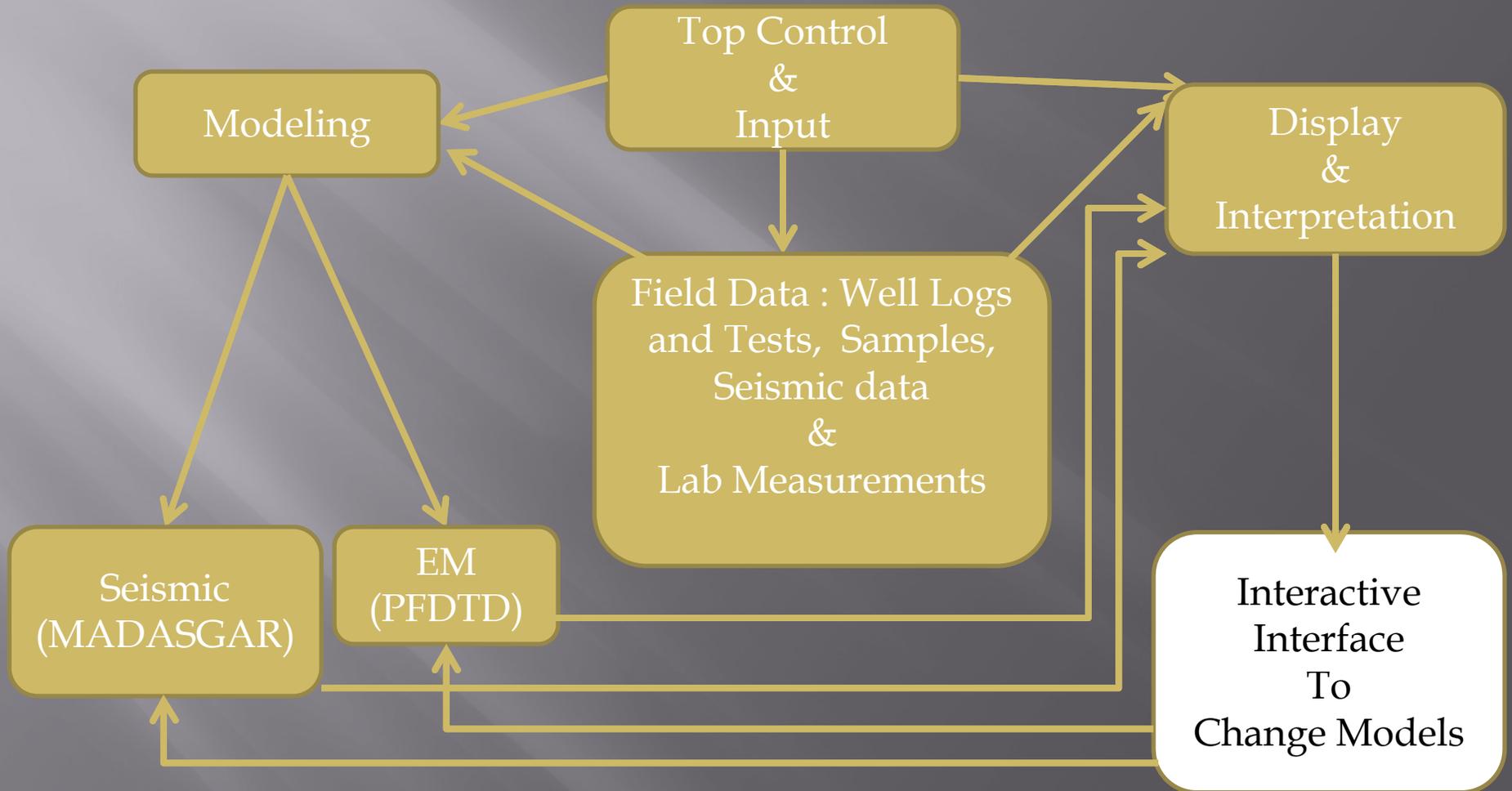
Project Funding

- ▣ Total Project Cost: \$300,000
- ▣ DOE Share: \$300,000
- ▣ Non-DOE Cost Share: Indirect new funding
- ▣ Cost Share Provider: Ohio Coal Development Office

Highlights of Project to Date

- ▣ Top Level Interface has preliminary GUI
- ▣ EM module made user-friendly and bugs removed
- ▣ Seismic module builds models, interfaces with packages, and outputs numerical model data
- ▣ Wireline module inputs multiple file formats and displays wiggle traces for logs
- ▣ Gained access to seismic and well log data from Mountaineer Site and Ohio Geological Survey

Flow of Program



Tasks - Overview

Task No.	Task Description	Task Duration	Task Funding
1	Project Management and Planning	12/01/2009 - 11/30/2012	\$20,000
2	Develop Top (System) Level Program	12/01/2009 - 12/30/2011	\$40,000
3	Develop Wireline Interpretation Module	12/01/2009 - 06/30/2012	\$50,000
4	Develop Geologic Characterization Module	1/01/2011 - 09/30/2012	\$50,000
5	Develop Seismic Data Interpretation Module	07/01/2010 - 12/30/2011	\$30,000
6	Develop EM Data Interpretation Module: Integrate with Seismic Module	12/01/2009 - 06/30/2012	\$30,000

Tasks - Overview

Task No.	Task Description	Task Duration	Task Funding
7	Develop Wellbore Manipulation Module	07/01/2010 - 02/30/2012	\$30,000
8	Develop Additional Modules	12/01/2009 - 11/30/2012	\$20,000
9	Application of Program to Site Model	04/01/2012 - 11/30/2012	\$30,000

Project Schedule



Planned

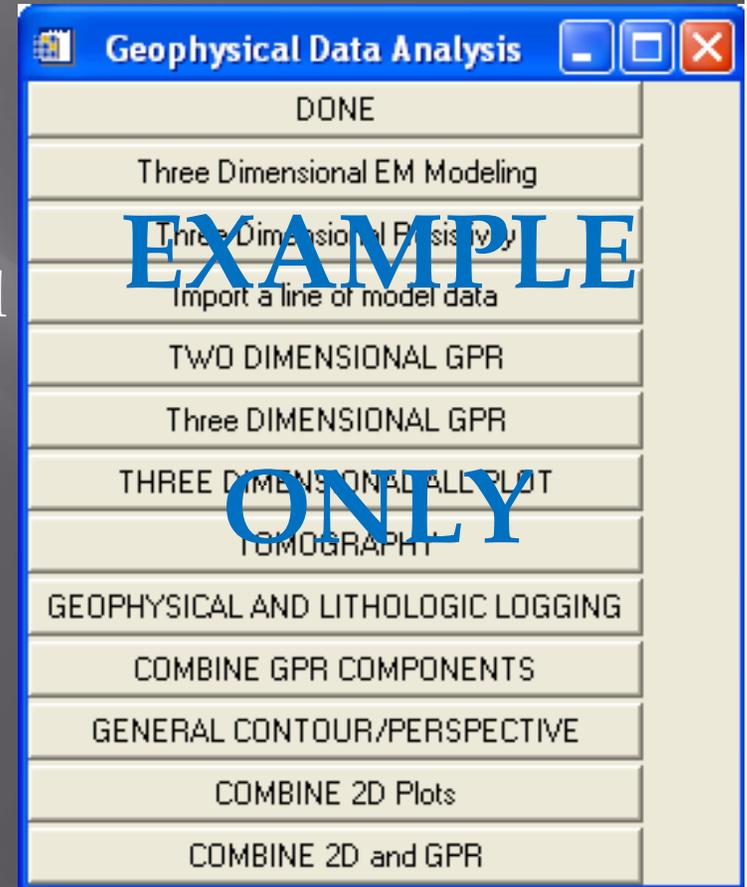


Augmented

Task	Year 1	Year 2	Year 3
1.0 Project Management Plan and Reporting: 12/1/2009 - 11/30/2012	Planned	Planned	Planned
2.0 Develop Top (System) Level Program:	Planned	Augmented	Planned
3.0 Develop a Wireline Interpretation Module:	Planned	Planned	Planned
4.0 Develop Geologic Characterization Module:	Planned	Planned	Planned
5.0 Develop Seismic Data Interpretation Module :	Augmented	Planned	Planned
6.0 Develop Electromagnetic Data Interpretation Module to integrate with the seismic module:	Planned	Planned	Planned
7.0 Develop Wellbore Manipulation Module:	Planned	Planned	Augmented
8.0 Develop Additional Modules:	Planned	Planned	Planned
9.0 Application of Program to Site Model:	Planned	Planned	Planned

Discussion – Task 2

- ▣ Develop Top (System) Level Program
- ▣ Kyle Shalek and Jeff Daniels
- ▣ Task Status: %50 complete
- ▣ Major accomplishments
 - ▣ Main GUI menu is operational to various modules



Discussion – Task 3

- ▣ Develop a Wireline Interpretation Module
- ▣ Jeff Daniels and Mike Murphy
- ▣ Task Status: %50 complete
- ▣ Major accomplishment
 - Fundamental framework established
 - Input digital well log files
 - Wiggle trace display
 - Geologic Symbol Table and Display Developed
 - Logic for Automated Interpretation for multiple logs developed

Discussion – Task 4

- ▣ Develop a Geological Characterization Module
 - Tie together geophysical logs with geological information in a coherent display
- ▣ Jeff Daniels and Mike Murphy
- ▣ Task Status: %25 complete
- ▣ Major accomplishments
 - Obtained geological and geophysical information for site and region

Discussion – Task 5

- ▣ Develop a Seismic Data Interpretation Module
 - Build Seismic Data Interface
 - Validation of Seismic Module
- ▣ Kyle Shalek
- ▣ Task Status: %50 complete
- ▣ Major accomplishments
 - Developed IDL GUI to design 3D seismic property models
 - Successfully input IDL models into Madagascar modeler
 - View output traces

Discussion - Task 5

Design 3D model blocks with:
Multiple seismic property values
Multiple 3D bodies

CONTINUE to Next Step

0.0200000 cell size (m)

2.00000 P-wave velocity of background (km/s)

3.00000 S-wave velocity of background (km/s)

0.00100000 density of background (units)

info 600 number of time steps

0.500000 Dimension in x-dir (km)

0.500000 Dimension in y-dir (km)

0.500000 Dimension in z-dir (km)

1000.00 Freq in MHz

transmit antenna center x location (m)
0.250000

transmit antenna center y location (m)
0.250000

transmit antenna center z location (m)
0.250000

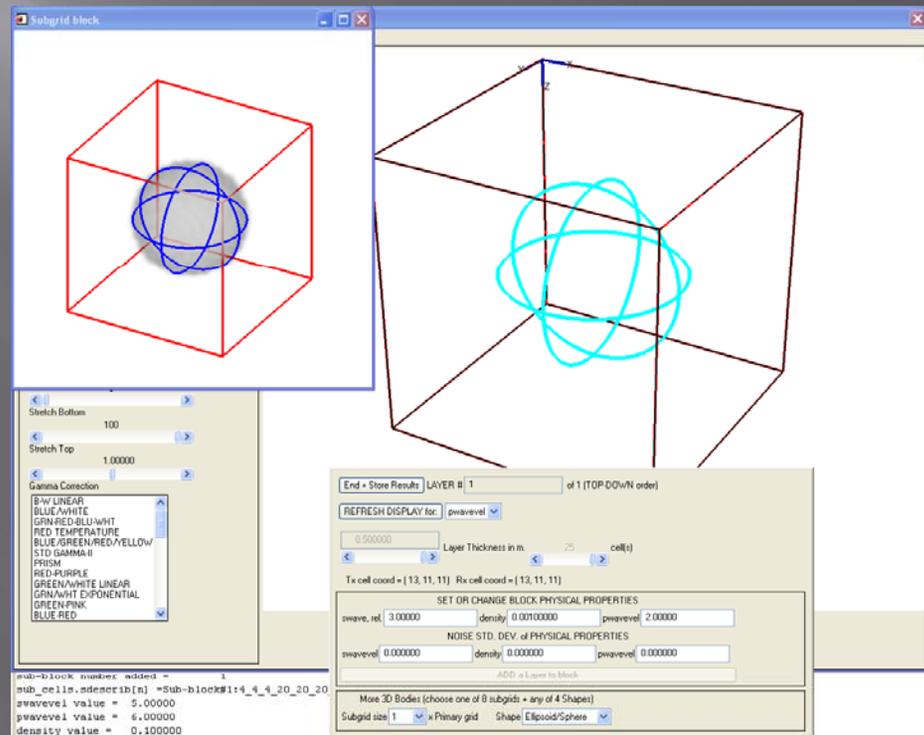
receiver antenna center x location (m)
0.250000

receiver antenna center y location (m)
0.250000

receiver antenna center z location (m)
0.250000

PRISM
RED-PURPLE
GREEN/WHITE LINEAR
GREEN/WHITE EXPONENTIAL
GREEN/PINK
BLUE/WHITE

sub_block number = 1
sub_cell_mdescription = sub-block#1:4_4_20_20_20
swavevel value = 3.00000
pwavevel value = 6.00000
density value = 0.100000



Discussion – Task 5

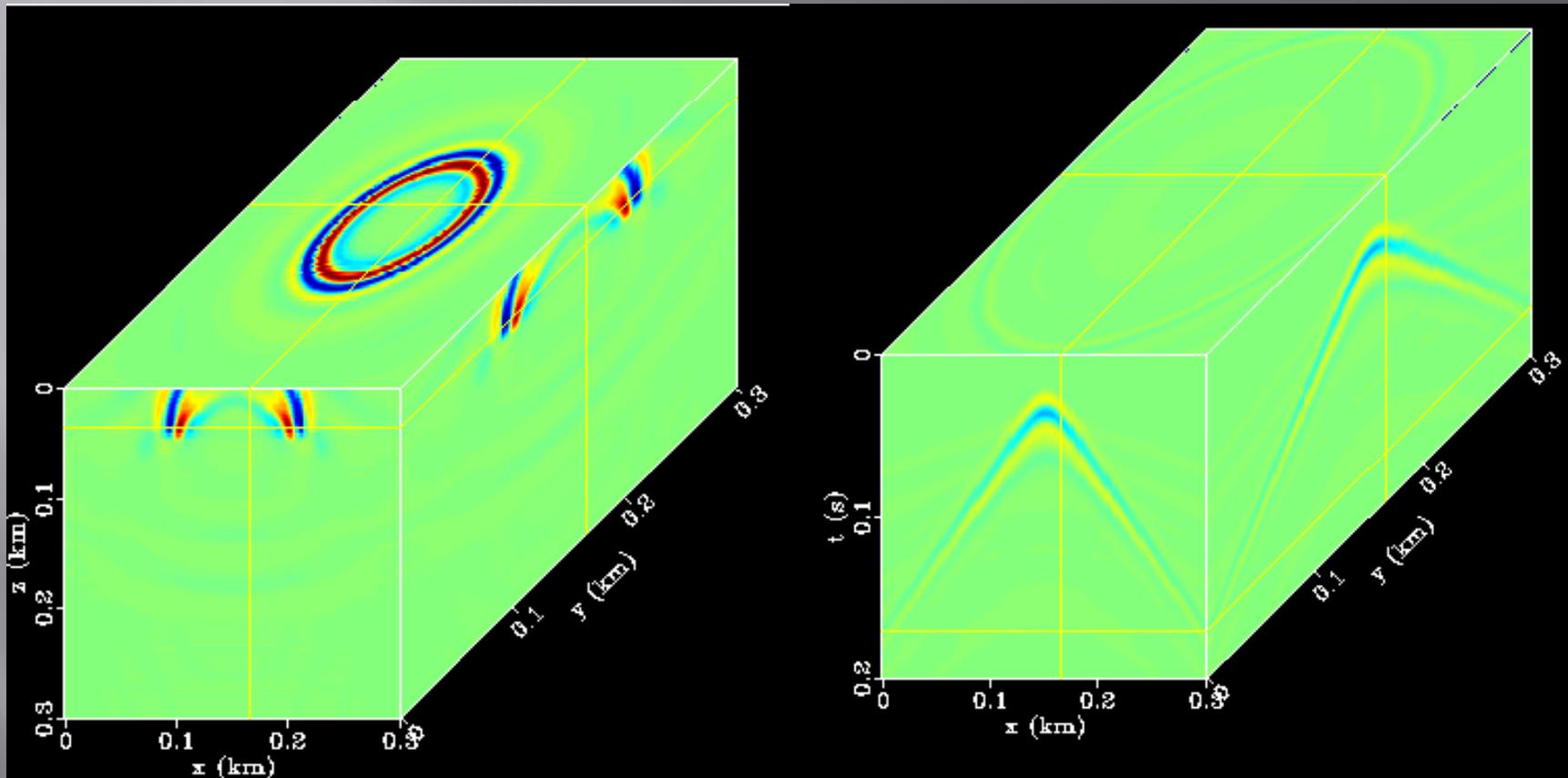


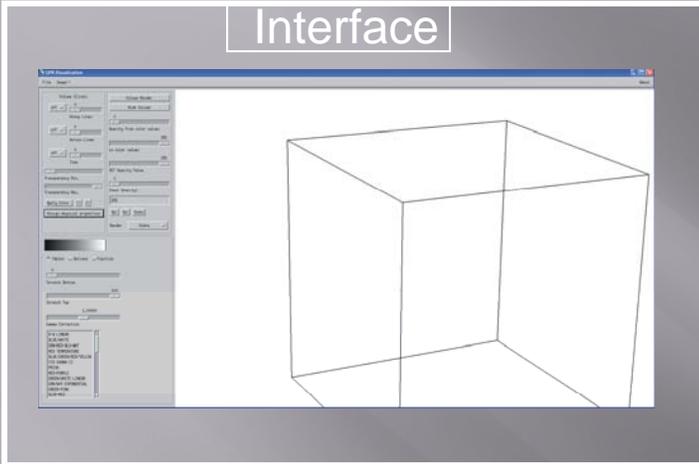
Image the data output from the numerical model calculations

Discussion – Task 6

- ▣ Develop EM Interpretation Module and Integrate with Seismic Module
 - Build EM Data Interpretation Interface
 - Demonstration of EM Module
- ▣ Jeff Daniels and Kyle Shalek
- ▣ Task Status: %75 complete
- ▣ Major accomplishments
 - The EM module is mostly done but contingent upon the completion of the top level program and the seismic module.
 - An overhaul has been completed making the module more fine-tuned and user-friendly.

Discussion - Task 6

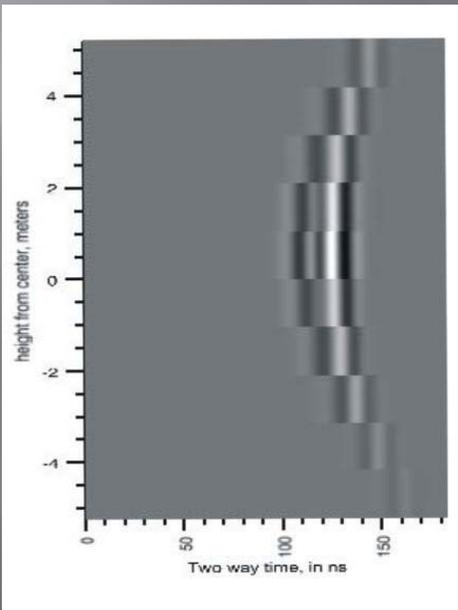
Interface



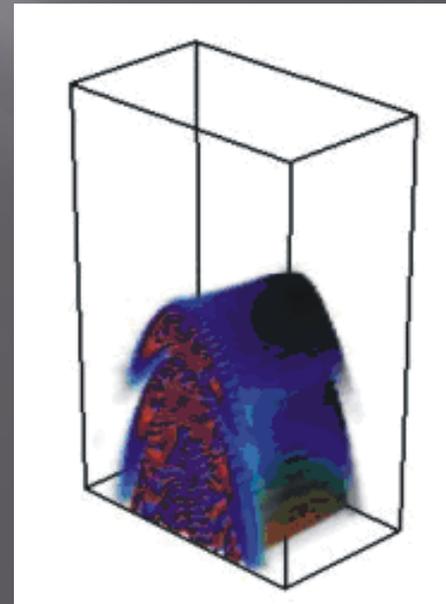
Input to
Computational
Cluster



2D



Output
Plots



3D

Discussion – Task 7

- ▣ Develop Wellbore Manipulation Module
- ▣ Jeff Daniels and Mike Murphy
- ▣ Task Status: %25 complete
- ▣ Major accomplishment
 - Program outline has been developed

Discussion – Task 8

- ▣ Develop Additional Modules
 - ▣ Jeff Daniels, Mike Murphy, Kyle Shalek
 - ▣ Task Status: %0 complete
-
- As the package progresses modules will be developed as needed (MOSTLY INTERFACES FOR MAIN CONTROL, AND POSSIBLE ON-LINE HTML INTERFACE)

Discussion – Task 9

- ▣ Application of Program to Site Model
 - Select a Site: Mountaineer
 - Data Gathering: Seismic and well logs for site and same from OGS for regional perspective
 - Test Software with Field Data
- ▣ Jeff Daniels, Mike Murphy, and Kyle Shalek
- ▣ Task Status: %25 complete

Discussion – Task 9

- ▣ Major accomplishments
 - Selected Mountaineer Injection Site
 - Gained access to various seismic and well log information for site region through AEP and Ohio Geological Survey
 - Began analysis of the data

Project Milestones

Milestone	Planned Completion Date	Actual Completion Date
Development of top level program	03/01/2010	03/01/2010
Development of seismic, EM, and wireline modules	06/01/2010	06/01/2010
Geologic characterization module	09/01/2010	09/01/2010
Completion of top level program	12/30/2011	
Develop additional modules	04/15/2011	

Project Milestones

Milestone	Planned Completion Date	Actual Completion Date
Complete Seismic Interpretation Module	09/01/2011	
Complete Wellbore Manipulation Module	02/01/2012	
Complete EM data interpretation interface & geologic characterization module	05/01/2012	
Complete simulations as applied to field site data	07/15/2012	
Final reporting	09/30/2012	

Anticipated Efforts for the Coming Year

- ▣ Complete Seismic and EM modules
- ▣ Complete top level program
- ▣ Continue Developing Well log modules
- ▣ Analyze the field data we obtained

PI Contact Information

If you have any questions or would be interested in collaboration please contact:

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